Commonwealth
Edison

Byron 1
Confirmation of Design Adequacy for Jet Impingement Effects

August 1984

Commonwealth
Edison

Byron 1
Confirmation of Design Adequacy for Jet Impingement Effects

August 1984

Confirmation of Design Adequacy For Jet Impingement Effects

Executive Summary

This report has been developed in response to questions raised by the NRC Integrated Design Inspection (IDI) Team in their inspection report of September 30, 1983, and the subsequent NRC letters of April 9, 1984, and May 2, 1984. The purpose of this report is to demonstrate the adequacy of the existing design and original design methodology. This report is confirmatory in that no required design changes have been identified as a result of this in-depth review of the effects of jet impingement from postulated High Energy Line Breaks (HELB's).

The Byron station design relies primarily on separation of redundant safe shutdown systems and separation of potential high energy line break locations from safe shutdown systems. This approach of redundancy and separation, applied in accordance with Standard Review Plan Sections 3.6.1 and 3.6.2, has resulted in a design which requires very few special protective features (such as impingement shields) to insure that safe shutdown capability is maintained following a postulated high energy line break.

The body of report is divided into three major parts. The first, Section 3, is an overview of the Byron design approach, explaining the basis and procedures used to accommodate jet impingement effects in the basic layout and arrangement of the Byron station. This Section also includes a partial chronology, by way of selected examples of documentation of the Byron HELB design work from 1974 to the present.

Section 4, Confirmation Study, details the scope and the procedures used to confirm the adequacy of the design. In order to demonstrate that safe shutdown capability would not be lost as a result of a HELB, resulting jet impingement damage, and a limiting single failure, the systems and components used for safe shutdown are identified. The potential for jet impingement damage and the effect on safe shutdown capability is then evaluated.

Section 5 summarizes the results of the study. The results are reported for each type of break. This was done because the systems and components required for safe shutdown are dependent upon the size and location of the break. The conclusions reached in Section 5 are supported by Appendices A,B,C, and D. These Appendices are in-depth evaluations of the potential for jet impingement damage to the safe shutdown systems and components.

Appendix A addresses equipment (pumps, valves, switches, motors, instruments, etc.) both inside and outside of containment. It also addresses cables outside of containment because a "hazard zone" approach was used.

Appendix B addresses the cables inside containment and the instrumentation lines both inside and outside of containment. For instrumentation lines and cables, availability of instruments is reviewed both from the aspect of automatic reactor trip and ESF functions and the necessary post accident monitoring functions.

Appendix C addresses jet impingement effects on piping. This includes the potential effects on piping supports and snubbers.

Appendix D addresses jet impingement on Auxiliary Building and Containment structures. Included is a review of the potential effects of structural failure for those areas where the structure has not been designed for the postulated jet impingement loads.

Each appendix has a clearly defined scope. Components outside containment were evaluated using a "hazard zone" approach. "Hazard zones" are areas with boundaries that will restrict the effects of HELB jets. Safe shutdown equipment in these areas were assumed to be potentially damaged by impingement from HELB's within the area unless it could be easily shown that the energy or orientation of the jet would not result in damage to the specific component. Inside containment, hazard zones can not be defined as easily as in the Auxiliary Building. However, the potential for damage due to jet impingement was evaluated by conservatively considering effects of nearby HELB's. Guidelines for separation of redundant components were utilized in the arrangement of safe shutdown systems to provide protection against loss of multiple components from a single jet. Recent information in NUREG/CR-2913, "Two Phase Jet Loads", and EPRI NP-3492 "Steam-Water Jet Analysis", provides a more realistic basis for predicting the extent of steam and two phase jet impingement.

The specific scope of each appendix is based on the approach used to review the components. Those components which were amenable to a common review procedure were evaluated in a single Appendix regardless of the relationship of the components. Section 5 of the report then draws conclusions about the capability to achieve safe shutdown based on the information in the four Appendices.

These reviews have demonstrated the adequacy of the Byron design with respect to protection against the effects of jet impingement. Separation and redundancy of safe shutdown systems and minimizing the number of high energy lines in proximity to safe shutdown systems has been verified to be an acceptable design approach to provide this protection. No changes in design have been required as a result of these reviews.

ERRATA TO CONFIRMATION OF DESIGN
ADEQUACY FOR JET IMPINGEMENT EFFECTS
AUGUST 1984

PAGE 10

Fourth line from bottom should read:

Main Steam) are expected ...

PAGE 25

First paragraph, 10th line should read:

encompass all events. The list is edited for ...

PAGE 74

Second paragraph, second line should read:

inside the pressurizer enclosure, or on ...

PAGE 77

The first and second lines of the final paragraph of Section 5.2.2.3.1.2 should be replaced with:

In summary, at least three narrow range Steam Generator level instruments on the damaged loop, at least two narrow range Steam Generator level instruments on each of the other loops, at least one RCS wide range pressure instrument, and at least ...

PAGE 78

The first line of Section 5.2.2.3.1.6 should read:

Appendix A demonstrates that the RH suction valves themselves are not affected by ...

PAGE 79

The third paragraph of Section 5.2.2.3.2.2 should read:

The Containment pressure and Main Steam pressure instrumentation are located outside the Containment. The Pressurizer pressure was reviewed for ESF initiation and the wide range RCS pressure, Pressurizer level, narrow range Steam Generator level, Core Exit temperature, and Containment radiation instrumentation were reviewed to confirm that the plant conditions could be monitored.

PAGE A-25

The first sentence in Section 5.15 should read:

> These components are the three redundant pressurizer level transmitters, one of which is required for indication per Reference 8.1.6.

PAGE A-71

Table 1-2, lines 19 and 20, Equipment Numbers should be:

1PSL-AF051
1PSL-AF055

PAGE A-84

Table 3, lines 22 and 39, Equipment Numbers should be:

1PSL-AF051
1PSL-AF055

PAGES A-31 and B-83

Section 5.27 of Appendix A and Section B.3.20 of Appendix B address the Containment radiation monitors 1RE-AR011 and 1RE-AR012. In addition the accident Containment radiation monitors, 1RE-AR020 and 1RE-AR021 should be included in these sections and the tables of instruments and cables. These instruments are located well above all high energy lines in the containment. The cables are routed along the containment wall to electrical penetrations and then into the Auxiliary Building. The cables are not near any postulated high energy line breaks. As a result, the function of 1RE-AR020 and 1RE-AR021 are not affected by jet impingement and the results of the confirmatory study are unchanged.

Byron - 1

Confirmation of Design Adequacy For Jet Impingement Effects

1.0 INTRODUCTION

The design of the Byron station includes extensive separation of redundant mechanical and electrical systems to insure that plant safety will not be compromised by damage resulting from all design basis events including High Energy Line Breaks (HELB), Moderate Energy Line Breaks (MELB), external flooding, fire, tornadoes, and turbine missiles. This confirmatory report specifically addresses the subject of potential jet impingement effects which could result from high energy line breaks. However, the approach used to incorporate separation, redundancy and diversity into the design of the safety systems provides a high degree of protection against all postulated events which could damage safe shutdown equipment.

This report has been developed in response to questions raised by the NRC Integrated Design Inspection (IDI) Team in their inspection report of September 30, 1983 and the subsequent NRC letters of April 9, 1984, and May 2, 1984. It must be emphasized that this report is confirmatory and has not resulted in any changes to the Byron/Braidwood design. The purpose of this report is to demonstrate the adequacy of the existing design and original design methodology.

This report describes the approach taken in the design process and major design features which were incorporated as a result. A complete review of potential jet effects on safe shutdown components has been completed to confirm that the design approach was, indeed, effective in protecting the plant from potential jet impingement effects.

This confirmation study specifically refers to Byron Unit 1. The design approach and basic design which are demonstrated to be adequate are common between all four Byron/Braidwood units.

2.0 DEFINITIONS

Diversity - A plant design feature whereby an independent, non-identical system or component is available in the event of a failure of a system or component.

Emergency Core Cooling System (ECCS) - Those systems which function, in the event of a LOCA, to prevent core damage. This includes the Safety Injection System and portions of the Chemical and Volume Control System and the Residual Heat Removal System.

Hazard Zone - A defined bounded area of the plant to be used to investigate the potential extent of damage and system failure following an event which has a physical effect which may be spatially limited (e.g., fire, HELB, missile generation). The initiating event may or may not be limited to one zone depending upon the nature of the event and the nature of the zone boundaries.

High Energy Line - A pipe line which operates during normal plant operations at temperatures in excess of 200°F and/or pressures in excess of 275 psia. Lines which operate at high energy conditions less than 2% of the system operating time are not considered high energy (Standard Review Plan Section 3.6.2).

High Energy Line Break (HELB) - A location within a piping system where, per the guidelines of Standard Review Plan (SRP) Section 3.6.2, a break is to be postulated.

HELB Zone - A hazard zone which contains a postulated HELB.

Loss of Coolant Accident (LOCA) - A HELB in the piping which forms the boundary of the reactor coolant system. For the purpose of this study large LOCA's are defined as those with a break area of greater than 1.0 ft^2 and small LOCA's are those with a break area less than 1.0 ft^2.

Redundancy - A plant design feature whereby an independent, functionally identical system or component is available in the event of a failure of a system or component.

Safe Shutdown - A plant condition such that:

1) The reactor can be maintained subcritical.

2) Decay heat can be removed.

3) Offsite release in excess of allowable limits is prevented.

Safe Shutdown Component - Any item of structure, equipment, cable, or piping required to maintain integrity or functionality to achieve safe shutdown following at least one postulated event scenario within the plant design basis.

Safe Shutdown Equipment - Mechanical and electrical equipment (e.g., pumps, valves, switches, instruments) required to function to achieve safe shutdown following at least one postulated event scenario within the plant design basis.

Safety Evaluation Report (SER) - The Byron Safety Evaluation Report (NUREG-0876) including Supplements 1, 2, and 3.

Separation - Physical isolation by distance or barrier of a safe shutdown system or component from a redundant component or hazards such as high energy lines.

Single Failure - Arbitrary failure of a single component to perform its safety function following a postulated initiating event. (See Section 4.3)

Standard Review Plan (SRP) - NUREG-75/087. The 1981 revision of the SRP (NUREG-0800) is utilized where it provides clarification into the intent of NUREG-75/087.

3.0 BYRON DESIGN APPROACH

The Byron design includes many features which eliminate or mitigate damaging effects of postulated High Energy Line Breaks (HELB's). This is a result of a design approach which addressed the requirements of General Design Criteria (GDC) 4 of 10CFR50. This design approach followed the guidelines of Branch Technical Position APCSB 3-1 (Section 3.6.1 of Standard Review Plan (SRP) (Reference 1). These guidelines state that plant designs should protect essential systems and components from the effects of high energy line failure. The preferred methods of protection are separation of the essential systems from high energy line breaks by an adequate distance or by structures. In the event these methods cannot be used, redundant design features which are protected should be provided. If these methods are not used restraints or barriers must be provided.

In 1972 and 1973 the Atomic Energy Commission (AEC) issued two letters which are referred to as the Giambusso letter (December 1972) and the O'Leary letter (July 1973). These letters gave criteria for protection against the effects of high energy line breaks and were incorporated into Standard Review Plan Section 3.6.1 (Reference 1). This section specifically refers to protection outside containment but the general guidelines have been applied inside containment also. On August 31, 1973 representatives of Sargent and Lundy attended a meeting with the AEC Directorate of Licensing to clarify the intent of a proposed Regulatory Guide based on the Giambusso and O'Leary letters. Notes of this meeting (Reference 21) clearly show that the intent of these criteria was to protect safe shutdown systems from high energy line breaks by the use of physical separation and remote location. At this meeting, the AEC suggested that a typical percentage of use of the three acceptable approaches (physical separation and remote location; protective structures around pipes; and restraints and other protective measures) might be 99%, 0.8%, and 0.2%, respectively.

The safe shutdown systems and components in the Byron design have been separated from high energy lines and also separated from redundant systems to the extent practicable. As a result, relatively few protective restraints and barriers have been required.

The Byron design approach centered around the early identification of the systems used for safe shutdown and the systems used to support safe shutdown systems. To insure that the safe shutdown functions can be accomplished, these systems are designed with adequate redundancy and functional diversity to insure that postulated events and single failures would not result in a loss of safe shutdown capability. This was accomplished by physically separating the redundant equipment. This separation approach provides a high degree of protection from fire, flood, missiles, and environmental effects as well as HELB effects such as pipe whip and jet impingement. Additional protection from HELB effects was provided by isolating high energy lines from safe shutdown systems. Implementation of this approach is documented in the Byron design files. For particular aspects of the designs, the remainder of this section will describe representative documented examples of the implementation of this design approach.

3.1 Separation of Mechanical Systems

In 1974, a Byron document (Reference 2) was issued entitled "Analytical Procedures for Meeting Separation Criteria and High/Moderate Energy Line Rupture Criteria." In 1975 a project transmittal (Reference 3) transmitted a revision of this document. The purpose of this document was to coordinate an effort to produce color coded drawings to demonstrate that separation was appropriate for high and moderate energy line rupture concerns. Among the effects to be considered were pipe whip, jet impingement, and environmental effects. Color coded drawings were produced by this effort (Reference 4).

A memo, dated February 9, 1976 (Reference 6) transmits to the S&L piping design group these color coded drawings for elevation 364'-0 in the Auxiliary Building and discusses routing of High Energy Lines to avoid affecting essential equipment. Another memo, dated March 26, 1976 (Reference 7), transmits these color coded drawings for elevations 383', 401', and 426' to the piping design group requesting that the high energy line routing be optimized.

At a special project team meeting on High Energy Line Rupture Studies held in 1976 (meeting notes - Reference 5), a variety of topics were discussed including the use of 20 foot separation to protect redundant safe shutdown instrument lines. This use of 20 feet is consistent with electrical separation work as discussed in Section 3.3.

3.2 Jet Impingement Loads on Structures

The above mentioned meeting notes (Reference 5) also discussed various aspects of structural loading. In addition to pressurization loading, procedures for generating and transmitting jet impingement loads on structures were discussed. One point brought out was that certain Auxiliary Building structures need not be designed for jet impingement because of the low forces resulting from Auxiliary Building HELB's.

Reference 8 documents a project decision made to not provide structural concrete walls rather than block walls around a high energy line area because there were no safety related components affected by wall failure.

3.3 Electrical Separation

Electrical separation, both from high energy lines and between the two safety related divisions has been a key design consideration. A design feature which is a key element in this separation is the Containment penetration design. The location of the electrical penetrations at elevations 417'-6" and above as compared to high energy line penetrations which are below elevation 401 allows separation to be maintained in the containment and in the Auxiliary Building Containment penetration area. Within the limitations required to provide service to mechanical equipment, the cables and conduits are routed at the higher plant elevations to provide protection from HELB effects. In the Containment, where the majority of high energy lines are located, the systems are designed to minimize the number of active mechanical components and thereby minimize the amount of safe shutdown cabling.

In accordance with Appendix R of 10CFR50, redundant electrical cables were separated by at least 20 feet in Containment. In 1981, the Safe Shutdown Report was added to the Fire Protection Report (Reference 9). This report shows that redundant safe shutdown cables in the Containment are separated by at least 20 feet. The 20 foot minimum separation used for redundant electrical cables as well as for instrument lines is considered to be adequate separation to protect against common failure from a single HELB.

The logic of using a 20 foot separation was not based on a judgment that jets would not extend for more than 20 feet. Instead it was an assessment of the jet definition per ANS 58.2 (Reference 10) as applied in S&L Technical Procedure #24 (Reference 11) which indicates that a jet, although assumed to be indeterminate in length, is restricted in the area it will cover because expansion is limited by the defined 10° half angle of expansion. Even the jets from very large pipes (e.g., Reactor Coolant and Main Stream) are expected to influence a cylindrical area only about 10 to 12 feet in diameter except at great distances from the break where the force is diminished. The majority of the high energy line breaks are much smaller lines with a potential area of influence only a few feet in diameter. References 19 and 26, based on test data, show that the jet spreads at a rate similar to that used in the Byron design and that the load is reduced with distance much more rapidly than predicted by References 10 and 11. Redundant safe shutdown components separated by over 20 feet inside containment therefore have a very low probability of being aligned such that a break will impinge upon both components without striking an intervening component or structure.

3.4 <u>Identification of High Energy Lines and Break Location</u>

The importance of identifying high energy lines was recognized throughout the design by the Project Team. Mechanical design drawings utilize a symbol (⊖) to identify high energy lines to enable the design engineers to readily identify areas potentially affected by HELB. A list of all High Energy Lines including design conditions was transmitted to the Project Team via Reference 12 in 1976. Reference 12 also notes a change in laundry drier design to eliminate High Energy Lines. High energy lines were also shown more prominently (cross hatched) on a special set of Piping and Instrumentation Drawings and included in the initial issue of the FSAR (Reference 13) in 1978. The identification of high energy lines was reviewed and updated in 1981 (Reference 14).

High Energy Line Break locations which are dependent upon calculated stress levels were not known for most systems at the time the plant layout and major routings were finalized. As a result, a very conservative approach was initially taken in assuming that breaks could occur at any location in the system which could potentially be a break location. In many cases, this was taken to be at all fittings. This led to a very conservative arrangement incorporating a high degree of separation. As the design progressed, more information became available which permitted break locations to be finalized. This information was used to complete detailed design of components such as pipe whip restraints but was not used to relax the plant separation basis. This insured conservatism of the design and limited the impact of as built conditions on the potential for jet impingement damage.

In 1982, break locations were marked on working copies of piping composite drawings (References 15, 22) to aid in evaluation of specific break effects and to confirm HELB protection.

3.5 <u>Safe Shutdown Equipment</u>

The plant layout and system routing was based on separation of redundant safety systems. The separation requirements can be reduced or eliminated in many areas because portions of certain safety related systems are not required following certain specific postulated HELB's. Elimination of separation requirements was not applied to the extent possible in the initial design stage which resulted in a more conservative arrangement. However, lists of safe shutdown components have been developed for various programs in the course of the plant design.

Equipment required for safe shutdown was developed through the Fire Protection Report (FPR) (Reference 9) and environmental qualification work. The FPR safe shutdown analysis contains equipment lists and color coded General Arrangement drawings showing safe shutdown equipment locations. P&I drawings, delineated to show systems required for safe shutdown, were developed and transmitted by S&L to Westinghouse for review in 1981 (Reference 16). In the mechanical equipment environmental qualification program, a list of safe shutdown mechanical equipment was transmitted to Westinghouse for review in 1982 (Reference 17).

4.0 CONFIRMATION STUDY

In order to resolve questions raised by the IDI Team concerning the adequacy of the Byron approach to design against potential jet impingement damage, a confirmatory study has been completed to demonstrate the adequacy of the design. This section describes the basis and procedure used in the confirmation study. Section 5.0 summarizes the results of the study while Appendices A through D are detailed compilations of the results.

4.1 Scope

This confirmation study considers potential jet effects from all postulated high energy line breaks in the Byron Containment and Auxiliary Building. Breaks are postulated following the guidelines of SRP Section 3.6.2. Break locations originally postulated for initial design conservatism but not required per SRP Section 3.6.2 are not included.

Components which might be used to safely shut the plant down following a postulated HELB (as described above) are included as potential jet targets.

4.2 Safe Shutdown Success Criteria

In accordance with the requirements of GDC 4 to protect against the dynamic effects of line break, this study will show that the HELB's in question can be mitigated and the unit brought to a safe shutdown condition. The criteria for achieving safe shutdown are as follows:

1. Reactivity is controlled such that the reactor is subcritical.
2. Mechanisms are provided to remove decay heat.
3. Offsite releases of radioactivity are restricted to the limits of 10CFR100.

4.2.1 Safe Shutdown

The Byron licensing basis is to attain a safe shutdown condition following any accident.

Safe shutdown following a LOCA is defined as attaining cold leg recirculation using only qualified (Safety Related) equipment and instrumentation, and maintaining offsite releases within the regulatory limits. Limiting offsite releases within the regulatory limits is accomplished by maintaining at least one barrier between the radioactivity and the environment (i.e., reactor coolant pressure boundary or reactor containment).

For non-LOCA breaks, safe shutdown is defined as hot standby (T_{avg} greater than or equal to 350 degrees F, zero percent rated thermal power and k_{eff} of less than 0.99). The reactor coolant pressure boundary must be maintained intact using only qualified (Safety Related) equipment.

4.2.2 Cold Shutdown

Since Byron's licensing basis is hot shutdown, it is not necessary to demonstrate capability to reach cold shutdown conditions (reactor coolant temperature less than or equal to 200°F, 0% rated thermal power, and k_{eff} of less than or equal to 0.99) using only safety related equipment. However, the existence of a method for reaching cold shutdown without repair or replacement of equipment has been reviewed and is described in this study. Non-safety related equipment may be used to attain cold shutdown.

4.2.3 Reactivity Control

Sufficient negative reactivity can be provided for hot shutdown by rod insertion with or without a single active failure of a worst case stuck control rod. The Byron Refueling Water Storage Tank (RWST) has sufficient boron concentration to insure that reactivity can be controlled in a cold shutdown condition without use of the boric acid transfer system except in a case which combines an unfavorable core history with a single active failure of a stuck control rod. The additional boration can be achieved through operation of boric acid transfer pumps 0AB03P and 1AB03P to utilize the boric acid tank (1AB03T) as a source of boration. Appendices A and D show that this equipment and required support components are located in an area not subject to HELB effects. Appendix C demonstrates that piping required for boration will not be damaged by HELB. Therefore, this source of boration will be available after any postulated HELB and a single failure of a stuck control rod will not be the limiting single failure for any postulated HELB.

4.2.4 Decay Heat Removal

Decay heat can be removed from the reactor in several ways. The primary mode of heat removal is through the steam generators. The Reactor Coolant (RC) system is designed to transfer heat to the steam generators by natural circulation (if forced flow using RC pumps is not available) in all events except large break LOCA's. Following a large break LOCA event, the core is cooled by the Emergency Core Cooling System (ECCS). No active components inside containment are required to function to remove heat when using either steam generator cooldown or ECCS. Instrumentation inside containment is used to monitor the conditions and system functions, but all pumps and valves (other than check valves) which must function for heat removal are located in the Auxiliary Building or Main Steam Tunnel.

Normal cooldown with the primary system in the natural circulation mode removes heat by supplying cool auxiliary feedwater from the condensate storage tank or the essential service water system to the steam generators and employs the steam generator relief valves to reject heat to the atmosphere. One operable steam generator is adequate to remove decay heat (Reference 23).

The ECCS function is to provide cooling water to the core after a LOCA. The sources of water are the accumulator tanks in containment, the Refueling Water Storage Tank (RWST) located external to the Auxiliary Building, and the containment recirculation sump which collects leakage from the break.

To bring the plant to a cold shutdown condition, the RHR system is normally used. After a non-LOCA HELB, the RHR system will take suction from the Loop 1 or 3 hot leg, cool the fluid in the RHR heat exchangers (transferring heat to the component cooling system) and reinject the fluid into the reactor coolant system cold legs. Following a LOCA, the containment recirculation sump is used as a suction source. The only active mechanical components inside containment used for cold shutdown decay heat removal are the RHR hot leg suction valves. These valves are used only in non-LOCA events.

Other options exist for removal of decay heat. Cool down to cold shutdown conditions can be accomplished by increasing the feedwater level in the steam generators with cooler water. This method eliminates the need for any active equipment inside containment to remove decay heat. This method, although available after a HELB, was not found to be required by the postulated events in the scope of this study.

It is also possible to reach cold shutdown conditions by adding cool water to the reactor vessel via the charging system and removing heat via the letdown system, the excess letdown system, or, if these paths are unavailable, the pressurizer relief valves. This cooldown method (primary system feed and bleed) is included in the Byron Emergency Operating Procedures but is not necessary for any event within the scope of this study.

4.2.5 Offsite Release

To prevent offsite release, a barrier must be maintained between radioactive material such as reactor coolant and the atmosphere. For non-LOCA HELB's, the reactor coolant system boundary forms this barrier. No additional barriers are required. After a LOCA, the containment integrity must be preserved. Systems which penetrate the containment must be isolated if they are open to both the contaminated system (or the containment atmosphere) and the atmosphere outside containment. The Containment Spray System is used to remove radionuclides from the containment atmosphere after a LOCA and to control the sump pH. The Containment Spray, as well as the Reactor Containment Fan Coolers and passive heat sinks, removes heat from the containment atmosphere to maintain containment integrity.

4.3 Single Failure Criteria

The Standard Review Plan (Reference 1) is explicit in its definition of the Single Failure Criteria for high and moderate energy line break. Section 3.6.1 refers in several places to the assumption of a "Single active component failure." This clearly refers to failure of a component which must perform an active (as opposed to passive) function to support operation of a safe shutdown system. Active components are those which must mechanically move or electrically change state to perform the required function. Examples of active components would be pumps which must run, valves which must open or close, transmitters or sensors which must function or switches which must open or close. Examples of passive components are pipes, valves which are not required to function, cables, breakers, and switches which do not change electrical state or mechanical position.

The definition of single failure in 10CFR50 Appendix A is slightly different from that in Reference 1. A footnote to the Appendix A definition indicates that passive failures of electrical equipment should be assumed and that the requirements for single passive failures of fluid systems is under review. Section 3.6.2 of Reference 1 clarifies the fluid systems single failure requirements. Under loss of offsite power conditions the uncertainty about consideration of passive electrical failures is of no significance because a single active mechanical failure (diesel generator failure) causes loss of one electrical division and bounds all potential active and passive electrical failures.

Events which do not result in loss of offsite power are less well defined with respect to single failures. Loss of an entire electrical division would require a passive failure when offsite power is not lost. Although it is believed that the intent of the SRP is to consider failure of a single active component, for the purpose of this confirmatory study, loss of an electrical division as a single failure has been considered.

4.4 Confirmation Procedure

The procedure used to confirm safe shutdown capability varies dependent upon the nature of the component and the area of the plant under investigation. Each of the four appendices treats a different set of components. Some components, by their nature, may be assessed independently of other components. Others, which are dependent upon other components to function in the event of their failure, must be evaluated in relation to other components and systems functions. These potential interactions have been considered as required. This procedure insures that a complete review of potential jet effects on safe shutdown components is performed.

4.4.1 Equipment Outside Containment

Equipment has been classified into equipment which can or cannot be affected by jet impingement based on its spatial relationship to postulated HELB's. For that equipment potentially damaged, the following procedure was used:

1. All equipment in the HELB zone was assumed to be damaged and unavailable as a result of breaks in the specific zone. Cables, as noted in Section 4.4.3 were also assumed to be damaged in this evaluation.
2. A limiting single failure (usually loss of an electrical division) was assumed.
3. If the zone is bounded by walls which are potentially inadequate for predicted jet or pressurization loads, all credible failures outside the zone as a result of wall failure were postulated.
4. The potential damage to systems used for safe shutdown was assessed and tabulated.

In certain locations where the potential jets could be shown not to damage equipment, this procedure was modified to eliminate unnecessary steps. Appendix A describes the results of this process in detail.

4.4.2 Equipment Inside Containment

Relatively little safe shutdown equipment is located inside Containment. The following procedure is used for the equipment inside Containment which could be damaged by jet impingement.

1. The equipment was postulated to be damaged and therefore unavailable.
2. A limiting single failure (usually loss of an electrical division) was assumed.
3. Equipment required to safely shutdown the plant following the postulated HELB and the failures postulated in steps 1 and 2 is located and reviewed for potential jet impingement effects.
4. The potential damage to systems used for safe shutdown was assessed and tabulated.

Appendix A describes the results of this process in detail.

4.4.3 Cables Outside Containment

Electrical cables outside Containment required to support safe shutdown functions are defined and located. Potential damage effects for those cables in HELB zones were assessed at the same time equipment was assessed as described in Section 4.4.1. The results are described in Appendix A.

4.4.4 Cables Inside Containment

Cables inside Containment which support safe shutdown consist primarily of instrumentation cabling with a limited number of power and control cables for valves. Therefore, the cables were evaluated concurrently with the instrumentation lines. For cables associated with equipment potential interactions were reviewed. The following procedure was used:

1. Each safe shutdown function supported by the cable was identified.
2. Required operability to achieve the function was identified.

3. Cable routing with respect to HELB's was reviewed.

4. Potential jet damage was determined.

5. A limiting single failure (usually loss of an electrical division or a Reactor Protection System channel) was assumed.

6. Equipment required to function (given the assumed failures) is reviewed for potential common jet damage.

7. The potential damage to systems used for safe shutdown was assessed and tabulated.

The results of this assessment are described in Appendix B.

4.4.5 Instrument Lines Outside Containment

Safe shutdown instrument lines outside Containment were located and reviewed. None of these lines are located in HELB zones. Therefore, no further assessment was required. (See Appendix B.)

4.4.6 Instrument Lines Inside Containment

Safe shutdown instrument lines inside Containment were located and reviewed in conjunction with cables. The procedure was equivalent to and performed concurrently with the evaluation described in Section 4.4.4. Results of the assessment are reported in detail in Appendix B.

4.4.7 Piping Outside Containment

The potential loads on piping from HELB jet impingement loading outside Containment have been evaluated. For systems other than the Auxiliary Steam and Steam Generator Blowdown, the jet energy is insufficient to cause damage to piping systems. Break locations in the Auxiliary Steam and Steam Generator Blowdown systems do not affect safe shutdown piping. Details of these reviews are included in Appendix C.

4.4.8 Piping Inside Containment

The postulated break locations inside containment were reviewed. Those breaks which could potentially result in jet loads and damage to safe shutdown piping systems were identified, loads were calculated as required, and the effects on piping systems were evaluated. The complete results are included in Appendix C.

4.4.9 Structure Outside Containment

Auxiliary Building and Tunnel Structure which is potentially loaded by jets has been identified. Either the structure has been evaluated and shown adequate or the structure has been shown to be not required for safe shutdown and an evaluation of the effects of failure completed. This is described in detail in Appendix D.

4.4.10 Structure Inside Containment

Break locations inside Containment were reviewed for potential impact on structures. Internal concrete structures were designed for impingement loads if jet loads were possible. Primary structural steel was evaluated if a significant potential jet load was postulated. The details and results of this evaluation are included in Appendix D.

4.4.11 Summary

The above mentioned evaluations were reviewed for postulated HELB events and the safe shutdown capability was assessed. This summary is included in Section 5.1 (Auxiliary Building) and Section 5.2 (Containment).

4.5 Safe Shutdown Systems and Components

Components required to withstand or be protected from the effects of jet impingement have been determined by identifying equipment potentially used to reach safe shutdown, as defined in Section 4.2. It should be noted that, because of the redundancy and diversity of the Byron safety systems design, no single component or system is required for safe shutdown unless failures occur in one or more independent systems. As a result, a unique safe shutdown component list can be established for each postulated combination of initiating event and single failure. To facilitate this confirmatory study, a single list has been established which is intended to encompass all events. The list is modified edited for specific events only if necessary to establish safe shutdown capability.

Safe shutdown systems are those systems which may be used to establish a safe shutdown condition following a postulated accident. The particular systems required for safe shutdown will be a function of the specific HELB and the postulated single failure. Safe shutdown may, in some cases, be reached using a variety of system and subsystem combinations.

4.5.1 Identification of Safe Shutdown Systems

Safe shutdown systems can be categorized in several ways. A group of fluid safety systems insure the capability to remove decay heat. These systems are:

Chemical and Volume Control	(CV)
Safety Injection	(SI)
Residual Heat Removal	(RH)
Auxiliary Feedwater	(AF)

These systems are supported by two fluid support systems:

Essential Service Water	(SX)
Component Cooling	(CC)

To remove heat from the core in non-LOCA events, the Main Steam (MS) and Reactor Coolant (RC, RY) systems must retain the integrity of pressure boundaries and relief valve operability to the extent that decay heat is removed.

For certain severe HELB events, portions of the Reactor Protection System must be operable to initiate mitigation.

Electrical and HVAC support systems are required to insure operability of fluid systems. The Containment Spray (CS) and HVAC systems may be required to control environmental conditions.

The systems listed here have been designed to insure that safe shutdown can be achieved following initiating events which may disable certain portions of safe shutdown systems because of the physical location or system configuration.

4.5.2 Safe Shutdown System Design Features

The Byron station design utilizes systems which consist of two redundant full capacity subsystems. These redundant subsystems are mechanically and electrically independent. Electrically these systems are referred to as "Division 11" and "Division 12" (for Byron 1) and mechanically as "Train 1A" and "Train 1B." In addition to being functionally independent, the subsystems are separated by distance and/or physical barriers when the potential hazards require such separation. This insures that the system is functional after an event that affects one redundant subsystem.

With this separation and independence, an entire system can be disabled only if:

a) The initiating event (HELB) occurs in a safe shutdown subsystem and a single failure occurs in the redundant subsystem;

b) The potential HELB results in jet impingement which disables one safe shutdown subsystem and a single failure occurs in the redundant subsystem.

The design of the safe shutdown systems insure that if either of the two above scenarios can be postulated, another safe shutdown system will be available to perform the required function. Each of the safe shutdown fluid systems will be discussed to demonstrate the plant design approach. The conclusion reached for each of these systems is provided in Section 5.

4.5.2.1 Chemical and Volume Control (CV) System

The CV system is a normally operating system which serves as the high head ECCS system during a LOCA. The CV system operates continuously. Therefore, HELB's are postulated in the CV system in accordance with Section 3.6.2 of the SRP (Reference 1). The system includes two pumps in separate cubicles which are widely separated by both distance and barriers. The CV system contains an additional pump not supplied by emergency power which would be available after an event not involving the loss of offsite power. When operating in the ECCS mode, the CV system does not have active components which must function inside Containment. Therefore, the CV system, although it can suffer a complete failure due to CV system HELB and single failure, is protected from HELB effects in other systems. The Safety Injection (SI) system can be considered a backup system to the CV system because, with complete loss of CV capability, the primary system pressure can be reduced by heat removal via the steam generators or by the Power Operated Relief Valves to the point at which the SI system will operate.

4.5.2.2 Safety Injection (SI) System

The Safety Injection system, since it does not operate during normal plant operating conditions, does not contain HELB's with the exception of the normally pressurized accumulator lines inside Containment. The SI system contains no valves other than check valves which must open to insure the SI system function. The two SI pumps are located in separate cubicles widely spaced in the Auxiliary Building. Therefore, since an initiating event will not disable the SI system and it is protected from HELB's, at least one SI train will remain functional after a HELB due to the system design. Due to the accumulator location and design, at least three accumulators will be available after any LOCA.

4.5.2.3 Residual Heat Removal (RH) System

The RH system is used during normal shutdown operations to remove decay heat and to bring the system to cold shutdown. It is also used as the low head ECCS following a LOCA. The two RH pumps are located in cubicles at a low elevation adjacent to the Containment. High energy lines are not routed near the pumps and the routing of the RH lines (which carry radioactive water) is confined to limited areas of the Auxiliary Building. The components which are potentially vulnerable to effects of HELB inside Containment have been minimized by locating the RHR pumps, heat exchangers, and most valves (all but two loop suction valves in each RHR subsystem) outside Containment. The valves inside Containment are not used after a LOCA.

The RH system is classified as a dual purpose, moderate energy system (Reference 1) because it functions during normal operations and after accidents and it operates at high energy conditions less than 2% of the time. Breaks are not postulated in the RH system. The only active components in the system subject to jet impingement considerations are the loop suction valves. These valves are only affected by LOCA breaks. However these valves are not used post-LOCA.

4.5.2.4 Auxiliary Feedwater (AF) System

The Auxiliary Feedwater (AF) system provides water to the steam generators in the event the main feedwater system is unavailable. The system consists of two redundant pumps, one motor driven and one diesel driven, which are located away from high energy lines with barriers between the two pumps. The systems are designed such that the only active components (other than the pumps) which must function are the instruments and valves used to switch over the suction to the SX system in the event of failure or loss of the condensate storage tank. The AF system is not used during normal plant operations and, in accordance with Section 3.6.2 of the SRP (Reference 1), it is not considered a high energy system and breaks are not postulated. In the event of total loss of the AF system (which would result only from events beyond the design basis), the plant can be safely shutdown by "bleed and feed" of the primary system (Reference 18). This option is not required by any of the events addressed in this report but is mentioned to demonstrate the additional safety margin included in the plant station design.

4.5.2.5 Essential Service Water (SX) System

The Essential Service Water (SX) system is a dual purpose moderate energy system as defined in Section 3.6.1 of Reference 1. As such, the SX system is exempted from single failure if the initiating event is a failure of one of the redundant SX subsystems. However, since the SX system is a moderate energy system and does not experience HELB, the design features provide that jet impingement from a postulated HELB will not disable either SX subsystem. This is provided by the SX system design which isolates active SX components from HELB's and from the redundant SX subsystem.

4.5.2.6 Component Cooling System (CC) System

The Component Cooling (CC) system is also a dual purpose moderate energy system and is subject to the same design considerations as the SX system. In addition to two independent pumps, the CC system contains an additional "swing" pump which can be used on either Byron Unit 1 or Unit 2 and which can be powered by either electrical division.

4.5.2.7 Shared Systems

Advantage has been taken of the two unit Byron station design to provide additional redundancy in the SX and CC systems. These systems include permanent cross connections between Unit 1 and 2 which are normally isolated by valves. Only valve realignment is necessary to utilize equipment from one unit to shut down the other unit. It should be noted, however, that no credit was taken for these features in this confirmatory report and therefore the procedures required will not be discussed here. This capability is mentioned to show the additional safety margin inherent in the Byron design.

4.5.2.8 Containment Spray System (CS) System

The Containment Spray (CS) system is required only after a LOCA. All CS components with the exception of two independent sets of spray headers and nozzles are in the Auxiliary Building.

4.5.2.9 Electrical Systems

The plant safety systems are normally powered by offsite power. If, as a result of an event, this power source is lost, the two electrical safety divisions are automatically connected to the emergency diesel generators. The design basis provides that, in the event of a postulated single failure, at least one of these divisions will remain functional.

4.5.2.10 Reactor Protection/ESF System

The Reactor Protection (RP) system scrams the reactor and initiates appropriate safety systems to mitigate the accident. This action is taken based on data from system instrumentation. The instrumentation systems include either two or four independent channels.

4.5.2.11 HVAC Systems

Containment and Auxiliary Building HVAC is designed with two redundant and independent subsystems for overall HVAC functions. The Auxiliary Building is designed to draw air from safety related rooms and cubicles so that individual supply fan loss will not result in total loss of HVAC. Cubicles containing safety related pumps are cooled by cubicle coolers which are powered by the same electrical division as the pump. The cubicle coolers are fitted with multiple fans so a single fan or cable failure will not cause a complete loss of function.

Postulated Auxiliary Building HELB's are not located in areas where major HVAC supply ducts would be threatened. Jet impingement on supply ducts in cubicles would not result in loss of function because air would still be supplied to the area.

4.6 High Energy Lines

Location and design of high energy lines (HELB's) is an important part of the Byron design. Advantageous routing of these lines has significantly reduced the potential for jet impingement damage.

4.6.1 High Energy Line Definition

High energy lines are defined in Section 3.6.2 of the SRP (Reference 1) as those lines which, in normal plant operations, operate at conditions above 200°F and/or 275 psia for more than 2% of the system operating time. The Byron design purposely limited the number of HELB's in the Auxiliary Building to reduce the hazards associated with these lines. Startup feedwater pumps were installed to insure that Auxiliary Feedwater lines are not required during normal plant operations. Tunnels were designed to contain Main Steam, Feedwater, and Auxiliary Steam lines and to isolate them from safety related equipment.

As a result, in the Byron design, only 6 systems contain piping which qualifies as high energy. These systems are:

Reactor Coolant (RC, RY, SI Accumulators)

Feedwater (FW)

Main Steam (MS)

Chemical and Volume Control (CV)

Auxiliary Steam (AS)

Steam Generator Blowdown (SD)

These 6 systems are designed to minimize the number of areas where safe shutdown systems and equipment could be affected by the results of a high energy line break. This is accomplished by utilizing physical separation (distance and barriers) to isolate safe shutdown systems from high energy lines, and by protective features such as pipe whip restraints and jet impingement shields to restrict or eliminate effects of high energy line breaks.

Only the last 3 of these systems (CV, AS, SD) are located in the Auxiliary Building and the AS and SD routing in safety related areas is very limited.

4.6.2 Containment High Energy Lines

The general Byron approach to routing high energy lines is to route the lines away from safety related systems. In Containment, application of this approach is limited because of the number of high energy lines. However, the routing segregates the four primary and secondary loops and concentrates high energy lines at lower elevations and inside the shield walls. The electrical penetrations are at elevations 417'-6" and above while the high energy lines penetrate Containment at elevation 401 and below. Within the limitations required to provide electrical service to mechanical equipment, the cables and conduit are routed at higher elevations to protect them from HELB effects. The small amount of active safe shutdown equipment in Containment is another design feature which reduces potential problems due to high energy line break effects.

4.6.3 Auxiliary Building High Energy Lines

In the Auxiliary Building, the high energy line routing is very important to the protection of safe shutdown components. Of the six high energy systems, three (Reactor Coolant, Feedwater, Main Steam) are not located in the Auxiliary Building. The Reactor Coolant System is inside Containment while the Main Steam and Feedwater outside of Containment are routed through a pipe tunnel rather than the Auxiliary Building. The Auxiliary Steam System is routed through a tunnel and into rooms in non-safety related areas except for some small lines (2", 50 psia), which are routed in an open area separated from safe shutdown components. The steam generator blowdown system in the Auxiliary Building consists of 3" lines and is routed directly to the blowdown condenser. The CV system is complex and extensive but the charging pumps and let down heat exchangers have been located close to Containment to minimize the area potentially affected by HELB. The charging portion of the CV system is limited in HELB effects by the runout characteristics of the CV pumps while flow limiting orifices inside containment limit the effects of line breaks in the letdown portion of the system.

4.7 High Energy Line Breaks

In the early phase of design, breaks were postulated in high energy systems following Reg. Guide 1.46. This resulted in breaks postulated at locations judged to potentially threaten safe shutdown components. Breaks, for this confirmatory study, have been postulated in accordance with the guidelines of Section 3.6.2 of the SRP (Reference 1). In general, this results in break locations at terminal ends and two intermediate locations of highest stress. All longitudinal breaks are excluded on the basis of the stress level with the exception of one break in each primary loop.

4.7.1 Containment High Energy Line Breaks

Some portion of all high energy systems except the Auxiliary Steam System is inside Containment and breaks are postulated. Most of these breaks are located inside the secondary shield wall and at the lower station elevations.

4.7.2 Auxiliary Building High Energy Line Breaks

Auxiliary Building HELB's are located in a limited number of areas shown on the hazard zone maps (Figures 1 through 5 of Appendix A of this report). The breaks are classified into two groups based on the system the break occurs in and the location in the plant which could be affected. Breaks in the Auxiliary Building include breaks in the Auxiliary Steam system, the Steam Generator Blowdown, and Volume Control system.

4.7.3 Jet Impingement Load Definition

The potential loads and region of influence of high energy line break jet impingement can be defined using the information available in ANS 58.2 (Reference 10), and NUREG-CR/2913 (Reference 19). Jets can be classified as either subcooled, non-flashing liquid jets or two-phase and steam jets.

ANS 58.2 is used to predict liquid jet loads. These jets are predicted from the charging portion of the CV system and the SI system accumulator piping. The CV system lines are pump discharge lines which are limited in discharge flow by the pump runout and the piping configuration. Calculations (Reference 20) demonstrate that the loads from breaks in these lines are relatively low (less than 500 lbf total). The SI accumulator line breaks could potentially result in higher loads because they are fed from a pressure vessel. However, these are located inside Containment such that they do not pose a safe shutdown hazard. These breaks are discussed in detail in Section 5.

NUREG-CR/2913 provides a simplified method for determining loads due to two phase and steam jets. The range of conditions applicable to Byron is covered. Two general conclusions can be reached from the report:

1) Loads decrease rapidly as the break to target distance increases with the jet pressure becoming insignificant at some distance between 5 and 10 pipe break diameters from the break.

2) Loads are lower than predicted by previously used methodologies at distances greater than 1 to 3 pipe break diameters (depending on break conditions).

References 10 and 19 were used to confirm that the Byron design approach has resulted in acceptable protection against the effects of high energy line breaks. When the design was reviewed it was found in many cases that the required components would not be affected by any postulated jets. In these cases, a further review of the separation of redundant components was not performed since adequacy was already demonstrated. Separation of components provides additional protection against HELB and other hazards.

4.7.4 Conservatism in HELB Definition

The break location criteria in Section 3.6.2 of the SRP (Reference 1) is recognized as very conservative both in the location of breaks and the nature of the break postulated (doubled ended guillotine rupture). Recently two programs have been successful at reducing the number of breaks to be postulated to cause dynamic effects on Westinghouse PWR plants. The first is a program to completely eliminate primary loop breaks on the basis that a failure will cause a detectable leak prior to pipe rupture. This has been accepted by the NRC for other Westinghouse PWR's. The second program eliminates intermediate breaks at low stress locations. These locations are referred to as arbitrary intermediate breaks. Deletion of these breaks has been approved at Catawba-2. These revisions to break definition requirements have not been used in this confirmatory report and are noted here to provide an additional perspective with regard to the inherent conservatism of the Byron design approach.

5.0 RESULTS OF CONFIRMATORY STUDY

This section summarizes the results of the individual, detailed confirmatory evaluations included in Appendices A through D of this report. This section categorizes all Auxiliary Building and Containment High Energy Line Breaks (HELB's) according to location and effect on systems and demonstrates that, for these breaks, adequate safe shutdown capability exists.

5.1 Auxiliary Building High Energy Line Breaks

Areas where HELB's are located in the Auxiliary Building and piping tunnels are shown on the Hazard Zone Maps (Figures 1 through 5 of Appendix A). Relatively few areas in the Auxiliary Building are potentially exposed to HELB's and jet impingement. The main steam, feedwater and portions of the auxiliary steam and steam generator blowdown systems are located in piping tunnels which contain no safe shutdown components.

In the Auxiliary Building, high energy portions of the Auxiliary Steam, Steam Generator Blowdown, and Chemical and Volume Control Systems are located in 16 Hazard Zones. Appendix A discusses effects on equipment and cables in these zones. Instrumentation lines are addressed in Appendix B. Appendix C discusses effects on structure. This section will summarize these effects.

5.1.1 Auxiliary Steam Line Breaks

The auxiliary steam (AS) system provides low pressure (50 psig) steam for various plant process uses. The AS system is not a safe shutdown system. It is located in areas near the turbine building and in the radwaste areas. To allow routing of some large diameter AS system piping through the auxiliary building without creating a HELB hazard, a pipe tunnel is used. The following hazard zones are postulated to experience AS system breaks:

Zone 11.2A-0	Recycle Waste Evaporator, Elevation 346'-0
Zone 11.4D-0	Auxiliary Steam Tunnel, Elevation 394'-0
Zone 11.5B-0	General Area, Elevation 401'-0
Zone 14.3-0	Radwaste Evaporator Condenser Rooms, Elevation 401'-0
Zone 14.5-0	Radwaste Evaporator Rooms, Elevation 414'-0.

5.1.1.1 Classification of Breaks

Because all Auxiliary Steam Line breaks are in a non-safety system, the initiating break, itself, does not affect safe shutdown capability.

5.1.1.2 Potential Jet Impingement Damage

No safe shutdown equipment or cables are potentially affected by jet impingement from postulated AS system breaks as discussed in Section 6 of Appendix A. Instrumentation is not adversely affected as shown in Appendix B. Concrete panels and block walls which are potentially impacted by jet impingement have been shown to be adequate or have been shown not to damage safe shutdown systems in the event of failure (Appendix D). Safe shutdown piping is not affected by postulated AS breaks as shown in Appendix C.

5.1.1.3 Single Failure

Safe shutdown systems are not damaged by the postulated AS system breaks. Therefore, loss of an entire safety division can be postulated to bound all potential single failures.

5.1.1.4 Postulated Damage Summary

Based on the above conservative assessment of single failures, one division of safety equipment is postulated to be unavailable for safe shutdown.

5.1.1.5 Safe Shutdown Requirements and Availability

Although shutdown of the plant is not required following the postulated event, shutdown capability will be available as discussed in the following sections.

5.1.1.5.1 Hot Shutdown Requirements

To bring the plant to a hot shutdown condition, the following major system functions are sufficient:

1) 1 Auxiliary Feedwater Train

2) 1 Unfaulted Steam Generator with an Operable Relief Valve

3) 1 Centrifugal Charging Pump or Safety Injection Pump

4) 1 Letdown Path (Normal or Excess)

5.1.1.5.2 Hot Shutdown Capability

One fully functional train of all safe shutdown systems are available following a postulated AS system failure. As a result, there are no restrictions on hot shutdown capability.

5.1.1.5.3 Cold Shutdown Requirements

To bring the plant to a cold shutdown condition, the following additional major system functions are sufficient:

1) 1 Train of Residual Heat Removal

2) 1 Boric Acid Transfer Pump (required only after stuck rod occurrence)

5.1.1.5.4 Cold Shutdown Capability

At least one postulated train of all safe shutdown systems is available following postulated AS system failure. As a result, there are no restrictions on cold shutdown capability.

5.1.2 Steam Generator Blowdown System Breaks

The steam generator blowdown (SD) system consists of lines from each steam generator which are routed from the Containment through the main steam tunnel and the Auxiliary Building to the blowdown condenser. The SD system is not required for safe shutdown. Breaks in the SD system are postulated in the following hazard zones in the auxiliary building.

Zone 11.3A-0 - End of corridor at location 10-Q on elevation 364'-0

Zone 11.3B-0 - Blowdown Condenser Room, Elevation 364'-0

The direct effects of a postulated HELB in the SD system would be a loss of steam generator blowdown capability. This break can be isolated with containment isolation valves. There would be no immediate need to shutdown and no restriction on safe shutdown systems as a result of these postulated breaks.

5.1.2.1 Classification of Breaks

Because the steam generator blowdown system is not a safe shutdown system, the break itself does not affect safe shutdown capability. The break flow is limited by the restricted flow area of valves in the system and can be isolated by the containment isolation valves.

5.1.2.2 Potential Jet Impingement Damage

There are no safe shutdown equipment, instrumentation, or cables in the hazard zones affected by SD system breaks. There is no safe shutdown piping in these zones. The structure is the main steam tunnel structure designed for main steam whip and impingement loads. These loads bound those produced by SD system breaks. Therefore, there will be no structural damage due to jets. Zone 11.3B-0 may suffer block wall damage. This has been reviewed and found not to be a hazard to safe shutdown components.

5.1.2.3 Single Failure

Safe shutdown systems are not damaged by the postulated SD system breaks. Therefore, loss of an entire safety division can be postulated in order to bound all potential single failures.

5.1.2.4 Postulated Damage Summary

Based on the above conservative assessment of single failures, one division of safety equipment will be available for safe shutdown.

5.1.2.5 Safe Shutdown Requirements and Availability

Although shutdown of the plant is not required following the postulated event, the shutdown capability will be available as discussed in the following sections.

5.1.2.5.1 Hot Shutdown Requirements

To bring the plant to a hot shutdown condition, the following major system functions are sufficient:

1) 1 Auxiliary Feedwater Train
2) 1 Unfaulted Steam Generator with an Operable Relief Valve
3) 1 Centrifugal Charging Pump or Safety Inject Pump
4) 1 Letdown Path (Normal or Excess)

5.1.2.5.2 Hot Shutdown Capability

One fully functional train of all safe shutdown systems is available following a postulated SD system failure. As a result, there are no restrictions on hot shutdown capability.

5.1.2.5.3 Cold Shutdown Requirements

To bring the plant to cold shutdown conditions, the following additional major system functions are sufficient:

1) 1 Train of Residual Heat Removal

2) 1 Boric Acid Transfer Pump (required only after stuck rod occurrence)

5.1.2.5.4 Cold Shutdown Capability

At least one functional train of all safe shutdown systems will be available following a postulated SD system failure. As a result, there are no restrictions on cold shutdown capability.

5.1.3 Chemical and Volume Control System Breaks

The chemical and volume control (CV) system is a large and complex system with many functions. However, only a limited portion of the system is considered high energy and only a limited portion of the system is required to safely shut down the plant.

The high energy portions of the CV system are from the charging pump discharge nozzle to the reactor coolant system and to the RC pump seals and the letdown path from the RC system.

A review of all the postulated CV system break locations in the Auxiliary Building results in four categories of breaks with specific effects on the CV system. These types of breaks are:

I: Breaks which affect only one charging pump.

II: Breaks which affect the normal charging flow and/or seal water flow but not the charging (SI) path.

III: Breaks which affect all charging flow.

IV: Breaks in the letdown system.

5.1.3.1 Type I CV System Breaks

These postulated breaks are at the outlet of a charging pump. The locations where these breaks can occur are:

- Zone 11.3C - 1 Positive Displacement Charging Pump room, Elevation 364'-0.
- Zone 11.3D - 1 Centrifugal Charging Pump 1A Room, Elevation 364'-0.
- Zone 11.3G - 1 Centrifugal Charging Pump 1B Room, Elevation 364'-0.

Loss of the Positive Displacement Charging Pump has no effect on the safe shutdown capability of the plant because this pump is not considered safe shutdown equipment. Loss of either Centrifugal Charging Pump will result in one train of charging operable. Total loss of a safe shutdown system does not directly result from these breaks.

5.1.3.1.1 Potential Jet Impingement Damage

Table 4-1 of Appendix A shows that there is no safe shutdown equipment in Zone 11.3C-1 and the only equipment in Zones 11.3D-1 and 11.3G-1 are directly associated with the Charging Pump Train in that zone.

Safe Shutdown Cables in these zones are listed in Table 4-2 of Appendix A and discussed in Sections 6.2.5, 6.2.6, and 6.2.7 of Appendix A. These cables are not associated with equipment required for safe shutdown after these breaks.

Safe shutdown instrumentation and lines are not located in these zones.

These postulated HELB's do not have sufficient force to damage piping or structure. This is discussed in Appendices C and D.

The result of any of these postulated breaks is that the maximum damage to safe shutdown systems would be the loss of one centrifugal charging pump train.

5.1.3.1.2 Single Failure

The limiting single failure combined with these postulated breaks would be loss of the remaining centrifugal charging pump. Although this event would not result in a loss of offsite power, the charging train loss has been conservatively assumed to result from loss of one electrical division.

5.1.3.1.3 Postulated Damage Summary

Based on the above conservative assumptions, both centrifugal charging pumps and one division of all other safe shutdown systems are postulated to be unavailable for safe shutdown procedures.

5.1.3.1.4 Safe Shutdown Requirements and Capability

Following the postulated event, the plant would be maintained in a hot standby condition until charging is restored. However, this section will cover both the capability to maintain hot standby conditions and to proceed to cold shutdown.

5.1.3.1.4.1 Hot Shutdown Requirements

Two options are available to maintain hot shutdown conditions. To maintain high pressure conditions (2250 psig), the following equipment may be utilized as the first option:

1) 1 Auxiliary Feedwater Train
2) 1 Unfaulted Steam Generator with an Operable Relief Valve
3) Pressurizer Heaters
4) 1 Letdown Isolation Valve
5) 1 Train of Component Cooling (to provide RCP Seal Protection)

The pressurizer heaters, although not Class 1E equipment, can be powered by emergency power per the Byron Emergency Operating Procedures (Reference 18).

The second option, which would allow boration and require a reduction in primary system pressure, would use the following equipment:

1) 1 Auxiliary Feedwater Train

2) 1 Unfaulted Steam Generator with an Operable Relief Valve

3) 1 Safety Injection Pump

4) 1 Letdown Path (Normal or Excess)

5) 1 Train of Component Cooling (to provide RCP Seal Protection)

5.1.3.1.4.2 Hot Shutdown Capability

One functional train of safe shutdown systems listed is available following the postulated breaks. As a result, hot shutdown capability is demonstrated.

5.1.3.1.4.3 Cold Shutdown Requirements

Cold shutdown, in addition to the systems discussed above, utilizes the following:

1) 1 Train of Residual Heat Removal

2) 1 Boric Acid Transfer Pump (required only after stuck rod occurrence)

5.1.3.1.4.4 Cold Shutdown Capability

One functional train of the systems listed is available after the postulated HELB's. As a result, cold shutdown capability is not adversely affected.

5.1.3.2 Type II CV System Breaks

The discharge from the charging pumps flows into a common header. Flow may be directed in this header to the normal charging path which feeds the reactor coolant system via the regenerative heat exchanger and also the RC pump seal water system or it may be directed to the ECCS (high head safety injection) path. Breaks which would result in a degradation of both the normal charging path and the seal water flow, but which can be isolated from the SI path, are located in the seal water system and the charging fill path. These breaks are postulated in the following Hazard Zones:

- Zone 11.3H-1 - Containment Piping Penetration Area, Elevation 364/383
- Zone 11.4E-0 - Valve Aisle, Elevation 383'-0.

5.1.3.2.1 Potential Jet Impingement Damage

Table 4-1 of Appendix A lists the safe shutdown equipment in Hazard Zone 11.3H-1. The equipment consists primarily of containment isolation valves. Containment isolation is not required following these postulated breaks as discussed in Section 6.1.2 of Appendix A. The remaining equipment is shown in Section 6.2.8 of Appendix A to not be adversely affected by jet impingement. Safe shutdown instrumentation and lines are not located in these zones (Appendix B).

These postulated HELB's in Zone 11.3H-1 do not have sufficient force to damage piping or structure. This is discussed in Appendices C and D.

Safe Shutdown Cables in Zone 11.3H-1 are listed in Table 4.2 of Appendix A. Jet impingement on equipment and cables will not affect safe shutdown as discussed in Sections 6.1.2 and 6.2.8 of Appendix A.

There are no safe shutdown equipment, cables, instruments, or instrument lines in Zone 11.4E-0 as documented in Appendix A and B.

The location and potential force of these postulated jets in Zone 11.4E-0 provides that structure or piping will not be damaged by jet impingement. This is discussed in detail in Appendices C and D.

5.1.3.2.2 Single Failure

This event would not result in loss of offsite power. However, for conservatism, a loss of one electrical division has been assumed.

5.1.3.2.3 Postulated Damage Summary

Seal injection flow is lost in this event and charging flow is lost until one of three valves (manual valves 1CV8483A, 1CV8483B, or fail closed control valve 1CV121) is closed. One train of all other safe shutdown systems is assumed lost.

5.1.3.2.4 Safe Shutdown Requirements and Capability

Following this postulated event, the plant will be maintained in a stable hot shutdown condition until charging flow is restored. Depending upon the nature of the break, the plant could be returned to power or shut down for repairs.

5.1.3.2.4.1 Hot Shutdown Requirements

Prior to restoration of the charging flow, the following system functions will be adequate to maintain hot shutdown.

1) 1 Auxiliary Feedwater Train
2) 1 Unfaulted Steam Generator with an Operable Relief Valve
3) Pressurizer Heater
4) Letdown Isolation Valve
5) 1 Train of Component Cooling (to provide RCP Seal Protection)

A second option, which would allow boration and require a reduction in primary system pressure, would use the following equipment:

1) 1 Auxiliary Feedwater Train

2) 1 Unfaulted Steam Generator with an Operable Relief Valve

3) 1 Safety Injection Pump

4) 1 Letdown Path (Normal or Excess)

5) 1 Train of Component Cooling (to provide RCP Seal Protection)

5.1.3.2.4.2 Hot Shutdown Capability

The postulated events will not adversely affect the systems required for hot shutdown.

5.1.3.2.4.3 Cold Shutdown Requirements

Cold shutdown, in addition to the systems discussed above and the charging system which can be restored, the following:

1) 1 Train of Residual Heat Removal

2) 1 Boric Acid Transfer Pump (required only after a stuck rod occurrence)

5.1.3.2.4.4 Cold Shutdown Capability

One functional train of the systems listed is available after the postulated HELB's. As a result, cold shutdown capability is not adversely affected.

5.1.3.3 Type III CV System Breaks

These postulated CV system breaks affect both centrifugal charging pumps. All breaks of this type are located in Hazard Zone 11.3H-1, the piping penetration area. One of these breaks is on the common charging pump miniflow line. This break is downstream of the miniflow orifice and also can be isolated by either of two valves in series. Therefore, the miniflow line break has no effect on safe shutdown capability. There are two other breaks on the common charging pump header which supplies the normally closed high head safety injection line. A break in this header would disable the high head SI path and normal charging/seal injection path.

This event would not result in loss of offsite power. Closure of one of three valves (manual valves 1CV8483A, 1CV8483B, or control valve 1CV121) will allow the positive displacement charging pump to function normally supplying charging and seal injection flow.

An alternate procedure would use closure of one of the above mentioned valves, closing manual valve 1CV8485A or 1CV8485B, and opening 1CV8387A or 1CV8387B. This would isolate the break and allow centrifugal charging flow to bypass the break and supply charging and seal water injection flow.

5.1.3.3.1 Potential Jet Impingement Damage

The safe shutdown equipment located in Zone 11.3H-1 is listed in Table 4-1 of Appendix A. The equipment consists primarily of containment isolation valves. Containment isolation is not required following these postulated breaks as discussed in Section 6.1.2 of Appendix A. The remaining equipment is shown in Section 6.2.8 of Appendix A to not be adversely affected by jet impingement. No safe shutdown instrumentation or lines are located in this zone.

Safe shutdown cables in Zone 11.3H-1 are listed in Table 4-2 of Appendix A. Jet impingement will not affect safe shutdown cables for this event as discussed in Sections 6.1.2 and 6.2.8 of Appendix A.

The location and potential force of these jets provides that no structure or piping will be damaged by jet impingement. This is discussed in detail in Appendices C and D.

5.1.3.3.2 Single Failure

The limiting single failure for this case would be loss of the Positive Displacement Charging Pump which would eliminate charging flow until valves are realigned. However, since the positive displacement pump is not safe shutdown equipment, no credit will be taken for its operation and a limiting single failure of one train of safe shutdown systems due to loss of an electrical division will be assumed.

5.1.3.3.3 Postulated Damage Summary

Seal injection and charging flow are lost until valves are realigned. One train of safe shutdown systems is lost.

5.1.3.3.4 Safe Shutdown Requirements and Capability

Following the postulated event, the plant can be maintained in a stable hot shutdown condition until charging flow is restored. The plant can then be restored to power. Although there is no need to achieve a cold shutdown condition, the capability will be evaluated.

5.1.3.3.4.1 Hot Shutdown Requirements

Prior to restoration of the charging flow, the following system functions will be adequate to maintain hot shutdown.

1) 1 Auxiliary Feedwater Train
2) 1 Unfaulted Steam Generator with an Operable Relief Valve
3) Pressurizer Heater
4) Letdown Isolation Valve
5) 1 Train of Component Cooling (to provide RCP Seal Protection)

A second option, which would allow boration and require a reduction in primary system pressure, would use the following equipment:

1) 1 Auxiliary Feedwater Train
2) 1 Unfaulted Steam Generator with an Operable Relief Valve
3) 1 Safety Injection Pump

4) 1 Letdown Path

5) 1 Train of Component Cooling (to provide RCP seal protection)

5.1.3.3.4.2 Hot Shutdown Capability

The postulated events will not adversely affect the systems required for hot shutdown.

5.1.3.3.4.3 Cold Shutdown Requirements

Cold shutdown, in addition to the systems discussed above and the charging system, which can be restored, utilizes the following:

1) 1 Train of Residual Heat Removal

2) 1 Boric Acid Transfer Pump (required only after a stuck rod occurrence).

5.1.3.3.4.4 Cold Shutdown Capability

One functional train of the systems listed will be available after the postulated HELB's. As a result, cold shutdown capability is not adversely affected.

5.1.3.4 Type IV CV System Breaks

Postulated CV system breaks in the letdown line are the only high temperature CV breaks in the Auxiliary Building. The letdown flow is reactor coolant. To limit the potential release of radioactivity in the event of a break the letdown line is designed with flow restricting orifices inside containment. This system is routed from the containment penetration to the letdown heat exchanger. Postulated breaks are located in the following hazard zones:

- Zone 11.3H-1 - Piping Penetration Area, Elevations 364'-0/383'-0
- Zone 11.2B-0 - Letdown Reheat Heat Exchanger Room

- Zone 11.4C-1 - Letdown Heat Exchanger Room
- Zone 11.4D-1 - Letdown Heat Exchanger Room
- Zone 11.4F.0 - Valve Aisle

Safe shutdown systems are not affected as a direct result of this break since the charging system remains functional to supply seal water injection and charging flow. The letdown line must be isolated to prevent release of reactor coolant to the Auxiliary Building. This is accomplished by closure of any one of the isolation valves inside and outside containment or one of three valves inside containment which are designed to fail closed.

5.1.3.4.1 Potential Jet Impingement Damage

There are no safe shutdown equipment or cables in Zones 11.2B-0 and 11.4D-1. Zones 11.4C-1 and 11.4F-0 contain cables which are associated with the Train 1A Centrifugal Charging pumps.

Safe shutdown equipment in Zone 11.3H-1 is listed in Table 4-1 of Appendix A and cables in Zone 11.3H-1 are listed in Table 4-2 of Appendix A. The equipment consists primarily of containment isolation valves. Isolation is required only on the broken letdown line. The postulated letdown line breaks do not affect the letdown isolation function as demonstrated in Section 6.2.8.4 of Appendix A.

Safe Shutdown instrument lines are not affected as discussed in Appendix B.

The location and potential force of these jets provide that no structure or piping required for Safe Shutdown will be damaged by jet impingement. This is discussed in detail in Appendices C and D.

5.1.3.4.2 Single Failure

This event would not result in loss of offsite power. However, for conservatism, a loss of one electrical division has been assumed.

5.1.3.4.3 Postulated Damage Summary

The postulated event would result in loss of normal letdown. If the cables in Zones 11.4C-1 or 11.4F-0 are damaged Charging Pump 1A may eventually be unavailable with loss of an electrical division, charging will be unavailable.

5.1.3.4.4 Safe Shutdown Requirements and Capability

Following the postulated event, the plant would not be required to shutdown. If shutdown was required, normal procedures would be used except the excess letdown system would be used in place of the normal letdown and charging may not be available.

5.1.3.4.4.1 Hot Shutdown Requirements

The following system functions will be adequate to maintain hot shutdown conditions:

1) 1 Auxiliary Feedwater Train

2) 1 Unfaulted Steam Generator with an Operable Relief Valve

3) 1 Charging Train

or

1 Safety Injection Train and 1 Train of Component Cooling (to provide RCP Seal Protection).

5.1.3.4.4.2 Hot Shutdown Capability

The postulated events will not adversely affect the systems required for hot shutdown.

5.1.3.4.4.3 Cold Shutdown Requirements

Cold shutdown, in addition to the systems discussed above and the charging system which can be restored, utilizes the following:

1) 1 Train of Excess Letdown

2) 1 Train of Residual Heat Removal

3) 1 Boric Acid Transfer Pump (required only after a stuck rod occurrence)

5.1.3.4.4.4 Cold Shutdown Capability

One fully functional train of the systems listed will be available after the postulated HELB's. As a result, cold shutdown capability is not adversely affected.

5.2 Containment Building High Energy Line Breaks

In the Containment, HELB's are postulated in the Reactor Coolant System (RC, RY), the Chemical and Volume Control System (CV), the Main Steam System (MS), the Feedwater System (FW), the Steam Generator Blowdown System (SD) and the high pressure portion of the SI (Accumulator) System. Breaks in these systems will be categorized according to the effects of the initiating failure and the functions required to mitigate the break and safely shut down the plant. Breaks which cause a LOCA are all classified as Reactor Coolant breaks regardless of the specific system identification of the failed piping.

Postulated break locations are primarily located inside the secondary shield wall and at the lower elevations in the containment. With the exception of the CV letdown line (with break flow limited by orifices), LOCA's are located inside the secondary shield wall.

5.2.1 Safe Shutdown Systems

Systems used for safe shutdown following a HELB inside Containment may be required for all, part, or none of the postulated events. The need for some of the systems is based on availability of other systems. Some of the more important safe shutdown systems can be shown to be unaffected by any postulated HELB's inside containment as a result of the design of the systems. In this section, uses and design features of safe shutdown systems are summarized. Those systems or system functions which are shown to be available after all HELB's will not then be repetitiously discussed for each type of break.

5.2.1.1 Main Steam (MS) System

Following a HELB, the MS System is used in conjunction with the AF System to remove decay heat. The steam generator relief valves and/or safety valves are used to release steam to the atmosphere. The valves are located in the valve room of the Main Steam Tunnel. No equipment, instruments, and cables required for the MS System Function are located inside the containment. This can be seen in Appendices A and B. Appendix C demonstrates that MS piping inside containment will not be damaged by jet impingement. Appendix D demonstrates that jet impingement will not damage structure resulting in an effect on the MS System. From this information it is concluded that jet impingement will not impair the safe shutdown function of the Main Steam System. The MS System will be available for all break cases examined in Section 5.2.2.

5.2.1.2 Feedwater (FW) System

The FW System has no active components inside containment. The only required function of the FW System following a HELB in containment is to provide a secondary (steam) system pressure boundary. Appendices A and B demonstrate that FW equipment, instrumentation, and cables are not adversely affected by jet impingement following HELB's inside containment. Appendix C demonstrates that FW piping will not be damaged by jet impingement in the Containment. Appendix D demonstrates that Containment structure will not be damaged by jet impingement and affect the FW System. From this information, it is concluded that jet impingement will not impair the Safe Shutdown Function of the FW System. The FW System will fulfill its safety function for all break cases examined in Section 5.2.2.

5.2.1.3 Essential Service Water (SX) System

The SX System has only one safety function which includes components inside the containment. This is the cooling water supply to the Reactor Containment Fan Coolers (RCFC's). There are no active components inside Containment. Appendices A and B demonstrate that equipment, instruments or cables required to supply SX water to the RCFC's are not located in the Containment. Appendix C demonstrates that SX piping will not be damaged by jet impingement in the Containment. Appendix D demonstrates that structure inside Containment will not be damaged and cause SX System damage because of jet impingement. From this information, it is concluded that jet impingement inside Containment will not impair the Safe Shutdown Function of the SX System. The SX System will fulfill its safety function for all break cases examined in Section 5.2.2.

5.2.1.4 Containment Spray (CS) System

The CS System is used only following a LOCA. The CS System will remove heat from the Containment atmosphere and control the concentration of radionuclides in the Containment atmosphere both by washing the atmosphere and by controlling the Containment sump pH. As is demonstrated by Appendices A and B, CS system equipment, instrumentation, and cables required for Safe Shutdown are not located in Containment. Appendix C demonstrates that CS piping in the Containment will not be damaged by LOCA's. Appendix D demonstrates that structure inside Containment will not be damaged and cause CS System damage because of jet impingement. From this information it is concluded that jet impingement inside Containment will not impair the Safe Shutdown Function of the CS System. The CS System will fulfill its safety function for all break cases examined in Section 5.2.2.

5.2.1.5 Residual Heat Removal (RH) System

The RH System functions in two distinct modes following a HELB inside Containment. Following a LOCA, the RH pumps serve as low head ECCS pumps, initially taking suction from the Refueling Water Storage Tank (RWST) and subsequently from the Containment Sump (recirculation mode). Following a LOCA, RH System equipment, instrumentation, and cables inside containment, as demonstrated by Appendices A and B, are not required for safe shutdown. Appendix C demonstrates that RH piping used for safe shutdown is not damaged by jet impingement. Appendix D demonstrates that structure inside Containment will not be damaged and cause RH System damage because of jet impingement. From this information it is concluded that jet impingement following a LOCA will not impair the Safe Shutdown Function of the RH System. The RH System will fulfill its safety function for all break cases examined in Section 5.2.2.

Following a non-LOCA HELB the RH System may be utilized to achieve cold shutdown. The RH System is not used to achieve safe shutdown in these non-LOCA HELB events. Appendices A and B list only the RH loop suction valves and associated cables as inside Containment components used for cold shutdown after these events. Appendix C demonstrates that RH piping used for safe shutdown is not damaged by jet impingement. Appendix D demonstrates that structure inside Containment will not be damaged and cause RH System damage because of jet impingement. For the non-LOCA break cases examined in Section 5.2.2, the potential effects on operability of the RH suction valves are reviewed and resolved.

5.2.1.6 Reactor Coolant (RC/RY) System

The RC System is considered to include the primary system portion of the RY System and all others which attach to the primary coolant system. The RC System performs its safety functions of heat removal and prevention of radioactive releases by natural circulation. Hence it has no active components. Appendices A and B demonstrate that RC equipment and cables are not required for safe shutdown. Instrumentation is addressed with the ESF System (Section 5.2.1.10). RC piping is addressed in Appendix C to demonstrate that break propagation does not exceed guidelines in Reference 25. Appendix D demonstrates that structure inside containment will not be damaged and cause RC System damage because of jet impingement. For each break case in Section 5.2.2, the potential effects on integrity of the RC System are reviewed and resolved.

5.2.1.7 Safety Injection (SI) System

The SI System includes injection paths to supply water to the RC System from the centrifugal charging pumps, safety injection pumps, and residual heat removal pumps. The SI System is used following LOCA's. Appendices A and B demonstrate that equipment, instruments, and cables required for the safety function of the SI System are not located in the containment. Appendix D demonstrates that structure inside containment will not be damaged and cause SI System damage because of impingement. Appendix C demonstrates that SI piping required for a specific event will not be damaged by jet impingement in that event. The adequacy of the piping design is addressed for each of the break cases examined in Section 5.2.2.

5.2.1.8 Chemical and Volume Control (CV) System

The CV System inside Containment consists of the normal charging, seal injection and letdown paths. Appendices A and B include an assessment of equipment, instruments, and cables used for safe shutdown. Appendix C includes an assessment of the piping used for safe shutdown. Appendix D demonstrates that structure inside Containment will not be damaged and cause CV System damage because of jet impingement. Jet impingement effects on the CV System are addressed in each of the break cases examined in Section 5.2.2.

5.2.1.9 Component Cooling (CC) System

The CC System has only one function inside Containment which may be required for safe shutdown. This is supply of cooling water to the Reactor Coolant Pumps (RCP's) thermal barriers. In the event, seal injection (CV System) flow is interrupted in a non-LOCA event, the CC flow to the thermal barrier insures seal integrity and prevents leakage of primary coolant. As demonstrated in Appendices A and B, the only equipment, instrumentation or cables associated with the CC system and located inside containment are involved with CC system isolation. Appendix C addresses the potential for common failure of the seal injection function and CC piping. Appendix D demonstrates that structure inside containment will not be damaged and cause CC system damage. Jet impingement effects on the CC system are addressed in each of the non-LOCA break cases examined in Section 5.2.2.

5.2.1.10 ESF/Reactor Trip

Following a HELB, automatic reactor trip and safety system initiation will occur as required based on signals from qualified instrumentation. After the automatic functions are initiated, manual actions are taken by the plant operators based on qualified instrument readings and the Byron Emergency Operating Procedures. Each type of accident will cause a unique response of the reactor and Steam System and therefore requires a different set of functional instruments for automatic actions and monitored output for manual actions. Appendix B demonstrates that, for the breaks postulated in containment, ESF/Reactor Trip instrumentation will be available as required. This is summarized for each type of break in Section 5.2.2.

5.2.1.11 Containment Isolation

Fluid Systems which penetrate Containment but do not have a safety function following a LOCA are automatically isolated following the break if high Containment pressure or radiation signals are generated. Appendix A demonstrates that containment isolation valves cannot be directly disabled by LOCA jets with the exception of the RH suction and CV (letdown) valves. Both of these systems are designed to contain radioactive fluid and have redundant isolation valves. Appendix B demonstrates that cables required for operation of isolation valves are not damaged by jet impingement caused by LOCA's. Appendices A and B, together, demonstrate that the necessary containment isolation will be achieved if piping between the Containment boundary and isolation valves remains intact. Appendix C demonstrates that piping between Containment isolation valves and the Containment boundary will not be damaged by jet impingement caused by LOCA's. Appendix D demonstrates that structure inside Containment will not be damaged by jet impingement and affect the Containment isolation function. From this information, it is concluded that Containment isolation will be achieved following postulated LOCA's.

5.2.1.12 Off Gas (OG) System

The OG System is designed to remove airborne radioactivity from the Containment atmosphere following a LOCA. Appendix A demonstrates that the OG System equipment (valves) in Containment will not be affected by jet impingement from postulated LOCA's. Appendix B demonstrates that cables and instrumentation required for function of the system will not be damaged by jet impingement from postulated LOCA's. Appendix C demonstrates that OG piping will not be damaged by jet impingement from postulated LOCA's. Appendix D demonstrates that structure inside containment will not be damaged by jet impingement and cause damage to the OG System. From this information, it is concluded that the OG System is not adversely affected by jet impingement.

5.2.1.13 HVAC Inside Containment

The HVAC System inside Containment consists of the Reactor Containment Fan Coolers (RCFC's). The RCFC's are supplied with cooling water by the Essential Service Water (SX) and Chilled Water (WØ) Systems. Only the SX is required after a HELB. The Containment Spray system provides a backup means of heat removal for the Containment. The availability of SX water has been addressed in Section 5.2.1.3. The RCFC fans and housings are addressed in Appendix A where it is demonstrated postulated jet impingement will not affect this equipment. Cables required to operate the RCFC's are demonstrated in Appendix B not to be damaged by postulated jet impingement. The only required piping is the SX piping which has been addressed in Section 5.2.1.3. Appendix D demonstrates that structure inside Containment will not be damaged by jet impingement and cause damage to the RCFC's. From this information, it is concluded that Containment HVAC will be functional following any HELB inside Containment. Containment cooling will be assumed operable for the break cases addressed in Section 5.2.2.

5.2.1.14 Auxiliary Feedwater (AF) System

The Auxiliary Feedwater System is used to supply water to the steam generators to remove decay heat either to remain in a hot standby condition or to proceed toward cold shutdown. The AF System contains no active components inside containment. Appendices A and B demonstrate that all equipment, instrumentation, and cables required for the AF Function are located outside containment. Appendix C demonstrates tha the piping inside containment used for the AF Function will not be damaged by jet impingement. Appendix D demonstrates that structure will not be damaged by jet impingement and cause damage to the AF System. From this information it is concluded that jet impingement from postulated

HELB's inside containment will not impair the safe shutdown function of the Auxiliary Feedwater System. The Auxiliary Feedwater System will be available in all break cases examined in Section 5.2.2.

5.2.2 Summary of Jet Impingement Effects

In this section, the postulated HELB's inside Containment will be classified according to the break effects and the systems and components required for subsequent safe shutdown. For each type of break, the systems required and the potential effects of jet impingement are reviewed. Single failure is considered and the resulting safe shutdown capability is reviewed to insure that jet impingement for HELB's inside Containment will not adversely affect safe shutdown.

5.2.2.1 Types of HELB's Inside Containment

The postulated HELB's inside Containment have been classified into LOCA and non-LOCA events. LOCA's have been divided into three types: Large Liquid LOCA's, Small Liquid LOCA's, and Steam Space (Pressurizer) LOCA's. The non-LOCA HELB's have been divided into six types: Main Feedwater, Main Steam, Bypass Feedwater, Charging, Steam Generator Blowdown, and Safety Injection (Accumulator).

5.2.2.2 LOCA

LOCA's are those HELB events which result in a loss of primary coolant to the Containment. LOCA's which occur in liquid lines result in a two phase blowdown while those occurring in steam lines result in steam release. LOCA's may or may not be isolable depending upon break location.

5.2.2.2.1 Large Liquid LOCA's

Large liquid LOCA's are defined as those breaks with an area of greater than 1.0 ft^2. These breaks occur in the main loops of the Reactor Coolant system and the pressurizer surge line. These breaks result in a large release of primary coolant to the Containment and a rapid depressurization of the primary system.

5.2.2.2.1.1 Safe Shutdown Requirements

To bring the plant to a safe shutdown condition following a large liquid LOCA, the reactor must be tripped and necessary plant parameters monitored. Containment isolation as required to prevent offsite release must be accomplished. Heat must be removed from the Containment atmosphere and decay heat must be removed from the reactor vessel. To insure that the event stays within the analyzed design basis, break propagation must be controlled as described in Westinghouse Design Criteria SS 1.19 (Reference 25).

Table 2.6.1 of Appendix B lists the instrumentation required for ESF initiation and for monitoring after the event. Pressurizer pressure and containment pressure signals will trip the reactor and initiate containment isolation and Emergency Core Cooling (ECCS). In addition, the wide range Reactor Coolant System (RCS) pressure, the Containment pressure, the Main Stream pressure, the Refueling Water Storage Tank (RWST) level, and Containment Radiation level are used to monitor the plant conditions.

Following this event, the CS system is used to cool the Containment and cleanse the Containment atmosphere. The RCFC's are also used to cool the Containment. The OG system may be used as a long term containment atmosphere cleanup system.

Initial and long term decay heat removal is provided by the ECCS System operating initially in an injection mode (RWST) and ultimately in a recirculation mode (containment sump). For this event, the SI accumulators are required (three injecting and one spilling through break) to reflood the core as well as one of the following three systems or combinations of systems to replace core coolant boil-off:

a. one train of the residual heat removal system, or

b. one train of the high head safety injection system in conjunction with the use of one residual heat removal pump and one residual heat exchanger (of the same train as the high head safety injection system) to provide suction from the sump, or

c. one train of the charging/safety injection system in conjunction with the use of one residual heat removal pump and one residual heat exchanger (of the same train as the charging/safety injection system) to provide suction from the sump.

5.2.2.2.1.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged and affect the function of safe shutdown systems. Appendix C demonstrates that jet impingement from large liquid LOCA's will not damage piping required for safe shutdown after the event. As a result, there will be no interaction of postulated structural and piping failures with equipment, cables, and instrumentation.

The piping review confirmed that large liquid LOCA's will not cause propagation to other loops or to the secondary (steam) system and that the required fluid systems inside Containment will not be damaged. In particular, the ECCS piping was reviewed to confirm that damage would be confined to the faulted loop and that SI pump discharge lines would not be affected upstream of runout orifices.

The only equipment inside Containment used in this postulated accident are the instrument sensors and transmitters listed in Section 5.2.2.2.1.1 and the Containment isolation valves. Appendix A includes a summary of the potential for jet impingement damage to these instruments and valves. The Containment pressure, Main Steam pressure, and RWST level are located outside containment and the Containment Radiation Sensors are not affected by jet impingement. The pressurizer pressure transmitters are located outside the secondary shield and are not affected by large LOCA's. Appendix B shows that the pressurizer pressure cables are not affected by LOCA's and that a break in a sensing line will result in reactor trip (low pressure). The containment isolation valves and the necessary cables are addressed in Appendices A and B and shown to not be adversely affected by jet impingement.

The RC system wide range pressure transmitters and cables are located outside the secondary shield and are not affected by large break LOCA's. The sensing lines are near LOCA break locations and it has been conservatively assumed that one sensing line could fail as a result of jet impingement.

In summary, the maximum loss of function of safe shutdown components from large liquid LOCA jet impingement would be loss of one RCS wide range pressure transmitter.

5.2.2.2.1.3 Single Failure

The limiting single failure in this event would be loss of one of four Reactor Protection System (RPS) channels. Loss of an electrical division would result in loss of one train of safety systems but the safe shutdown capability would not be impaired since one train would remain functional. Loss of one RPS channel could disable the remaining RCS wide range pressure sensor.

5.2.2.2.1.4 Safe Shutdown Capability

After the postulated failures and the single failure discussed above, the plant will have all safe shutdown systems available with the possible exception of wide range RCS pressure. In the unlikely event that a LOCA jet disabled one channel of the wide range RCS pressure and the other was rendered inoperable because of a single active failure, the ECCS would still operate automatically and the RCS pressure could be inferred from the ECCS pump performance.

As a result of NRC I.E. Bulletin 79-06, in 1982, design changes were initiated to add wide range RCS pressure instrumentation at the first refueling outage. This equipment will be installed and routed such that at least one channel will be operable after any postulated HELB and single failure.

5.2.2.2.1.5 Cold Shutdown Requirements

No additional components inside Containment are required for cold shutdown.

5.2.2.2.1.6 Cold Shutdown Capability

Cold shutdown capability is not adversely affected by jet impingement because the components required inside Containment are a subset of those addressed for hot shutdown in Section 5.2.2.2.1.4.

5.2.2.2.2 Small Liquid LOCA's

Small liquid LOCA's are those with a break area of less than 1.0 ft^2. These breaks are similar in effects to the large breaks except the rate of break flow, RC system depressurization, and Containment pressurization are all slower. The wide range of break sizes add to the total list of components which could be used because of the variety of options available to shut down. These breaks are located in the lines connected to the reactor coolant loops. Most are located in short sections of piping between the loop and an isolation valve. The RC loop bypass piping and the RTD manifold piping is longer but is located between the hot and cold legs of the loop which restricts the breaks to an area near the faulted loop. The only small liquid LOCA break outside the secondary shield is in the letdown line. The effects of this break are minimized due to the flow restricting orifices in the line.

5.2.2.2.2.1 Safe Shutdown Requirements

To bring the plant to a safe shutdown condition following a small liquid LOCA, the reactor must be tripped and necessary plant parameters monitored. Containment isolation must be accomplished as required to prevent offsite releases. Heat must be removed from the Containment atmosphere and decay heat must be removed from the reactor vessel. To limit the severity of the event, break propagation must be restricted.

Table 2.6.1 of Appendix B lists the instrumentation required for ESF initiation and for monitoring after the event. Pressurizer pressure and containment pressure signals will trip the reactor and initiate Containment isolation and Emergency Core Cooling (ECCS). In addition, the wide range RCS pressure, Containment pressure, Main Steam pressure, RWST level, Pressurizer level, narrow range Steam Generator level, Core Exit temperature, and Containment Radiation level are used to monitor the plant conditions.

Following this postulated event, the CS system may be used to cool the Containment and cleanse the Containment atmosphere. The RCFC's are also used to cool the Containment. The OG system may be used as a long term Containment atmosphere cleanup system.

Initial and long term decay heat removal is provided by the ECCS system operating initially in an injection mode (RWST) and ultimately in a recirculation mode (containment sump). For most of these postulated events, the secondary system (steam generators) will remove decay heat also. For these events, the required flow to the reactor vessel is dependent upon break size. For the smallest breaks, the centrifugal charging pumps operating in the safety injection mode can maintain the RC system inventory. For larger breaks, the accumulators (three injecting and one spilling through the faulted line) may be required. Therefore, availability of the accumulators and one train of charging/safety injection, high head safety injection, and residual heat removal was evaluated.

5.2.2.2.2.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged by jet impingement and affect the function of safe shutdown systems. Appendix C demonstrates that jet impingement from small liquid LOCA's will not damage piping required for safe shutdown after the event. As a result, there will be no interaction of postulated structural and piping failures with equipment, cables, and instrumentation.

The piping review confirmed that small liquid LOCA's will not cause failures in other RC loops, the other leg of the same loop, or the secondary (steam) system within the limits defined by Westinghouse Design Criteria SS1.19 (Ref. 25). The ECCS piping was reviewed to confirm that damage would be confined to the faulted loop, SI pump discharge lines would not be affected upstream of the runout orifices, and breaks in lines smaller than 4" in diameter would not affect the charging/safety injection lines.

The only other components inside Containment used in this postulated accident are the instrument sensors and transmitters listed in section 5.2.2.2.2.1 and the Containment isolation valves. Appendix A includes a summary of the potential for jet impingement damage to these instruments and valves. The Containment pressure, main steam pressure, and RWST level instruments are located outside Containment and the Containment Radiation Sensors are not affected by jet impingement because of location. The pressurizer pressure transmitters are located outside the secondary shield and are not affected by LOCA's. Appendix B shows that pressurizer pressure cables are not affected by LOCA's and that a break in a sensing line will result in reactor trip (low pressure).

The RC system wide range pressure transmitters and cables are located outside the secondary shield and are not affected by small liquid LOCA's. The sensing lines are near LOCA break locations and it has been conservatively assumed that one sensing line could fail as a result of jet impingement.

The pressurizer level transmitters are located outside the secondary shield wall. The transmitters themselves and the cables will not be affected by jet impingement from small LOCA's as shown in Appendices A and B. Appendix B demonstrates that at least two transmitters will have undamaged sensing lines after any postulated HELB.

The narrow range steam generator level transmitters and cables are located outside the secondary shield wall and are unaffected by LOCA's. For this event one of the three steam generators in the unfaulted loops is required. Appendix B demonstrates that at least two level sensors will be operable in each of the three steam generators in unfaulted loops.

The core exit thermocouple cables routed through the Containment are located such that no postulated jets will affect the cables. The thermocouples themselves are located in the reactor vessel.

The only Containment isolation valves potentially affected by LOCA jet impingement are the valves on the RH suction and CV letdown lines. These lines are designed to transport radioactive fluid outside Containment. Isolation is not required to prevent offsite release.

In summary, following a small liquid LOCA, the only components needed for safe shutdown which could be damaged are the instruments and associated lines and cables. As discussed above, the instruments used for ESF initiation are not affected by jet impingement from these breaks. Instruments used for monitoring have been shown to have at least two redundant channels available with the exception of the wide range RCS pressure transmitters.

5.2.2.2.2.3 Single Failure

The limiting single failure in this event would be loss of one of four Reactor Protection System (RPS) channels. Loss of an electrical division would result in loss of one train of safety systems but the safe shutdown capability would not be impaired since one train would remain functional. Loss of one RPS channel could disable the remaining RCS wide range pressure sensor.

5.2.2.2.2.4 Safe Shutdown Capability

After the postulated failures and the single failure discussed above, the plant will have all safe shutdown systems available with the possible exception of wide range RCS pressure. In the unlikely event that a LOCA jet disabled one channel of the wide range RCS pressure and the other was rendered inoperable because of a single active failure, the ECCS would still operate automatically and the RCS pressure could be inferred from the ECCS pump performance.

As a result of NRC I.E. Bulletin 79-06, in 1982, design changes were initiated to add wide range RCS pressure instrumentation at the first refueling outage. This equipment will be installed and routed such that at least one channel will be operable after any postulated HELB and single failure.

5.2.2.2.2.5 Cold Shutdown Requirements

No additional components inside Containment are required for cold shutdown.

5.2.2.2.2.6 Cold Shutdown Capability

Cold shutdown capability is not adversely affected by jet impingement because the components required inside Containment are a subset of those addressed for hot shutdown in Section 5.2.2.2.2.4.

5.2.2.2.3 Steam Space LOCA's

These LOCA's are postulated to occur when a pipe attached to the upper portion of the pressurizer is ruptured. This type of break can occur in the pressurizer spray line, the pressurizer Power Operated Relief Valve (PORV) lines, and the pressurizer safety valve lines. The mass flow rate is less from these breaks than an equivalent liquid break because of the reduced density of the steam.

5.2.2.2.3.1 Safe Shutdown Requirements

To bring the plant to a safe shutdown condition following a steam break LOCA, the reactor must be tripped and necessary plant parameters monitored. Containment isolation as required to prevent off-site release must be accomplished. Heat must be removed from the containment atmosphere and decay heat must be removed from the reactor vessel. As discussed in Westinghouse Design Criteria SS1.19, these breaks are allowed to cause additional primary steam breaks but should not cause liquid LOCA or secondary system breaks.

Table 2.6.1 of Appendix B lists the instrumentation required for ESF initiation and for monitoring after the event. Pressurizer pressure and containment pressure signals will trip the reactor and initiate containment isolation and Emergency Core Cooling (ECCS). In addition, the wide range RCS pressure, the Containment pressure, the Main Steam pressure, the RWST level, the narrow range Steam Generator level, the Core Exit temperature, and containment radiation are used to monitor the plant conditions.

Following this event, the CS system is used to cool the Containment and cleanse the Containment atmosphere. The RCFC's are also used to cool the Containment. The OG system may be used as a long term Containment atmosphere cleanup system.

Initial and long term decay heat removal is provided by the ECCS operating initially in an injection mode (RWST) and ultimately in a recirculation mode (Containment sump). The secondary system (steam generators) is available to remove heat also since the reactor vessel will not be drained. As was noted for the small liquid breaks, the SI components used are, to some extent, dependent on the break size and the rate and extent of primary system depressurization. The accumulators and one of the pumps (Charging, Safety Injection or RHR) are adequate to maintain RCS Inventory. The SI system, as noted in Section 5.2.1, is designed such that required equipment or instrumentation is not located inside Containment.

5.2.2.2.3.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged by jet impingement and affect the function of safe shutdown systems.

Appendix C demonstrates that jet impingement from steam LOCA's affects only pressurizer steam piping which is not required to remain functional after this event. As a result, there will be no interaction of postulated structural and piping failures with equipment cables and instrumentation.

These steam breaks are all located either at the top of the pressurizer, inside the pressurizer, enclosure or on the pressurizer spray line on the pressurizer side of the spray valves. Of the equipment, cables, and sensing lines required, only the pressurizer pressure instrumentation lines are located in this area. As shown in Appendix B, damage to pressurizer pressure instrumentation lines will result in reactor trip (low pressure).

5.2.2.2.3.3 Single Failure

The limiting single failure in this event would be loss of one electrical division. This would disable one redundant train of each of the safety systems.

5.2.2.2.3.4 Safe Shutdown Capability

After the postulated failures and single failure discussed above, all required safe shutdown systems will be operable. The postulated failure of the pressurizer pressure line will still result in reactor trip and ESF initiation.

5.2.2.2.3.5 Cold Shutdown Requirements

No additional components inside containment are required for cold shutdown.

5.2.2.2.3.6 Cold Shutdown Capability

Cold shutdown capability is not adversely affected by jet impingement because the components required inside Containment are a subset of those addressed for hot shutdown in Section 5.2.2.2.3.4.

5.2.2.3 Non-LOCA HELB's

HELB's which do not result in a loss of primary coolant occur in the secondary coolant system (Main Steam, Feedwater, Steam Generator Blowdown) and the systems which serve the primary system (charging, Safety Injection). For these events, decay heat is removed via the Auxiliary Feedwater and Main Steam Systems (see Sections 5.2.1.1 and 5.2.1.2). Because the primary coolant boundary is intact, the Containment isolation function is not required.

5.2.2.3.1 Main Feedwater Line Break

The Main Feedwater lines are four 16-inch lines which supply the four steam generators. Breaks are located in the Containment penetration area, near the steam generators inside the secondary shield wall, and at one elbow just outside the secondary shield wall. The postulated break causes a reduction in level and pressure in one steam generator, and an increase in Containment pressure.

5.2.2.3.1.1 Safe Shutdown Requirements

To reach a safe shutdown condition following the event, the reactor must be tripped and plant conditions must be monitored. Heat must be removed from the Containment atmosphere and decay heat must be removed from the reactor coolant system. The break must be confined to the secondary system and not cause a release of primary coolant.

Table 2.6.1 of Appendix B lists the instrumentation required for ESF initiation and for monitoring after the event. Main Steam Pressure and narrow range Steam Generator level provide the signals which trip the reactor and initiate ESF functions. Although the Containment will be isolated on high Containment pressure, this is not necessary following a non-LOCA event. Containment pressure is used to monitor the plant conditions, as well as wide range RCS pressure, Pressurizer level, and Core Exit temperature. Containment radiation is monitored to verify the HELB is not a LOCA.

The RCFC's remove containment atmosphere heat. The Containment Spray System, although it is available as a backup heat removal system, is not required. One functional Auxiliary Feedwater train and one functional steam generator will remove decay heat to maintain hot standby conditions.

5.2.2.3.1.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged and affect the function of safe shutdown systems. Appendix C demonstrates that jet impingement from Feedwater line breaks will not damage piping required from safe shutdown after these events. As a result, there will be no interaction of postulated structural and piping failures with equipment, cables, and instrumentation.

The piping review in particular confirmed that the postulated Feedwater line breaks would not cause a LOCA either by impingement on an RC system line or by impingement on seal injection and component cooling lines to the RC pump seals and that the postulate Feedwater line would not result in piping failures in other secondary system loops.

Appendices A and B demonstrate that the RCFC fans, motors, coils and cables will not be damaged by jet impingement from a Feedwater line break. The only other components inside Containment used after these events are instruments and associated lines and cables.

Narrow range steam generator level has two functions: ESF initiation and monitoring steam generator performance during cooldown. Appendices A and B demonstrate that the location and routing of the transmitters, lines, and cables is such that, following a Feedwater line break, at least three transmitters will be functional on the damaged loop and at least two transmitters will be functional on the other three loops.

Wide range RCS pressure transmitters and sensing lines were evaluated in Appendix B which demonstrates that a transmitter will not be damaged by a feedwater line break and the only sensing line near a feedwater line break is outside the secondary shield, near the 16" feedwater line to the loop C Steam Generator. These breaks are restrained and review of the predicted pipe movements has established that the postulated jets will not affect the RCS wide range pressure instrumentation.

Appendices A and B demonstrate that at least two pressurizer level instruments will be available following any HELB. The core exit thermocouples are also shown to not be affected by HELB jet impingement.

The Main Steam pressure, Containment pressure, and Containment radiation instrumentation are located outside the containment and are not affected by Feedwater line breaks inside Containment.

In summary, at least three narrow range Steam Generator level instruments, at least one RCS wide range pressure instrument, and at least two of the other instruments inside containment used to monitor the plant will be undamaged following a postulated Main Feedwater line break. No other system functions are affected.

5.2.2.3.1.3 Single Failure

The limiting single failure, since all postulated failures are in the instrumentation, would be the failure of one of four RPS channels.

5.2.2.3.1.4 Safe Shutdown Capability

After the postulated failures and single failure discussed above, the plant will have all required safe shutdown systems available.

5.2.2.3.1.5 Cold Shutdown Requirements

The RH system is the normal method used to cool the plant to a cold shutdown condition. The only components inside Containment used for cold shutdown which are not used in achieving hot standby are the RH suction valves from the RC loops.

5.2.2.3.1.6 Cold Shutdown Capability

Appendix A demonstrates that the valves themselves are not affected by non-LOCA jet impingement. If the valves are inoperable due to loss of cables, power, or a single failure, they would be manually operable after containment temperatures and pressures have been reduced by the Containment HVAC system.

5.2.2.3.2 Main Steam Break

The main steam breaks occur only at the top of the steam generator enclosures and in the main steam pipe chase and containment penetration area. These breaks do not occur inside the secondary shield wall.

5.2.2.3.2.1 Safe Shutdown Requirements

To reach a safe shutdown condition following this event, the reactor must be tripped and plant conditions must be monitored. Heat must be removed from the containment atmosphere and decay heat must be removed from the reactor coolant system. The break must be confined to the secondary system and not cause a release of primary coolant.

Table 2.6.1 of Appendix B lists the instrumentation required for ESF initiation and for monitoring after the event. Main Steam and Pressurizer pressure reductions and containment pressure increase will cause reactor trip. The containment will also be isolated but this is not necessary following this non-LOCA event. Additional parameters which are monitored are wide range RCS pressure, Pressurizer level, narrow range Steam Generator level, Core Exit temperature, and Containment radiation.

The RCFC's remove containment atmosphere heat. The Containment Spray System, although it is available as a backup heat removal system, is not required following a main steam break.

One functional Auxiliary Feedwater system train and one functional steam generator will remove decay heat after a Main Steam line break.

The charging and safety injection systems, which can be used to maintain RC system volume and boration level during shutdown, contain only piping components inside containment.

The other systems used for safe shutdown are not located in the Containment.

5.2.2.3.2.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged and affect the function of safe shutdown systems. Appendix C demonstrates that jet impingement from Main Steam line breaks will not damage piping required for safe shutdown after these events. As a result, there will be no interaction of postulated structural and piping failures with equipment, cables, and instrumentation.

Appendices A and B demonstrate that the RCFC fans, motors, coils, and cables will not be damaged by jet impingement from a Main Steam line break. The only other safe shutdown components inside Containment used after these events are instruments and associated lines and cables.

The Containment pressure, Main Steam pressure, and Containment radiation instrumentation are located outside the Containment. The Pressurizer Pressure was reviewed for ESF initiation and the wide range RCS pressure, Pressurizer level, narrow range Steam Generator level, and Core Exit temperature were reviewed to confirm that the plant conditions could be monitored.

Appendix B demonstrates that no more than one Pressurizer pressure transmitter is potentially affected by a Main Steam break. As a result, at least three channels will be available.

Appendices A and B demonstrate that for any postulated HELB, at least two channels of the Pressurizer level and narrow range Steam Generator level on unaffected loops will be functional.

The Core Exit Thermocouples and cables are shown in Appendices A and B to be unaffected by HELB's. The wide range RCS pressure instrumentation is shown in Appendix B to be unaffected by Main Steam breaks.

5.2.2.3.2.3 Single Failure

The limiting single failure, since all postulated failures are in the instrumentation, would be failure of one of four RPS channels.

5.2.2.3.2.4 Safe Shutdown Capability

After the postulated failures and single failure discussed above, the plant will have all required safe shutdown systems available.

5.2.2.3.2.5 Cold Shutdown Requirements

The RH system is the normal method used to cool the plant to a cold shutdown condition. The only components inside Containment used for cold shutdown which are not used in achieving hot standby are the RH suction valves from the RC loops.

5.2.2.3.2.6 Cold Shutdown Capability

Appendix A demonstrates that the valves themselves are not affected by non-LOCA jet impingement. If the valves are inoperable due to loss of cables, power, or a single failure, they would be manually operable after containment temperatures and pressures have been reduced by the Containment HVAC system.

5.2.2.3.3. Bypass Feedwater Line Break

Postulated breaks in these lines are located in the Steam Generator enclosures and the Containment penetration area. These breaks are in 6-inch lines and would initially release two phase fluid but, as the steam generator level drops, would become a steam break.

5.2.2.3.3.1 Safe Shutdown Requirements

To reach a safe shutdown condition following this event, the reactor must be tripped and plant conditions must be monitored. Heat must be removed from the Containment atmosphere and decay heat must be removed from the reactor coolant system. The break must be confined to the secondary system and not cause a release of primary coolant.

Table 2.6.1 of Appendix B lists the instrumentation required for ESF initiation and for monitoring after the event. Containment pressure, Main Steam pressure, and the narrow range RCS temperature RTD's will provide input to trip the reactor. The Containment pressure, Main Steam pressure, wide range RCS pressure, Pressurizer level, narrow range Steam Generator level, Core Exit temperature, and Containment radiation will be used to monitor the plant condition.

The RCFC's remove Containment atmosphere heat. The Containment Spray System, although it is available as a backup heat removal system, is not required following a Feedwater Bypass line break.

One functional Auxiliary Feedwater system train and one functional steam generator will remove decay heat after a Feedwater Bypass line break.

The charging and safety injection systems, which can be used to maintain RC system volume and boration during shutdown, contain only piping components inside Containment.

The other systems used for safe shutdown are not located in the Containment.

5.2.2.3.3.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged and affect the function of safe shutdown systems. Appendix C demonstrates that jet impingement from Feedwater Bypass line breaks will not damage piping required for safe shutdown after these events. As a result, there will be no interaction of postulated structural and piping failures with equipment, cables, and instrumentation.

Appendices A and B demonstrate that the RCFC fans, motors, coils, and cables will not be damaged by jet impingement from a Feedwater Bypass line break. The only other safe shutdown components inside Containment used after these events are instruments and associated lines and cables.

The Containment pressure, Main Steam pressure, and Containment Radiation instrumentation is located outside Containment. The location and routing of the instrumentation for wide range RCS pressure, Pressurizer level and Core Exit thermocouples is such that Feedwater Bypass lines will not affect them. The narrow range Steam Generator level instrumentation is not affected for the three Steam Generators other than the damaged loop. No more than one of four Steam Generator level channels is affected on the damaged Steam Generator.

5.2.2.3.3.3 Single Failure

The limiting single failure for this event would be either loss of an electrical division or loss of a RPS channel.

5.2.2.3.3.4 Safe Shutdown Capability

With loss of one Steam Generator level instrument on the damaged loop and loss of one RPS channel or electrical division, the plant can be shut down normally following a Feedwater Bypass line break.

5.2.2.3.3.5 Cold Shutdown Requirements

The RH system is the normal method used to cool the plant to a cold shutdown condition. The only components inside Containment used for cold shutdown which are not used in achieving hot standby are the RH suction valves from the RC loops.

5.2.2.3.3.6 Cold Shutdown Capability

Appendix A demonstrates that the valves themselves are not affected by non-LOCA jet impingement. If the valves are inoperable due to loss of cables, power, or a single failure, they would be manually operable after containment temperatures and pressures have been reduced by the Containment HVAC system.

5.2.2.3.4 Charging Line Break

Charging line breaks occur only on the normal charging and seal injection lines upstream of the isolation valves at the RC system and RC pump connections. Other postulated Chemical and Volume Control (CV) System piping breaks will result in a loss of reactor coolant and were addressed in Section 5.2.2.2.2 (Small Liquid LOCA's).

5.2.2.3.4.1 Safe Shutdown Requirements

Following a charging line break, the reactor will not be automatically tripped because no ESF signal will be generated. To bring the plant to a safe shutdown condition normal plant procedures can be used. Charging is still available because two of three paths (Normal, Charging/SI, Seal Injection) will remain functional.

The RCFC's remove Containment atmosphere heat. The normal Feedwater system or one Auxiliary Feedwater train in conjunction with at least one functional Steam Generator will remove decay heat. To prevent seal damage, if the break is in the seal injection system, damage to the component cooling supply to the RC pump thermal barriers must be prevented.

Table 2.6.1 of Appendix B lists the instrumentation to be available for monitoring after the break. The Containment pressure, Main Steam pressure, and Containment radiation instrumentation are outside of the containment. Equipment, cables, and/or sensing lines for the wide range

RCS pressure, Pressurizer level, narrow range Steam Generator level, and Core Exit temperature are located inside Containment.

5.2.2.3.4.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged and affect the function of safe shutdown systems. Appendix C demonstrates that jet impingement from charging line breaks will not damage piping. As a result, there will be no interaction of postulated structural and piping failure with equipment, cables and instrumentation.

Appendices A and B demonstrate that the RCFC fans, motors, coils, and cables will not be damaged by jet impingement from a charging line break. The only other safe shutdown components inside containment used after this event are instruments and associated lines and cables.

Table 2.6.1 lists the instruments monitored during shutdown. The Containment pressure, Main Steam pressure, and Containment radiation instrumentation are located outside Containment. Appendices A and B demonstrate that at least two channels of the Pressurizer level and narrow range Steam Generator level on each Steam Generator will be available after any HELB. The wide range RCS pressure and Core Exit temperature are demonstrated to be unaffected by charging line breaks.

5.2.2.3.4.3 Single Failure

The limiting single failure for this event would be either loss of an electrical division or loss of a RPS channel.

5.2.2.3.4.4 Safe Shutdown Capability

With loss of one electrical division, one train of all safe shutdown systems will be functional. With loss of one RPS channel, at least one channel of all instrumentation to be monitored will be available. Therefore, safe shut-down can be reached normally.

5.2.2.3.4.5 Cold Shutdown Requirements

The RH system is the normal method used to cool the plant to a cold shutdown condition. The only components inside Containment used for cold shutdown which are not used in achieving hot standby are the RH suction valves from the RC loops.

5.2.2.3.4.6 Cold Shutdown Capability

Appendix A demonstrates that the valves themselves are not affected by non-LOCA jet impingement. If the valves are inoperable due to loss of cables, power, or a single failure, they would be manually operable after containment temperatures and pressures have been reduced by the Containment HVAC system.

5.2.2.3.5 Steam Generator Blowdown (SD) Line Break

Blowdown line breaks are 1-1/2" or 2" breaks in the liquid Steam Generator boundary. These postulated breaks are located near the Steam Generators or in the Containment Penetration area.

5.2.2.3.5.1 Safe Shutdown Requirements

Following a SD line break, the reactor will be tripped on low level in the affected Steam Generator. A normal shutdown procedure is then used because of the small size of this break.

Table 2.6.1 of Appendix B lists the parameters to be monitored after the break. The Main Steam pressure instrumentation is located outside the Containment. Equipment, cables, and/or sensing lines for the wide range RCS pressure, Pressurizer level, narrow range Steam Generator level, and Core Exit temperature are located inside the Containment.

The RCFC's remove Containment atmosphere heat. One Auxiliary Feedwater Train in conjunction with one Functional Steam Generator will remove decay heat.

5.2.2.3.5.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged and affect the function of safe shutdown systems. Appendix C demonstrates that jet impingement from SD line breaks will not damage safe shutdown piping. As a result, there will be no interaction of postulated structural and piping failures with equipment, cables, and instrumentation.

Appendices A and B demonstrate that the RCFC fans, motors, coils and cables will not be damaged by jet impingement from a SD line break. The only other safe shutdown components inside Containment used after this event are instruments and associated lines and cables.

Of the instruments inside Containment listed in Table 2.6.1 of Appendix B, the wide range RCS pressure, Pressurizer level, and Core Exit temperature instruments are shown in Appendices A and B to not be affected by SD line breaks. No more than one of the Steam Generator level instruments on the damaged loop is affected and no more than two level instruments are affected on any steam generator by HELB's.

5.2.2.3.5.3 Single Failure

The limiting single failure for this event would be either loss of an electrical division or loss of a RPS channel.

5.2.2.3.5.4 Safe Shutdown Capability

With loss of one electrical division, one train of all safe shutdown systems will be functional. With loss of one RPS channel, at least one channel of all instrumentation to be monitored and two channels of ESF signals will be available. Therefore, safe shutdown can be reached normally.

5.2.2.3.5.5 Cold Shutdown Requirements

The RH system is the normal method used to cool the plant to a cold shutdown condition. The only components inside Containment used for cold shutdown which are not used in achieving hot standby are the RH suction valves from the RC loops.

5.2.2.3.5.6 Cold Shutdown Capability

Appendix A demonstrates that the valves themselves are not affected by non-LOCA jet impingement. If the valves are inoperable due to loss of cables, power, or a single failure, they would be manually operable after containment temperatures and pressures have been reduced by the Containment HVAC system.

5.2.2.3.6 Safety Injection Line Break

SI line breaks are postulated in the portion of piping normally pressurized by the accumulators. The pipes contain ambient temperature liquid at 700 psi. Failure of this piping would not cause reactor trip or directly affect any other safe shutdown systems.

5.2.2.3.6.1 Safe Shutdown Requirements

Following a SI line break, the reactor will not be automatically tripped because no ESF signal will result. To bring the plant to a safe shutdown condition, normal plant procedures can be used.

The RCFC's will remove the normal containment heat load. The normal Feedwater system or one Auxiliary Feedwater train in conjunction with one functional Steam Generator will remove decay heat.

Table 2.6.1 of Appendix B lists the instrumentation to be used for plant monitoring during shutdown. The Main Steam pressure instrumentation is located outside Containment. Equipment, cables, and/or sensing lines for the wide range RCS pressure, Pressurizer level, narrow range Steam

Generator level, and Core Exit temperature are located inside Containment.

5.2.2.3.6.2 Postulated Damage Summary

As demonstrated in Appendix D, structure will not be damaged and affect the function of safe shutdown systems. Appendix C demonstrates that jet impingement from SI line breaks will not damage piping. As a result there will be no interaction of postulated structural and piping failures with equipment, cables, and instrumentation.

Appendices A and B demonstrate that the RCFC fans, motors, coils and cables will not be damaged by jet impingement from a SI line break. The only other safe shutdown components inside containment used after this event are instruments and associated lines and cables.

Of the instruments inside Containment listed in Table 2.6.1 of Appendix B, the Pressurizer level, and Core Exit temperature instruments are shown in Appendices A and B to not be affected by SI line breaks. No more than two of the of the four level instruments on a Steam Generator is affected by HELB's.

Sensing lines for one wide range RCS pressure transmitter are potentially damaged by jet impingement.

5.2.2.3.6.3 Single Failure

The limiting single failure for this event would be either loss of an electrical division or loss of a RPS channel.

5.2.2.3.6.4 Safe Shutdown Capability

With loss of one electrical division, one train of all safe shutdown systems will be functional. With loss of one RPS channel, at least one channel of all instrumentation to be monitored except wide range RCS pressure will be available. Safe shutdown can be reached in this non-LOCA accident by use of the pressurizer pressure or monitoring the charging pump performance.

5.2.2.3.6.5 Cold Shutdown Requirements

The RH system is the normal method used to cool the plant to a cold shutdown condition. The only components inside Containment used for cold shutdown which are not used in achieving hot standby are the RH suction valves from the RC loops.

5.2.2.3.6.6 Cold Shutdown Capability

Appendix A demonstrates that the RH suction valves themselves are not affected by non-LOCA jet impingement. If the valves are inoperable due to loss of cables, power, or a single failure, they would be manually operable after Containment temperatures and pressures have been reduced by the Containment HVAC system.

6.0 Conclusion

Postulated High Energy Line Break locations have been compared with the safe shutdown component locations to confirm the Byron safe shutdown capability following HELB's. It has been demonstrated that potential component damage will not prevent safe shutdown. This is a result of the separation and redundancy incorporated into the basic Byron design.

7.0 REFERENCES

1. NUREG-75/087, NRC Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, September 1975.

2. Byron/Braidwood Analytical Procedures for Meeting Separation Criteria and High/Moderate Energy Pipe Rupture Criteria, 5-14-74.

3. Sargent and Lundy Interoffice Memorandum, "Analytical Procedures for Meeting Separation and High/Moderate Energy Line Rupture Criteria," R.B. Johnson to J.C. LaVellee, et al., 9-26-75.

4. Color Coded Mechanical Composite Drawings (105 sheets), Various Dates in 1975.

5. Notes of Special Interdepartmental Meeting of March 23, 1976 - High Energy Line Rupture Studies.

6. Sargent and Lundy Interoffice Memorandum, "Auxiliary Building Pipe Whip Studies, Elevation 364'-0"." R.B. Johnson to M.Z. Khlafallah/B. Tatosian, February 9, 1976.

7. Sargent and Lundy Interoffice Memorandum, "Auxiliary Building High Energy Line Rupture Studies - Els. 383'-0", 401'-0", 426'-0"," R.B. Johnson to M.Z. Khlafallah/ B. Tatosian, 3-26-76.

8. Sargent and Lundy Interoffice Memorandum, "Pipe Rupture Analysis at El. 364'-0" in Auxiliary Building," R.J. Netzel to J.C. LaVallee, 7-7-26.

9. Byron/Braidwood Fire Protection Report [Original Issue, 1977; Safe Shutdown Analysis 1981].

10. ANS 58.2, American National Standard - Design Basis for Protection of Nuclear Power Plants Against Effects of Postulated Pipe Rupture.

11. Sargent and Lundy Engineering Mechanics Division Technical Procedure No. 24, "Analysis of Postulated Pipe Rupture," September 1976.

12. Sargent and Lundy Interoffice Memorandum, "Auxiliary Building High Energy Line Rupture Studies," R.B. Johnson to J.C. LaVellee, et al. 4-20-76.

13. Byron/Braidwood Final Safety Analysis Report (FSAR).

14. Sargent and Lundy Calculation 3C8-1181-001, "Survey of Auxiliary Building High Energy Line Breaks," 12-21-81.

15. Working Copies, Byron/Braidwood Piping Composite Drawings.

16. Sargent and Lundy Letter "Environmental Equipment Qualification," J.E. Szupillo to T. Willis. (Westinghouse) 9-25-81.

17. Sargent and Lundy Letter SLWC-2052 "Mechanical Equipment Qualification," M.S. Leutloff to W. Kortier (Westinghouse) 10-18-82.

18. Emergency Operating Procedures for Byron Station.

19. NUREG/CR-2913, "Two Phase Jet Loads," January 1983.

20. Sargent and Lundy Calculation HELB-WL-2, Rev. 0, 6-8-84.

21. Notes of Meeting with AEC Directorate of Licensing; Bethesda Maryland, August 31, 1973.

22. Sargent & Lundy Interoffice Memorandum, "High Energy Line Break Locations", M.S. Leutloff to J. R. Lazowski, May 6, 1982.

23. Draft Technical Specifications for Byron Station Unit 1 (December, 1983).

24. (Deleted)

25. Westinghouse Design Criteria SS 1.19

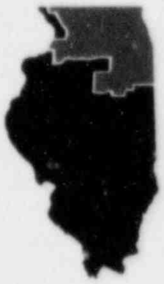
26. EPRI NP-3492 "Steam-Water Jet Analysis", May 1984.

Byron - 1
Confirmation of Design Adequacy
For Jet Impingement Effects

This report is based on calculations and design information as referenced. Electrical, Mechanical, and Structural components are addressed. The report was prepared by the Project Management Division and the Nuclear Safeguards and Licensing Division. A review for consistency with the Byron Station design has been completed by the design groups as documented below.

Prepared by:	K J Green	8-6-84 date
	M S Leutloff	8-6-84 date
	J W Ahrens	8-6-84 date
	[signature]	8-6-84 date
Reviewed by:		
Electrical Project Engineering	J D Regorn	8-6-84 date
Structural Project Engineering	Robert McClure	8-6-84 date
Control and Instrumentation	Gregory L Senomeli	8-7-84 date
Engineering Mechanics	J H Gray	8-6-84 date
HVAC	W B Panhal	08-06-84 date
Approved by:	W C Cleff	8-06-84 date 8-07-84 WC

Commonwealth
Edison



Appendices

Byron 1
Confirmation of Design Adequacy for Jet Impingement Effects

August 1984

APPENDIX A

VERIFICATION OF HIGH ENERGY LINE BREAK DESIGN APPROACH FOR JET IMPINGEMENT EFFECTS ON SAFE SHUTDOWN EQUIPMENT, INSTRUMENTATION, AND CABLES (OUTSIDE CONTAINMENT)

Commonwealth Edison Company
Byron Unit 1
Project No. 4391-00
Project File No. 13.6

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 PURPOSE

The purpose of Appendix A of this design assessment is to verify that an adequate design approach for safe shutdown equipment/instrumentation located inside and outside containment and safe shutdown cables located outside containment, has been accomplished which meets the objectives of SRP Sections 3.6.1 and 3.6.2. The scope of this assessment is limited to the cables and equipment/instrumentation described above since jet impingement effects on cables located inside containment, instrumentation lines, piping and structures are discussed in the Summary Report and other Appendices listed below.

1. Summary Report - "Verification of Design Adequacy for Jet Impingement Effects"
2. Appendix A - "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Equipment Instrumentation and Cables (Outside Containment)"
3. Appendix B - "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Cables Inside Containment and Safe Shutdown Instrument Sensing Lines Inside and Outside Containment"
4. Appendix C - "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Piping"
5. Appendix D - "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Structures"

Note: The reader should complete the Summary Report prior to interpreting the contents of this Appendix.

2.0 INTRODUCTION

Per Standard Review Plan (SRP) 3.6.2 10CFR Part 50, Appendix A, General Design Criterion 4 requires that structures, systems and components important to safety shall be designed to accommodate the effects of postulated accidents, including appropriate protection against the dynamic and environmental effects of postulated pipe ruptures. These requirements provide for the protection of structures, systems, and components relied upon for safe reactor shutdown or to mitigate the consequences of a postulated pipe rupture.

The purpose of this design assessment is to verify that an adequate design approach relative to high energy line break (HELB) jet impingement effects on safe shutdown equipment, instrumentation and cables (outside containment) has been accomplished which meets the intent and objectives of SRP 3.6.1 and 3.6.2. The basis of this verification is the basic and original premise that due to proper location and orientation of equipment, utilization of appropriate separation criteria, and provisions for proper redundancy and diversity, all mechanical equipment, electrical equipment and cables, and instrumentation required for safe plant shutdown and for mitigating the consequences of an accident are adequately protected against jet impingement effects.

The Byron design will accommodate the loss of a single train of a dual train safety system coincident with a single failure in the unaffected train and still be able to attain a safe shutdown condition (Reference 8.1.9). As will be discussed in Subsection 3.1, a single failure exemption is allowed per the Standard Review Plan for piping failures postulated to occur in one of two or more redundant trains of a dual-purpose moderate-energy essential system. However, a single failure must still be assumed in another system not in the redundant train. This jet impingement assessment is intended to establish that, because of plant layout and other design considerations mentioned above, HELB jets will not cause failures in equipment, instrumentation and cables used for safe shutdown which would incapacitate more than a single train of a dual train high energy safety system or either train of a moderate energy safety system.

The scope of this examination is limited to the following items which may be used to accomplish safe shutdown or to mitigate the consequences of the accident:

- o mechanical equipment inside and outside containment,
- o electrical equipment inside and outside containment,
- o electrical cables, conduits, and cable trays outside containment, and
- o instrumentation inside and outside containment.

3.0 METHOD OF ANALYSIS

The objective of this assessment is to evaluate the designs for equipment, instrumentation and cables (outside containment) supporting those systems used for safe shutdown and for mitigation of the consequences of an accident with respect to the effects of a jet issuing from a high energy pipe break (and the associated consequences of the break) coincident with single failure criteria. In order to provide a basis for evaluation of the capability for attaining safe shutdown, it is first necessary to establish a list of the equipment which can be used to attain a safe shutdown condition. This will be referred to as the safe shutdown equipment list (SSEL). The SSEL for equipment inside containment is listed in Table 1-1. The SSEL for equipment outside containment is presented in Table 1-2. The equipment presented in Tables 1-1 and 1-2 were derived from active valve and active pump lists presented in the FSAR as well as from electrical and mechanical equipment qualification lists. The equipment included in this verification bounds the actual equipment which would be required to accomplish safe shutdown following all initiating HELB events. Not all equipment in these tables are required for every HELB scenario. The equipment listed in Tables 1-1 and 1-2 along with their associated power and/or control cables form the basis for this evaluation of jet impingement effects.

The evaluation is performed by reviewing, on an area-by-area basis, the potential effects of jet impingement on safe shutdown equipment, cable, and instrumentation within the scope of this assessment. This review, performed by assuming that the subject equipment, cables, and instruments were rendered inoperable by a jet emanating from the break, provides a basis to determine that safe shutdown is not precluded by these failures plus a single failure. Equipment, cable, and instrumentation which successfully satisfies the above criteria is considered to be "dispositioned".

3.1 LOOP and Single Failure Criteria

Consideration of the effects of the initiating event may require that loss-of-offsite power (LOOP) be postulated in certain situations. HELB analysis requirements relative to inclusion of the effects of LOOP and single failure criteria are to be applied only under those conditions defined in Section B.3.b of Branch Technical Position ASB3-1, "Protection Against Postulated Piping Failures in Fluid Systems Outside Containment" (Reference 8.1.1). The pertinent conditions are reproduced from Section B.3.b as follows:

"In analyzing the effects of postulated piping failures, the following assumptions should be made with regard to the operability of systems and components:

(1) Offsite power should be assumed to be unavailable if a trip of the turbine-generator system or reactor protection system is a direct consequence of the postulated piping failure.

(2) A single active component failure should be assumed in systems used to mitigate consequences of the postulated piping failure and to shut down the reactor, except as noted in Item B.3.b(3) below. The single active component failure is assumed to occur in addition to the postulated piping failure and any direct consequences of the piping failure, such as unit trip and loss of offsite power.

(3) Where the postulated piping failure is assumed to occur in one of two or more redundant trains of a dual- purpose moderate-energy essential system, i.e., one required to operate during normal plant conditions as well as to shut down the reactor and mitigate the consequences of the piping failure, single failures of components in the other train or trains of that system only, need not be assumed provided the system is designed to seismic Category 1 standards, is powered from both offsite and onsite sources, and is constructed, operated, and inspected to quality assurance, testing, and inservice inspection standards appropriate for nuclear safety systems. Examples of systems that may in some plant designs, qualify as dual-purpose essential systems are service water systems, component cooling systems, and residual heat removal systems.

(4) All available systems, including those actuated by operator actions, may be employed to mitigate the consequences of a postulated piping failure. In judging the availability of systems, account should be taken of the postulated failure and its direct consequences such as unit trip and loss of offsite power, and of the assumed single active component failure and its direct consequences. The feasibility of carrying out operator actions should be judged on the basis of ample time and adequate access to equipment being available for the proposed actions."

As a result, a LOOP must be postulated only if the initiating event (HELB) or the assumed single failure directly results in turbine and/or reactor trip. The worst single failure (SF) one could postulate is the loss of an electrical division.

Since the essential service water, component cooling and residual heat removal systems are dual purpose, normally operating, moderate energy systems*, the single failure need not be postulated in the other train of the same system if the initiating failure is within one of these systems. However, a single failure must still be assumed in a system other than the redundant train. This single failure exemption is not applicable if the initiating failure is in another system and as a result damages one train of the SX, CC or RHR system.

Although there are several non-IE components identified on the SSEL (i.e., the boric acid transfer pumps), these components were not actually required within the dispositioning of other safe shutdown equipment. These components may only be required in the event of a stuck control rod (single failure). Relative to safe shutdown, if a LOOP must be postulated as part of a particular scenario then it must be assumed that all non-IE components are unavailable for that scenario. However, power can be restored to non-IE components used for cold shutdown. LOOP will affect all electrical equipment but all IE equipment will be immediately provided with emergency power from the diesel generators. Since credit was not specifically taken for the non-IE equipment mentioned above under any scenario considered in this analysis, the effects of LOOP on safe shutdown are automatically accounted for. This is because in effect only IE equipment was actually used in the safe shutdown dispositioning as discussed in Subsection 4.1.

3.2 High Energy Line Break Locations

The inside-containment safe shutdown assessment considers specific break locations as documented in Reference 8.1.2. Within this assessment all safe shutdown equipment and instrumentation located within the containment compartment in which the break occurs are postulated to fail unless a component is clearly shielded from the jet by large physical barriers, (e.g., the missile barrier or reactor cavity walls). Pipe whip restraints are credited with restricting motion in the postulated broken line. No credit is taken for potential jet deflection by

*For example, RHR operates during cooldown and cold shutdown and is at high energy conditions less than 2% of the operating time.

other equipment in the area. Also, no credit is taken for the jet's pressure attenuation over large distances unless it is a steam and/or two-phase jet for which the zone of influence of the potential jet damage is limited according to Reference 8.1.3. Hence, if a component is in the same area as the jet, it is assumed conservatively to fail unless obvious barriers are present or unless the steam and/or two-phase jet criteria is appropriate for the line break.

The outside-containment safe shutdown analysis considers specific break locations as documented in Reference 8.1.4. Similarly, all safe shutdown components located within the area of the HELB are postulated to fail unless there is sufficient evidence from Reference 8.1.4 that specific components are not impacted by jets. No credit is taken for potential jet deflection by other equipment in the vicinity of the jets. Also, credit is not taken for the jet's pressure attenuation over large distances unless the steam and/or two-phase jet criteria, mentioned above, can be imposed.

3.3 Dispositioning of Equipment, Instrumentation and Cables from Jet Effects

This evaluation is performed by detailed dispositioning of safe shutdown equipment, instrumentation, and cables (outside containment) by one of the following methods:

- Using referenced break locations to show that a component is not influenced by jets either because no breaks occur in the vicinity of the component or because the component is shielded from breaks in the vicinity by existing physical barriers.

- Proving that a component is not required to operate when breaks exist in the component area.

- Assuming loss of component operability due to a jet along with other component failures in the jet zone of influence plus a single failure of another safe shutdown component, and identifying the redundant equipment or diverse means available for accomplishing safe shutdown.

- Proving that a radioactive release is not possible because the component is a containment isolation valve (CIV) located on a non-high energy line inside containment which is located on a "closed system" inside containment as defined in Subsection 6.2.4 of Reference 8.1.5. If a "closed system" line does not break or crack coincident with a LOCA, containment isolation is not required for that line.

- Showing that a component is located in a zone containing only safe shutdown equipment or cables and high energy piping from a single train of at least a dual train system. Failure of such a component would not further degrade the affected system beyond the initiating line break since that system's function is rendered inoperable by the initiating event. Since the Byron design will accommodate the loss of a single train of a dual train high energy safety system along with appropriate single failure criteria, safe shutdown is not precluded by a single train failure resulting from a HELB in that train.

- Showing that a component is a CIV located outside containment and its sole safe shutdown function is that of containment isolation. These components would only be required to isolate containment if a HELB occurred inside containment. A HELB outside containment would only require isolation of the ruptured line. Hence, loss of valve operability is permissible for all CIV's outside containment for a HELB also occurring outside containment.

Section 4.0 presents those assumptions and items of information utilized to perform the dispositioning. Sections 5.0 and 6.0 present the assessment for equipment and instrumentation inside containment and equipment, instrumentation, and cables outside containment, respectively.

4.0 INFORMATION AND ASSUMPTIONS

4.1 Class IE Equipment

Credit is not taken for the operation of non-Class IE equipment in achieving a safe shutdown path for any scenario considered. However, non-Class IE fail closed valves which are not impacted by jets may be assumed to maintain their fail-safe position upon loss of power or air to the activating device.

4.2 Essential Systems

The following seven essential systems, along with their associated electrical and mechanical support equipment, are major mechanical systems which are required to mitigate the accident and take the plant to a safe shutdown condition under a variety of HELB scenarios:

- Safety Injection (SI)
- Residual Heat Removal (RHR)
- Chemical & Volume Control (CVCS)
- Containment Spray (CS)
- Auxiliary Feedwater (AF)
- Component Cooling (CC)
- Essential Service Water (SX)

Equipment listed in Tables 1-1 and 1-2 belonging to any of the above systems are most likely required to provide some shutdown or accident mitigation function. Some equipment listed may be required for mitigating the consequences of the accident (i.e., containment isolation). Equipment listed in Tables 1-1 and 1-2 not belonging to one of the above systems are required to either support one of the safety systems above or to mitigate the consequences of the accident. Not all equipment listed in Tables 1-1 and 1-2 are required to accomplish safe shutdown for every scenario considered.

4.3 High Energy SI Piping

In the SI system, the only high-energy piping is located inside containment between the accumulator tanks and the accumulator check valves. Each of these lines has two check valves to prevent backflow of primary system fluid into the accumulator tank portion of the safety injection system. Since SI piping is not normally used and does not normally contain primary system fluid, postulated SI system piping breaks upstream of the accumulator check valves are not considered LOCA's.

4.4 Components Analyzed

This design verification includes the effects of jet impingement on mechanical equipment, electrical equipment, instrumentation, power and control cables outside containment with consideration of potential block wall failures. It is assumed in this equipment/cable assessment that the integrity of piping systems and structural walls is not compromised by jet effects. Jet impingement effects on cable inside containment and instrument lines are addressed in Reference 8.2.3.

4.5 Electrical Penetrations

Jet effects on electrical penetrations are inconsequential to attaining safe shutdown for the following reasons:

- For HELB's outside containment, the HELB jets will fail the cable passing through the penetration simultaneously with failing the penetration. Containment isolation is not a concern for outside-containment HELB's. Therefore, the only concern for outside-containment breaks is the loss of safe shutdown equipment operability. Since safe shutdown cable failures outside containment are being examined in this assessment the failure of the electrical penetrations is inherently included.

- For breaks inside containment, both electrical penetration structural integrity and loss of safe shutdown equipment operability due to cable failure must be considered. Loss of safe shutdown equipment operability due to potential cable failures from HELB jets is addressed in Reference 8.2.3. Structural integrity of the electrical penetrations requires that they be protected only from LOCA jets in order to prevent the release of radioactivity to the environment. The electrical penetrations are located at or above Elevation 417 feet 6 inches according to the electrical penetration schedule (Reference 8.1.10). With the exception of the letdown line, all LOCA breaks are isolated from the electrical penetrations by the missile barrier. The letdown line (Line 1CV01E3) is located below the Elevation 412 foot floor. Hence, the electrical penetrations are separated from LOCA jets by physical barriers.

4.6 Block Walls

Block walls which are subjected to HELB jets with substantial forces are shown not to be required for separation or safe shutdown and are conservatively assumed to fail allowing the jets to pass between adjacent or contiguous areas of the plant. The determination of which block walls may be subject to jet failures is made by examination of References 8.1.4, 8.3.5, and 8.3.7.

4.7 Associated Equipment

Mechanical and electrical components which operate as a unit (for example: valves and their associated solenoids, motor operators, actuators or pumps and their associated motors, etc.) are dispositioned as a single entity.

4.8 Instrumentation

Per Reference 8.1.6 the following indicates the required instrumentation needed to support safe shutdown:

- Wide range reactor coolant system pressure
- Narrow range steam generator pressure
- Containment pressure
- Steamline pressure
- RWST level

- Containment radiation level
- Wide range hot and cold leg temperature or core exit temperature
- Pressurizer level
- Narrow range reactor coolant temperature

4.9 Major Structures

It will be assumed that upon striking a major structure a jet becomes a spray. Class IE equipment inside containment that is required to operate post LOCA is qualified to containment spray per Section 3.7 of the Environmental Qualification Report (Reference 8.1.7).

4.10 High Energy Lines

Reference 8.1.8 presents the lines outside containment which contain high energy fluid. HELB's are not postulated in systems or lines other than those presented in this reference.

4.11 Containment Isolation

The sole safe shutdown function of containment isolation valves is to provide an essentially leaktight barrier against the uncontrolled release of radioactivity to the environment and to limit the leakage to the applicable federal requirements. The following criteria apply to piping for which containment isolation provisions are required:

- The design pressure of all piping and connected equipment comprising the isolated boundary is greater than the design pressure of the containment.

- Lines which must remain in service subsequent to certain accidents, due to safety considerations, are redundant, and each line is provided with manually actuated containment isolation provisions.

High energy systems inside containment for which containment isolation valves are provided are closed systems as long as the system does not connect directly with the containment atmosphere or with the reactor coolant pressure boundary. The only way their containment isolation function can fail is if such lines are postulated to experience a HELB.

4.12 Steam and/or Two-phase Jet Criteria

Based on NUREG/CR-2913 (Reference 8.1.3) and Reference 8.1.4, two-phase and steam jets have a limited spatial influence in terms of significant pressure loading. This two-phase and steam criteria results in a maximum jet zone of influence corresponding to ten pipe diameters or less in any direction from the break location. Ten pipe diameters represents a conservative application of the results contained in Reference 8.1.3 and will be applied for any break resulting in a steam and/or two-phase jet. All components/structures beyond the ten pipe diameter zone of influence are considered not impacted by the two-phase jet.

5.0 INSIDE CONTAINMENT SAFE SHUTDOWN EQUIPMENT ASSESSMENT

The equipment assessed here is shown in Table 1-1 and is all of the equipment inside containment that is used to achieve safe shutdown for any of a wide variety of HELB scenarios. However, not all of the equipment is needed for a given scenario.

Dispositions for electrical cables and instrument sensing lines for the inside containment equipment and instrumentation are discussed in detail in Reference 8.2.3. This reference determined that due to physical separation, barriers, and HELB jet orientation, an adequate number of electrical cables and instrument sensing lines remain undamaged following a HELB.

Certain solenoid valves are designed to fail closed upon loss of electrical power. Therefore, jet impingement effects on the cabling to these valves were not considered if the safe shutdown systems will function as required with the valve closed.

Each item in Table 1-1 is analyzed to determine if a jet in close proximity would prevent the performance of its safe shutdown function. Equipment inside containment is, therefore, assessed using one or more of the following:

- The HELB issues a steam and/or two-phase (liquid and steam) jet which dissipates after ten pipe diameters per Reference 8.1.3, and, therefore, does not cause an impingement on those components beyond the ten pipe diameters in the direction of the jet.

- The component is completely shielded by concrete walls which are unaffected by jet loads.

- Pipe whip restraints are credited with performing their function, thereby restricting the motion of the pipe to a prescribed direction whether it is toward or away from a component being analyzed.

- For jets which are made up of a single-phase (liquid), no attenuation due to distance is considered; therefore, components in the path of the jet are assumed to incur impingement.

In the event of a component impingement, an alternate shutdown route is determined, which includes taking credit for the availability of more than one component which accomplishes the same function.

The loop and single failure (SF) criteria is applied as discussed in section 3.1 of this Appendix.

5.1 Equipment Nos. IVP01CA, IVP01CB, IVP01CC, IVP01CD IVP01AA, IVP01AB, IVP01AC, and IVP01AD

These components are the reactor containment fan cooler (RCFC) motors and fans and essential service water (ESW) coils. Together they make up the RCFC units which serve to remove heat from the containment building during both normal operation and in the event of a LOCA. The RCFC's are an engineered safeguard system and are consequently located outside of the missile barrier. Two out of four RCFC units are required during normal and post-LOCA operation.

There are no HELB's located inside the RCFC rooms. Likewise, the RCFC units are shielded from HELB's outside the RCFC rooms and other jets by structural walls which form compartments as shown in Drawings A-333 through A-336 (Reference 8.2.5). These walls are also not impacted by jet forces since the orientation of the jets following any HELB is constrained by the use of pipe whip restraints. Therefore, due to isolation and separation from breaks, the RCFC units will not be affected by jet impingement.

Electrical cables are assessed in section 3.11 of Reference 8.2.3.

5.2 Equipment Nos. IVQ001A, IVQ002A, IVQ004A, and IVQ005A

These components are containment isolation valves (CIV's) on the primary containment vent and purge system. Per Drawings M-1276 and M-1277 (Reference

8.2.5), these valves are located above Elevation 462 feet. The only potential HELB's occurring in this vicinity are main steam line breaks at the top of the steam generators. Per Drawings M-175 and M-176 (Reference 8.1.2), the pressurizer cavity shields the isolation valves from potential main steam line breaks.

Electrical cables are assessed in section 3.12 of Reference 8.2.3.

5.3 Equipment Nos. lRC014A, lRC014B, lRC014C, and lRC014D

These components are atmospheric vent valves which are used for hydrogen control and also serve as a backup to collapsing a reactor pressure vessel (RPV) bubble when RPV pressure is raised. According to Emergency Operating Procedure (EOP) BFR-I.3, "Response to Void In Reactor Vessel," pressurizer heaters are used to increase pressure and collapse the bubble. In the event the pressurizer heaters are unavailable, the RPV head vent valves are used to collapse the RPV bubble. These valves are located above the reactor cavity and just below the control rod drive missile shield per Drawings M-167 and M-14 (References 8.2.4 and 8.2.5). The reactor cavity shields the valves from potential jets emanating below the valves. The control rod drive missile shield protects the valves from potential main steam line break jets from above the valves.

Electrical cables are assessed in section 3.16 of Reference 8.2.3.

5.4 Equipment Nos. lRY455A, lRY456, lRY8000A, and lRY8000B

These valves are the two pressurizer power-operated relief valves (PORV's) and the two PORV block valves. The PORV's are normally used to limit system pressure for a large power mismatch, prevent actuation of the fixed high-pressure reactor trip, and to limit the undesirable opening of the spring-loaded safety valves. Under abnormal operating conditions, the PORV's may be used along with the CVCS charging pumps, as a last resort, to maintain and control reactor coolant system inventory and pressure. The PORV block valves are normally open and serve to isolate a "stuck- open" PORV.

Per Reference 8.2.4 (Drawings M-175 and M-176), the PORV's and PORV block valves are located inside the pressurizer compartment. The only postulated HELB's inside this cavity occur on pressurizer piping (i.e., system RY). Hence, the loss of operability for any of these components from jets will not cause further degradation of the RY system beyond the line break itself. Since the PORV's also serve a pressure relief function, a line break incapacitating a PORV will also depressurize the system and eliminate the need for the pressure relief.

Electrical cables are assessed in section 3.18 of Reference 8.2.3.

5.5 Equipment Nos. 1SA033 and 1IA066

These valves are CIV's on station air (SA) and instrument air (IA) piping which penetrates containment.

According to Subsection 9.3.1.3 of Reference 8.1.5, failure of IA or SA systems will not prevent safety-related components or systems from mitigating the consequences of any design basis accident or performing as intended under emergency cool down conditions.

Additionally, examination of P&ID's (M-54 and M-55) indicates that each of these valves has redundant CIV's outside containment (e.g., 1SA032 and 1IA065). A loss of valve operability due to a jet coupled with a single failure (SF) of the redundant isolation valve could lead to a radioactive release if and only if the particular IA or SA line were broken. According to Reference 8.1.8 neither of these systems contain high energy piping. Hence, HELB's or cracks are not postulated to occur coincident with a LOCA in these systems and the containment isolation function of these valves is not degraded by jets.

Electrical cables are assessed in section 3.1 of Reference 8.2.3.

5.6 Equipment No. 1FP011

This valve is the CIV on the fire protection (FP) piping which penetrates containment. This line has a redundant CIV outside containment (1FP010). If

Valve FP011 is rendered inoperable by a jet and a SF incapacitates the redundant CIV (IFP010), a radioactive release could result if and only if the associated FP line breaks. This particular line is not a high energy line per review of Reference 8.1.8. As a result, the line is not postulated to break or crack coincident with a LOCA and the containment isolation function of the valve is not degraded by jets.

Electrical cable to this valve is assessed in section 3.1 of Reference 8.2.3.

5.7 Equipment Nos. lPS9354A, lPS9355A, lPS9356A, and lPS9357A

These components are CIV's for process sampling (PS) lines from the pressurizer, accumulator tanks, and reactor hot and cold legs. Each of these valves has a redundant outside containment isolation valve. If any of these valves is rendered inoperable by a jet and the redundant valve has an SF, a radioactive release would not result. Review of Reference 8.1.8 shows that high energy lines do not exist in the PS system; therefore, neither HELB's nor cracks coincident with a LOCA are postulated in these lines and the containment isolation function of these valves is not degraded by jets.

Electrical cables are discussed in section 3.1 of Reference 8.2.3.

5.8 Equipment Nos. lRE1003, lRE9159A, lRE9160A, and lRF026

These components are inside containment CIV's on the reactor building and equipment drain and vent lines and the reactor building and containment floor drains to radwaste. All of these valves have redundant CIV's outside containment. If any of these valves is rendered inoperable by a jet and the SF of its redundant isolation valve occurs, a radioactive release would not result since the outside containment portion of these systems is closed. Review of Reference 8.1.8 shows that these particular lines are not high energy lines. As a result these lines are not postulated to break or crack coincident with a LOCA and the containment isolation function of the respective valves is not degraded by jets.

Electrical cables are assessed in section 3.1 of Reference 8.2.3.

5.9 Equipment Nos. 1OG057A, 1OG079, 1OG080, and 1OG081

These components are inside containment CIV's for the off-gas lines from inside containment to the hydrogen recombiners and their return lines. The valves are normally closed and are only required to operate when the containment hydrogen concentration exceeds specified limits. These limits are only expected to be exceeded in a post-LOCA situation. Therefore, loss of OG valve operability due to jet impingement from any HELB other than a LOCA is permissible. By inspection of the valve locations on Drawings M-158 and M-163 (Reference 8.2.4) and the locations of adjacent pipe breaks (Reference 8.1.2), it is concluded that no postulated primary system breaks occur in the vicinity of these valves.

Electrical cables are assessed in section 3.15 of Reference 8.2.3.

5.10 Equipment Nos. 1CC9416 and 1CC9438

These components are inside containment CIV's for component cooling system lines. Both of these valves have redundant CIV's outside containment. Since the component cooling system is a "closed" moderate energy system inside and outside containment, failure of these isolation valves along with a SF of their redundant isolation valves would not result in release of radioactive contaminants since breaks or cracks coincident with a LOCA are not postulated in these lines.

Electrical cables are assessed in section 3.14 of Reference 8.2.3.

5.11 Equipment No. 1CV8112

This component is the inside containment CIV which is designed to close following a LOCA, and is located on the RC pump seal water return line 1CV16F2 inside containment. The redundant outside containment CIV is valve 1CV8100.

The only HELB's outside the missile barrier where the valve is located which would cause a LOCA is on the 3-inch diameter letdown line. A jet emanating from a break in this line would have a 30-inch jet zone of influence, per Reference 8.1.3. Since the valve is located approximately 6-feet away from any break on the line, no impingement of the valve would result.

The electrical cable to this valve is assessed in section 3.17 of Reference 8.2.3.

5.12 Equipment No. ICV8160

This component is the inside containment CIV for the CV system letdown line from the reactor coolant system.

If Valve ICV8160 is rendered inoperable by a jet emanating from a break in the letdown line and the redundant outside containment CIV (ICV8152) fails due to SF, then two requirements must be satisfied. The break must be isolated to avoid a loss of primary coolant and the containment penetration must be isolated to prevent the release of radioactive contaminants outside containment.

The first requirement is satisfied by fail-closed Valve ICV460 which is inside the missile barrier. Other valves between the missile barrier and the containment boundary might also be available but are not considered since they are located in the same cavity as the postulated breaks.

The second requirement of containment isolation is accomplished by fail-closed Valves ICV8401A and ICV8401B which are located outside containment. Potentially radioactive containment air (from the letdown line break) could penetrate containment through this letdown line but would be trapped in the piping upstream of the letdown heat exchangers. Since these lines normally transport radioactive primary system fluid, the presence of radioactivity within this portion of the letdown line does not present a release problem since the integrity of the letdown line is not compromised outside containment.

Electrical cables to this valve are assessed in section 3.1 of Reference 8.2.3.

5.13 Equipment Nos. IRH8701A, IRH8701B, IRH8702A, and IRH8702B

These components are the RHR system loop inlet isolation valves which are designed to open when initiating the RHR system to achieve cold shutdown in a non-LOCA situation.

The RHR system is designed to take suction from either the Refueling Water Storage Tank (RWST), hot leg loops 1 and 3, or the containment recirculation sump. Inlet isolation valves RH8701A/B and 1RH8702A/B are required to open when taking suction from hot leg loops 1 and 3, for normal plant cooldown. Therefore, failure of these valves in the closed position due to jet impingement and SF would preclude the use of hot leg loops 1 and 3 as RHR pump suction sources. Following a LOCA, RHR suction is taken from the containment sump and these valves are not used.

HELB's in the vicinity of Valve IRH8701A are oriented away from the valve, therefore, it will not incur an impingement. Valve IRH8701B is affected only by breaks in the RCS which would result in a LOCA. Since the valve is not required to operate during a LOCA, HELB's in the vicinity of Valve IRH8702A are located on the 3-inch diameter Letdown Line (ICV01E3) which has a 30-inch jet zone of influence per Reference 8.1.3. The valve is located over 10 feet away from any break in the letdown line, therefore, no impingement of the valve would occur. Valve IRH8702B is in the vicinity of breaks in the RC and SI systems. The RC system breaks are not considered since they would cause a LOCA and the valve is not used during a LOCA. The SI system breaks are oriented away from the valve, therefore, the valve will not sustain an impingement due to jets.

Electrical cables are assessed in section 3.19 of Reference 8.2.3.

5.14 Equipment No. IRY8026

This component is an inside containment CIV for the pressurizer relief tank vent line to the automatic gas analyzer. This isolation valve is located outside the missile shield. There are no HELB's located in the containment cavity in which the valve is located and the valve is shielded from other jets by the missile shield structural walls. Hence, this component is not subjected to jet impingement.

Electrical cables are assessed in Section 3.1 of Reference 8.2.3.

5.15 Equipment Nos. 1LT-459, 1LT-460, and 1LT-461

These components are the three redundant pressurizer level transmitters, one of indication per Reference 8.1.6. They are divisionalized such that Transmitter 1LT-459 and 1LT-461 are Division 11 and Transmitter 1LT-460 is Division 12. They are also supported by Reactor Protection Channels (R1 through R3), where Transmitters 1LT-459 through 1LT-461 are each assigned to a protection channel in a consecutive manner (e.g., Transmitter 1LT-459 belongs to Channel R1 and Transmitter 1LT-460 belongs to Channel R2, etc).

There are no breaks in close proximity to Transmitter 1LT-460 per examination of Reference 8.1.2, therefore, it will not suffer an impingement due to jets. Transmitter 1LT-459 is surrounded by breaks which may cause an impingement, however, these breaks would not cause the impingement of any other pressurizer level transmitter due to barriers (concrete walls) and the orientation of the jets. Transmitter 1LT-461 may be impinged by jets in close proximity. However, due to the orientation of the jets, no other pressurizer level transmitter would be impinged. When the impingement of one transmitter is included with the SF of a reactor protection channel, one transmitter would remain functional.

Electrical cables and instrument sensing lines for the transmitters are assessed in section 3.2 of Reference 8.2.3.

5.16 Equipment Nos. 1PT403 and 1PT405

These components are the redundant reactor coolant wide-range pressure transmitters, one of which is required to function during safe shutdown. Transmitters 1PT-403 and 1PT-405 are separated by being 90 degrees apart, outside the missile barrier, in containment quadrant 3. Due to this separation and the fact that a line of sight does not exist between the two transmitters, a jet affecting one will not affect the other. Transmitter 1PT-403 would be impacted by a break in the SI system located in close proximity. Transmitter 1PT-405 would be impacted by a break in the feedwater line. When the SF criteria is applied both transmitters would be lost. However, per Byron/Braidwood Design Change No. RC-14, 11-18-82, hot leg 1A and 1C, Transmitters 1PT403 and 1PT405 will be relocated outside containment and four new transmitters will be added (1PT406, 1PT407, 1PT408, and 1PT409). Transmitters 1PT406 and 1PT407 will be located inside containment and Transmitters 1PT408 and 1PT409 will be located outside containment. They will be installed to sustain the effects of jet impingement, thereby, leaving the required amount of transmitters available to achieve safe shutdown.

Electrical cables and instrument sensing lines for the transmitters are assessed in section 3.5 of Reference 8.2.3.

5.17 Equipment Nos. 1RC01BA, 1RC01BB, 1RC01BC, and 1RC01BD

These components are the four independent steam generators which serve as a heat transfer link between the primary and secondary systems through which steam is produced for the turbine-generator (secondary) cycle. The major HELB jet that could affect the steam generators are breaks in either the hot leg, main steam, or feedwater piping as well as breaks in smaller steam generator blowdown piping.

When the SF of a power division is assumed, two of four steam generator PORV's (1MS018A-D) would be lost. This would temporarily affect the capability of these two steam generators to reject decay heat through main steam venting. However, the PORV's could be operated manually via hand pumps per the response to FSAR Question 10.58 (Reference 8.1.5) thereby putting the steam generators back in operation. Per Reference 8.1.6, only one of the steam generators would be required to operate during safe shutdown operations.

5.18 Equipment Nos. 1SI04TA, 1SI04TB, 1SI04TC, and 1SI04TD

These components are the four redundant accumulator tanks that are required during a LOCA. From Reference 8.1.2, the HELB affecting each accumulator is located on the respective accumulator discharge line. Therefore, a failure in a discharge line would empty the respective accumulator, thus voiding any consequences that jet impingement would have on the accumulator. Since the HELB being assessed for jet impingement is not a LOCA, use of the accumulators is not required for this scenario.

5.19 Equipment Nos. IRY20MA and IRY20MB

These components are the two PORV nitrogen accumulator tanks which are used to operate the valves during normal and abnormal plant conditions. The tanks are located at Elevation 451 feet 0 inch and are not in close proximity to any HELB's, therefore, they will not be impacted by jet impingement.

5.20 Equipment No. IRY01S

This component is the pressurizer which provides a point in the reactor coolant system where liquid and vapor can be maintained in equilibrium under saturated conditions for pressure control purposes.

The HELB having the greatest effect on the integrity of the pressurizer would be a break in the pressurizer surge line. This would cause drainage of all fluids inside the pressurizer which would render it inoperable but would negate the effects of jet impingement on the pressurizer. The size of the break would constitute a large break LOCA; therefore, rapid depressurization of the reactor pressure vessel (RPV) would result.

5.21 Equipment No. IRC0IR

This component is the reactor pressure vessel (RPV) which is the principal component of the reactor coolant system. It contains the heat-generating core and associated supports, controls, and coolant circulating channels. Hot leg and cold leg nozzles (outlet and inlet) provide for the exit of the heated coolant and its return to the vessel interior for recirculation through the core.

The breaks affecting the RPV are located at the hot and cold leg nozzles.

However, the hot and cold legs are restrained by four reactor pressure vessel supports, under every other reactor vessel nozzle, which provide restraint against motion perpendicular to the axis of the pipes. As discussed in Subsection 3.9.1.4.6 of Reference 8.1.5, breaks occurring at the hot or cold RPV nozzles, even with the limited break area, would give the highest RPV support loads and the highest vessel displacements due primarily to the influence of reactor cavity pressurization. Therefore, jet impingement forces inside the reactor cavity would be bounded by the forces experienced during reactor cavity pressurization.

5.22 Equipment Nos. 1LT-517, 1LT-527, 1LT-537, 1LT-547, 1LT-518 1LT-528, 1LT-538, 1LT-548, 1LT-519, 1LT-529, 1LT-539, 1LT-549, 1LT-556, 1LT-557, 1LT-558, and 1LT-59

These components are the narrow-range steam generator level transmitters. They serve to monitor steam generator fluid level during shutdown procedures. One transmitter on a fully operational steam generator following a HELB inside containment is required to function during safe shutdown procedures. Two transmitters on a steam generator affected by a feedwater line break or a steam generator blowdown (SD) line break inside containment are required to be functional for ESF/reactor trip activation.

There are four level transmitters per steam generator which tap into the steam generators at Elevations 429 feet and 449 feet via instrument sensing lines. The transmitters are mounted on instrument panels or are mounted locally on walls at different locations inside the containment. They are also divided by Reactor Protection Channels (R1 through R4) as shown in the following tabulation, per Reference 8.2.3.

Steam Generator	R1	R2	R3	R4
1RC01BA (1A)	1LT-556	1LT-519	1LT-518	1LT-517
1RC01BB (1B)	1LT-529	1LT-557	1LT-528	1LT-527

Steam Generator	R1	R2	R3	R4
IRC01BC (1C)	1LT-539	1LT-558	1LT-538	1LT-537
IRC01BD (1D)	1LT-559	1LT-549	1LT-548	1LT-547

The maximum number of transmitters that could be failed by a single jet is two since no more than two transmitters are located on a single instrument panel. Likewise, the transmitters located on an instrument panel always belong to the same reactor protection channel. Therefore, when the SF of a reactor protection channel is included, at least ten transmitters would be left functional.

Electrical cables and instrument sensing lines are assessed in section 3.3 of Reference 8.2.3.

5.23 Equipment Nos. T1 through T65

These components are the core exit thermocouples which are installed in guide tubes that penetrate the reactor pressure vessel (RPV) through seal assemblies and terminate at the exit flow end of the fuel assemblies. Either the thermocouples or the hot leg temperature transmitters can be used for primary system temperature monitoring. Due to the thermocouples' location inside the RPV, they are protected from all HELB's and will, therefore, not be impinged upon by jets.

Electrical cables and instrument sensing lines are assessed in section 3.7 of Reference 8.2.3.

5.24 Equipment Nos. 1W0056A and 1W0056B

These components are inside containment CIV's which are used to isolate the chilled water supply from the RCFC coils during a LOCA, main steam or feedwater line break.

They are located on the chilled water system (WO) which is a closed system inside the containment. Since the valves are only required during a LOCA, their containment isolation function is not affected by HELB's which do not cause a LOCA. The only HELB's outside the missile barrier where the valves are located which would cause a LOCA are located on the letdown line (1CV01E3). However, a HELB on the letdown line would be more than 10 pipe diameters or 30 inches away from either of the valves, therefore, the valves will not be affected by jet impingement.

Electrical cables are assessed in Section 3.13 of Reference 8.2.3.

5.25 Equipment Nos. 1PT-455, 1PT-456, 1PT-457, and 1PT-458

These components are the four redundant pressurizer pressure transmitters, two of which are required for Engineered Safeguard Feature (ESF) actuation following a LOCA or main steam line break. They are supported by Reactor Protection Channels R1 through R4.

Transmitter 1PT-455 is located on instrument panel 1PL50J along with pressurizer level Transmitter 1LT-459. Both transmitters may be lost due to the proximity and orientation of jets. These jets would not cause an impingement on any other transmitter due to barriers (concrete walls) and the jet's orientation. Transmitter 1PT-456 is located next to pressurizer level Transmitter 1LT-460 where no breaks are located. Transmitter 1PT-457 is located on instrument panel 1PL52J along with pressurizer level Transmitter 1LT-461, which may be impinged by jets in close proximity. However, due to the orientation of the jets, no other transmitters would experience impingement. Transmitter 1PT-458 is located on instrument panel 1PL75J where Transmitters 1PT-403, 1LT-537, and 1LT-527 (see Table 1-1 for component names and individual disposition) are located. Due to its relative location and proximity to HELB, the instrument panel may incur an impingement which may cause a loss of all its supported instruments.

When the jet induced failure of a pressurizer pressure transmitter is included with the SF of a reactor protection channel, two transmitters would remain functional.

Electrical cables and instrument sensing lines are assessed in section 3.4 of Reference 8.2.3.

5.26 Equipment Nos. 1TE-411 A and B, 1TE-421 A and B, 1TE-431 A and B, and 1TE-441 A and B

These components are the narrow-range reactor coolant resistance temperature detectors (RTD's). They are located in separate bypass manifolds and provide $\Delta T/T_{avg}$ signals for the Reactor Control and Protection System. Two pairs are required to function following a break in the feedwater bypass lines.

The RTD's are located between Elevations 395 feet and 398 feet in their respective quadrants, inside the missile barrier. Between these elevations they would only be affected by HELB's in the Reactor Coolant System (RCS), however, they are not required to operate following an RCS break.

The feedwater bypass lines enter inside the missile barrier at Elevation 436 feet which would place the RTD's well out of the jet zones of influence per Reference 8.1.3. The lines extend to lower elevations outside the missile barrier (concrete wall) where the RTD's are not located. The RTD's are therefore protected against feedwater bypass line breaks due to distance separation and barriers (concrete walls) which are postulated not to fail due to jet impingement.

Electrical cables and instrument sensing lines are assessed in section 3.6 of Reference 8.2.3.

5.27 Equipment Nos. 1RE-AR011, and 1RE-AR012

These components are the containment radiation monitors, which are located at elevation 432-feet on the outside of the steam generator enclosure walls, in RC loops 3 and 4, per Reference 8.2.2. They are used for accident assessment and radiation monitoring inside containment. They are not used for safe shutdown or mitigating the consequences of an accident, but are used to indicate if the containment can be accessed.

Due to the location of the monitors, they will not be impacted by jet impingement, per Reference 8[illegible].

6.0 OUTSIDE CONTAINMENT SAFE SHUTDOWN EQUIPMENT AND CABLE ASSESSMENT

The assessment of equipment, instrumentation and cables located outside containment is based on a hazard zone approach. All areas of the plant are divided into zones for the purpose of performing various hazard analyses. The boundaries of each hazard zone are defined primarily by physical barriers (e.g., structural walls and slabs). However, a few boundaries are defined according to the maximum jet zone of influence which is appropriate for steam and/or two-phase jets according to Subsection 4.12. In other situations, boundaries may contain block wall structures which are examined for potential HELB jet effects in subsequent sections of this assessment. Safe shutdown equipment, identified on the outside containment SSEL (Table 1-2), is assigned a zone number based on equipment location. Equipment locations were obtained primarily from examination of the Mechanical Piping Drawings (M-205 through M-377).

The hazard zone approach for jet impingement either assumes conservatively that all safe shutdown instrumentation, equipment, and cables, which are located within a zone containing a HELB, will be incapacitated by the jet issuing from the break or examines specific break information to determine if jet failures are credible. The analysis consists of examining all of the equipment, cable, and instrument failures within the zone to assess the potential jet damage with the additional consideration of single failure criteria. This process is repeated for the remaining zones which contain HELB jets until all affected zones are evaluated. Hazard zones which contain HELB's will be heretofore called HELB zones. As will be shown later, only 17 zones contain HELB's.

The assessment of jet impingement effects on equipment and cables outside containment is performed in two steps to simplify the analysis without compromising its completeness. First, the equipment/instrumentation is examined independently of cables in order to establish which equipment/instrumentation is susceptible to HELB jet damage and whose failure may jeopardize attaining a safe shutdown condition. The purpose for this independent examination is to establish which equipment/instrumentation listed in Table 1-2 is actually located within a potential jet zone and requires further consideration along with cables in the

HELB zone analysis. This is because only a relatively small amount of safe shutdown equipment/ instrumentation is located in a HELB zone. In addition, most of the safe shutdown components which are within HELB zones either are components (1) which are not required to operate following a HELB outside containment, or (2) whose failure is inconsequential because of the specific breaks which could incapacitate them. Either of these arguments are valid regardless of whether component failures occur from jet impingement.

The result of the equipment analysis is a list of equipment whose failure could have a direct bearing on attaining a safe plant shutdown condition. This equipment is next subjected to a detailed safe shutdown assessment which is performed on a HELB zone-by-zone basis. In the second step, the HELB zone analysis, either the total loss of availability of all safe shutdown equipment, cable, and instrumentation within each HELB zone is assumed or specific HELB jet information pertinent to each zone is examined and the consequences on equipment, instrumentation and cables are assessed.

The equipment assessment is described in Subsection 6.1 and the HELB zone assessment is described in Subsection 6.2. The basis for both the equipment assessment and the HELB zone assessment and the entire outside containment safe shutdown effort are the HELB zones. The HELB zones are derived from Reference 8.1.4 and are depicted in Figures 1 through 5 which are the HELB zone maps. The HELB zones are also presented in Table 2 with a description of each zone, including an indication of the safe shutdown equipment and/or cable within each zone and the subsection where the zone is evaluated.

6.1 Equipment Assessment

The basis of the equipment assessment is the outside containment SSEL which is presented in Table 1-2. All equipment/instrumentation in this table is uniquely categorized by the respective zone assignment. Table 1-2 also contains equipment numbers and equipment descriptive information which does provide, in some cases, a second category of equipment identification which is based on system or component function. The reason for indicating these identification categories is that most safe shutdown equipment outside containment is eliminated from jet impingement analysis because it is not located within a HELB zone or because the system or equipment function is not required for a HELB outside containment. Hence, most equipment may be readily evaluated based on the information presented in Table 1-2.

The evaluation of equipment in Table 1-2 is based primarily on the HELB zone definitions which are presented in Figures 1 through 5. All equipment located inside of HELB zones may be subjected to HELB jets. Conversely, all equipment outside of the HELB zones is not subjected to jets.

In most cases, HELB zones are bounded by structural walls consisting of concrete or block construction. It is assumed that the integrity of concrete walls is not compromised by jets except for a few concrete partition and block walls which are assumed to fail if a jet is directed at the wall with a substantial force. In order to determine which block walls are subject to jet failure, the outside containment break locations (Reference 8.1.4) were examined along with the locations of block walls per Reference 8.3.5. Based on the location, force, and direction of jets, it was determined from the above references and also from Reference 8.3.7 that block wall or partition wall failures could occur only in conjunction with the following HELB zones:

- 11.2A-0: Recycle evaporator rooms,
- 11.3B-0: Blowdown condenser room,
- 11.4F-0: General area valve aisle,
- 14.3-0: Surface condenser rooms, and
- 14.5-0: Radwaste evaporator rooms.

Moreover, block wall failures in Zone 14.5-0 would occur internally to the zone boundaries. Hence, the only block wall or partition wall failures which may result in jet effects extending beyond a HELB zone boundary are in Zones 11.2A-0, 11.3B-0, 11.4F-0, or 14.3-0. These zones were examined for equipment located in the zone of influence of jets emanating through the failed block walls. In addition, equipment located in the path of the failed block wall was examined assuming the block wall experienced a cantilevered failure. A cantilevered failure is modeled such that the wall fails intact with the entire wall simply tipping over. It was established that safe shutdown equipment was not located in the zones of influence for the postulated jets or the failed block walls for these zones. Therefore, block wall failures have no affect on safe shutdown equipment outside containment. Jet effects on cable due to block wall failures will be considered in the zone analysis (Subsection 6.2).

6.1.1 Equipment in Non-HELB Zones

The HELB zones are defined in Table 2. All safe shutdown equipment, instrumentation, and cables which are not located in one of the HELB zones identified in this table are not subjected to HELB jets and are eliminated from further jet impingement analysis. Table 3 presents the equipment which is located in non-HELB zones and which is dismissed from further consideration in this safe shutdown assessment. All of the remaining safe shutdown equipment/instrumentation outside containment is located in HELB zones and may be subjected to jets. This equipment is listed separately in Table 4-1 on a zone basis. Table 4-2, similarly, presents the safe shutdown cables which are located in HELB zones. The cable information was obtained from Reference 8.3.1 and is also listed on a zone basis. Together, Tables 4-1 and 4-2 form the basis for detailed HELB jet impingement analysis of safe shutdown equipment, instrumentation and cables.

6.1.2 Equipment Not Required to Operate for a HELB Outside Containment

Some of the safe shutdown equipment/instrumentation outside of containment are required to function only for line breaks which occur inside the containment. Examples of such equipment include containment isolation valves (CIV's) located outside of containment, containment spray hardware, and certain safety injection system hardware. Safe shutdown components serving any of the above functions are not required to attain safe shutdown for any HELB outside of containment as discussed below:

- The containment isolation valves located outside of containment are required to mitigate the consequences of a LOCA inside containment. If a LOCA occurs inside containment, jets would not impinge on the isolation valves located outside the containment, because the primary containment boundary would serve as a barrier. If a LOCA occurs outside containment, only the operability of those valves located on the broken line would be required in order to isolate the break. Therefore, all outside containment valves whose sole function is to serve as a containment isolation valve are dispositioned on the basis that they will only be required for a line break inside containment. Loss of valve operability for the above valves due to a HELB jet outside containment does not jeopardize safe shutdown under these circumstances since containment isolation is not required. Table 6.2-58 of Reference 8.1.5 lists the containment isolation valves both inside and outside of containment.

- Similarly, all safe shutdown equipment/instrumentation within the containment spray (CS) system is not required to support safe shutdown following an outside containment HELB. This is because the containment spray system is required primarily for radioactivity scrubbing following a LOCA inside containment. A secondary function of the containment spray system is to provide redundancy to the RCFC's for containment pressure and temperature control following a line break inside containment. Since containment spray components are only required for inside containment breaks, outside containment HELB's have no impact on their safe shutdown function.

- The safety injection (SI) system is designed to provide emergency core cooling in order to prevent fuel clad melting and to maintain the integrity of the core in the event of a break in either the reactor coolant (RC) or steam system. The SI system also provides redundancy for the CVC system. Hence, safety injection system safe shutdown equipment/instrumentation outside containment is required to operate only upon occurrence of a primary system LOCA or secondary system break. Therefore, SI system components outside containment that are incapacitated by jets from line breaks not mentioned above, are not required to serve a safe shutdown function and may be dispositioned on that basis unless the SI components are required to back up CVC system components.

All safe shutdown equipment/instrumentation located outside containment which satisfies any of the three preceding criteria are not required to support safe shutdown for HELB's outside containment. These equipment, instrumentation, and cables are listed in Tables 5-1 or 5-2. Tables 5-1 and 5-2 list equipment and cables satisfying these criteria, respectively.

Table 6-1 lists all safe shutdown equipment and instrumentation outside containment which is both located in a HELB zone and which is not dispositioned according to Table 5-1. Similarly, Table 6-2 lists all safe shutdown cables outside containment which are routed through a HELB zone and which are not dispositioned according to Table 5-2. The safe shutdown cables were identified in Reference 8.3.1 as those cables routed through HELB zones which serve equipment/instrumentation listed in Tables 1-1 or 1-2. If potential block or partition wall overstresses occur for a particular zone, the additional zone of jet influence caused by assuming the wall failure was considered in the safe shutdown cable identification process. The equipment, instrumentation, and cables identified in Tables 6-1 and 6-2 are the basis for the detailed zone assessment which appears in Subsection 6.2.

6.2 HELB Zone Assessment

The bases for the HELB zone analysis are the Table 2 HELB zones and the equipment, instrumentation, and cables presented in Tables 6-1 and 6-2. Table 2 indicates that all HELB's outside of containment are located within a relatively few (17) hazard zones. Of these 17 HELB zones, 9 zones contain no safe shutdown equipment, instrumentation, or cables; 5 zones contain only cables; and the remaining 3 zones contain both equipment and cables.

Each HELB zone is addressed separately in one of the subsections that follows this discussion. The assessment is performed for each HELB zone either by:

- conservatively assuming that all safe shutdown equipment, instrumentation, and cables within the zone are unavailable due to jet failure and demonstrating that safe shutdown is not precluded by these failures or,

- examination of specific jet characteristics for HELB's in the zone to determine if equipment, instrumentation and cables are outside of the zone of influence of the HELB jet and therefore not subjected to jet failures.

6.2.1 HELB Zone 11.2A-0

This zone includes both of the recycle evaporator rooms. According to Reference 8.3.2, the zone boundaries include several small 5-foot high removable block walls along its west side which may be subjected to HELB jets.

Based on Reference 8.1.4, the potential breaks in this zone result in steam and/or two-phase jets. Hence, the extent of jet damage is limited to a maximum distance of 10 pipe diameters from the break according to References 8.1.3 and 8.1.4. The largest line which is postulated to break in this zone is a 10-inch auxiliary steam line (0AS96-10). Per inspection of Drawing M-210, Sheet 2, Revision G (Reference 8.3.2), this line is located at the east boundary of the zone. The removable block walls are at the opposite end of the zone and more than 20 feet from the 10-inch auxiliary steam line. When the 10 pipe diameter criteria is imposed, the jet zone of influence would only extend 100 inches from the break. Hence, the block walls are clearly not affected by jets from this break.

The remaining breaks in this zone are all from piping which is 6 inches or less in diameter per Reference 8.1.4. The corresponding 10 pipe diameter jet criteria results in a maximum jet zone of influence of 5 feet from the respective breaks. Per inspection of Drawing M-210, Sheet 2, the high-energy lines nearest the block walls (0AS03KA-6 and 0AS03KB-6) are at least 6 feet from the block walls. Therefore, it is concluded that HELB jets within this zone will not cause removable block wall failures because of the 10 pipe diameter jet criteria. Based on examination of the piping composite and architectural drawings (Reference 8.3.2), the following observations were made:

- No safe shutdown equipment or instruments are located within the zone boundaries.
- No safe shutdown equipment or instruments are located outside the zone in proximity to the block walls.

- The nearest safe shutdown equipment located in the proximity of the block walls are Valves ISX146 and ISX147 which are at least 14 feet from the block wall openings.

Assuming conservatively that the block walls do fail, the maximum damage extent from either the removable block wall failures or jets emanating from the block wall openings is 5 feet. Since the SX valves are at least 14 feet from the block wall openings, they are not affected by jet impingement. Hence, safe shutdown equipment is not damaged by jet impingement in this zone.

No safe shutdown cables are routed through this zone. However, one cable, which is listed in Table 7-1, is routed adjacent to the zone on the side where the block walls exist. This cable is located adjacent to the zone, 5 to 6 feet from the block walls at minimum Elevation 357 feet 6 inches according to Drawing 6E-0-3302 and its associated support drawings (Reference 8.3.2). According to Drawings A-207, A-208, and S-1550, the removable block walls are 5 feet high with their base at Elevation 346 feet. The top of the block walls are at Elevation 351 feet. Since the cable is routed 6 feet 6 inches above the top of the block wall opening, the jet will not impact the cable even if the jet could impact the block wall.

Safe shutdown equipment, instrumentation or cables are not impacted by HELB jets in this zone.

6.2.2 HELB Zone 11.2B-0

This zone is the letdown reheat heat exchanger room. There are no safe shutdown cables, instrumentation or equipment located within this zone. Also, there are no potential block wall failures due to jets or other HELB effects in this zone. Therefore, the effects of jet impingement due to breaks in this zone are totally contained within the zone boundaries. Safe shutdown equipment, instrumentation or cables are not impacted by HELB jets in this zone.

6.2.3 HELB Zone 11.3A-0

This zone is a piping area for the steam generator blowdown system. The zone is bounded on two sides by concrete walls. The other two sides of the zone are defined by the extent of influence of jets postulated in this area by Reference 8.1.4. HELB's in this zone result in steam and/or two-phase jets. Hence, the 10 pipe diameter criteria was imposed in order to define the zone boundaries based on the extent of jet influence.

There are no safe shutdown cables, instrumentation or equipment located in this zone.

6.2.4 HELB Zone 11.3B-0

This zone contains the blowdown condenser room. The boundaries of this zone which face north, south, and east are constructed of block walls which are assumed to fail due to pressurization from HELB's. These block walls are assumed not to inhibit jets from penetrating the zone boundaries. Based on Reference 8.1.4, the jets from postulated breaks in this zone are either directed vertically or lead to steam and/or two-phase jets for which the 10 pipe diameter zone of influence may be imposed. For steam and/or two-phase jets in this zone, the maximum zone of influence is 5 feet from the break per Reference 8.1.4. A maximum zone of jet influence corresponding to 5 feet from all block walls bounding the zone was conservatively examined.

Based on inspection of piping composite drawings (Reference 8.3.3), the following information was determined concerning safe shutdown equipment:

- No safe shutdown equipment or instrumentation are located within the zone boundaries.

- No safe shutdown equipment or instrumentation are located within the conservative zone of jet influence defined above for block wall failures.

- The safe shutdown equipment or instrumentation that is nearest any of the block walls is the Component Cooling Heat Exchanger 1A (1CC01A) which is at least 20 feet from the block wall boundaries. Since the maximum extent of jet damage from the block wall failures is 5 feet, the component cooling heat exchanger is unaffected by jet impingement from HELB's occurring in this zone. Hence, safe shutdown equipment is not affected by HELB jets in this zone.

There are no safe shutdown cables within this zone nor within the maximum extent of jet damage resulting from the assumed block wall failures. There are no safe shutdown cables, instruments or equipment subject to failures as a result of HELB jet impingement effects in the zone.

6.2.5 HELB Zone 11.3C-1

This zone is the positive displacement charging pump room. The zone is bounded by concrete and block walls. Based on Reference 8.1.4, there is only one postulated HELB in this zone. The jet from this break is directed toward the south wall of the zone, which is concrete, hence, block walls in this zone are unaffected by the jet. It is concluded that the HELB jets in this zone are totally contained within the zone boundaries. No safe shutdown equipment or instrumentation is located in the zone. Table 7-2 lists the only safe shutdown cable located in this zone. This cable serves local Panel 1VA10J which is the Charging Pump 1A cubicle cooler control panel.

The HELB in this zone occurs on Line 1CV07A-3 which is the discharge line from the positive displacement charging pump. The positive displacement charging pump is not considered a safe shutdown component. If it is assumed conservatively that the cubicle cooler control panel is unavailable due to cable failure from jet impingement, then the worst condition that could result is a loss of operability of the Charging Pump 1A as a result of losing the associated cubicle cooler. The loss of availability of the positive displacement charging pump does not affect safe shutdown capability. Because the SI system is unaffected by line breaks in this zone, the loss of Charging Pump Train 1A along with single failure criteria will not preclude safe shutdown.

6.2.6 HELB Zone 11.3D-1

This zone is the Centrifugal Charging Pump 1A room. The zone is bounded by concrete and block walls. The block walls that do exist are not impacted by jets within the zone based on Reference 8.1.4. Therefore, the HELB jets in this zone are totally contained within the zone boundaries. The safe shutdown cables, instrumentation and equipment contained within this zone are listed in Table 7-3. All safe shutdown components identifield in Table 7-3 are dedicated to the operation of Charging Pump 1A.

There are three breaks postulated in this zone according to Reference 8.1.4. These breaks result in very low jet forces and occur in the following CVCS lines:

1CV42CA-2: Charging Pump 1A Miniflow Line
1CV08AA-4: Charging Pump 1A Discharge Line

Hence, the only postulated breaks in this zone occur either on the Centrifugal Charging Pump 1A discharge line or miniflow line.

Since the postulated HELB's in this zone result automatically in the loss of Train 1A Charging Pump flow, the additional failure of all safe shutdown equipment and cables (Table 7-3) in this zone by jets would not lead to worse consequences than the initiating event by itself (loss of Train 1A Charging capability). Thus, either the initiating event (HELB) or its associated jet would result in the same consequence; namely, the loss of Train 1A Charging flow.

6.2.7 HELB Zone 11.3G-1

This zone is the Centrifugal Charging Pump 1B room. The zone is bounded primarily by concrete walls. A block wall does exist on the east end of the room but is impacted by a 2 lb jet based on Reference 8.1.4. This magnitude force does not jeopardize the integrity of the block wall in question. Therefore, the HELB jets in this zone are contained totally within the zone boundaries. The safe shutdown cables, instrumentation and equipment contained within this zone are listed in Table 7-4. All safe shutdown components identified in Table 7-4 are dedicated to the operation of the Centrifugal Charging Pump IB.

There are three breaks postulated in this zone according to Reference 8.1.4. These breaks result in very low jet forces and occur in the following CVCS lines:

ICV42CB-2: Charging Pump IB Miniflow Line

ICV08BA-4: Charging Pump IB Discharge Line

Hence, the only postulated breaks in this zone occur either on the Centrifugal Charging Pump IB discharge line or miniflow line.

Since the postulated HELB's in this zone result automatically in the loss of Train IB Charging Pump flow, the additional failure of all safe shutdown equipment and cables (Table 7-4) in this zone by jets would not lead to worse consequences than the initiating event by itself (loss of Train 1B Charging capability). Thus, either the initiating event (HELB) or its associated jet would result in the same consequence; namely, the loss of Train IB Charging flow.

6.2.8 HELB Zone 11.3H-1

This zone is the portion of the containment penetration area which is affected by HELB jet impingement. There are no block walls in its boundaries. This area includes a portion of the floors at plant Elevations 364 feet and 383 feet. The containment wall provides one boundary for this zone. The zone is divided into two areas at Elevation 383 feet due to the presence of some concrete structural walls on that floor. The boundaries for this zone are not all physical. Some boundaries accommodate the fact that some of the postulated jets only have sufficient energy to extend a maximum of 10 pipe diameters from the respective breaks per Reference 8.1.4.

According to Reference 8.1.4, there are 19 break locations in this zone, and they occur in different segments of the CVC system, including the letdown line. According to Reference 8.1.4, the jet forces are low for all 19 break locations and no pipe whip occurs for any of these breaks. The safe shutdown equipment, instrumentation and cables located in Zone 11.3H-1 are presented in Table 7-5. The physical location of the breaks and the nature of the break fluid (eight breaks are in cold water lines) combine to limit the extent that HELB Zone 11.3H-1 is impacted by jet impingement. Although there are safe shutdown equipment and cables in this zone, most components cannot be struck by the postulated jets per examination of the piping composite drawings (Reference 8.3.4). However, it will be conservatively assumed that jet failures do occur in this zone.

The following paragraphs will evaluate jet impingement effects on each piece of safe shutdown equipment, instrumentation and cable in Zone 11.3H-1.

6.2.8.1 Equipment No. 1CV112D and 1CV112E and Cable Nos. 1CV077, 1CV078, 1CV545, 1CV082, 1CV084, 1CV572

These components are centrifugal charging pump suction valves from the refueling water storage tank (RWST) and their power or control cables.

Due to the physical locations of these two valves, they are not impacted by any of the jets produced by the 19 breaks in this zone. Breaks in Lines 1CV09D-3, 1CV14EA-2, 1CV14ED-2, 1CV14EB-2, and 1CV14EC-2 all occur near their respective containment penetration and only discharge toward the containment wall. Since there is no equipment between these break locations and the containment, no components (including Valves 1CV112D and 1CV112E) are hit by breaks in these lines. A break in Line 1CV01E-3 produces a jet that only need be considered for a distance of 10 pipe diameters (~ 30 inches) per Reference 8.1.4. The distance from this break to these valves exceeds 10 pipe diameters so this break's jet does not impinge upon the valves. The remaining 12 breaks produce jets that are not directed (i.e., not in-line with) at these components as can be seen by examination of References 8.1.4 and 8.3.4 and, therefore, do not cause failure.

Additionally, sufficient redundancy exists in the plant design such that, even if both of these components and/or their power or control cables failed, the plant could still be safely shut down. The loss of both Valves 1CV112D and 1CV112E due to jet impingement would result in the loss of Line 1CV98C8 which transports borated water from the refueling water storage tank (RWST) to Line 1CV05B8 which serves as a suction header for the charging pumps and the safety injection pumps.

Access to the RWST or Volume Control Tank (VCT) is available via several other paths. These paths branch off of either the RWST Suction Line (1SI01B24) or the VCT Suction Line (1CV05B8). These paths include direct suction paths from the RWST to the SI pumps and also from the VCT to either the charging pumps or SI pumps. A single failure of the isolation valves between either the RWST or VCT and the SI or charging pump suction lines would not preclude safe shutdown. The unaffected isolation valves would still be available to permit flow to the SI or charging pumps since the isolation valves are not located in the same HELB zone as Valves 1CV112D and 1CV112E.

6.2.8.2 Equipment No. 1CV8100 and Cable Nos. 1CV035, 1CV036

These components are the CIV outside containment for the reactor coolant pumps seal water return line (1CV16F2) and its p[illegible]or control cables.

Due to the physical location of this valve, it is not impacted by any of the breaks in Zone 11.3H-1. The same reasons stated in Subsection 6.2.8.1 also apply here.

If Valve 1CV8100 or its power or control cables could be rendered inoperable due to jet impingement, there would be no adverse consequences relative to safe shutdown or mitigating the consequences of the accident because there is no requirement to isolate containment for outside containment breaks. But, in the event that system isolation is necessary, it could be achieved as discussed below. If Valve 1CV8100 is rendered inoperable due to jet impingement and Valve 1CV8112 fails to close due to single failure criteria, the line could be isolated manually via Valve 1CV8396A which is not located in HELB Zone 11.3H-1 per Drawing M-241 (Reference 8.3.4).

6.2.8.3 Equipment Nos. lCV8110 and lCV8111 and Cable Nos. 1CV057, 1CV058, 1CV059, 1CV061, 1CV062

These components are the charging pump miniflow valves and their power or control cables. During normal operation, these valves are open and are part of the miniflow circuit which is provided to protect the centrifugal charging pumps.

Due to the physical location of these valves, they are not impacted by any of the breaks in Zone 11.3H-1. The same reasons stated in Subsection 6.2.8.1 also apply to these valves.

Even if Valves lCV8110 or lCV8111 and/or their power or control cables could be rendered inoperable due to jet impingement, there would be no adverse consequences during normal operation. These valves are normally open and would fail in the open position. Thus, the miniflow circuit would be maintained. These valves are interlocked to automatically close after the safety injection signal is received. This signal requires that the break is a LOCA. A review of Reference 8.1.4 shows that three line breaks in Zone 11.3H-1 could potentially become LOCA's if not isolated. These breaks are all in the letdown line, and are considered LOCA's outside of containment if not isolated. If a safety injection signal were to result from these breaks, lCV8110 and lCV8111 would be directed to close by the interlock. This is done to avoid diverting any of the charging flow from the primary system. However, the breaks of interest are displaced 50 feet horizontally from the miniflow valves and the corresponding jets can not impact either of these valves. Furthermore, the three letdown line breaks are LOCA's only if not isolated. Isolation of the letdown line is not inhibited by jet impingement as discussed in Subsection 6.2.8.4.

Hence, even if Valves 1CV8110 or 1CV8111 or their associated cables were incapacitated by jet impingement, closure of the miniflow circuit would not be required following letdown line breaks due to letdown line isolation.

6.2.8.4 Equipment No. ICV8152 and Cable Nos. ICV323, ICV325, ICV326, and ICV327

These components are the CIV outside containment for the CV system letdown line from the reactor coolant system and its associated power and control cables.

For the reasons stated in Subsection 6.2.8.1, Valve ICV8152 is not impacted by any jets due to line breaks in Zone 11.3H-1 with two exceptions:

- A break in reactor coolant pump IA seal water injection line (ICV14DC) does produce a jet which may impinge on Valve ICV8152. However, if Valve ICV8152 is rendered inoperable by a jet emanating from Line ICV14DC, there are no adverse consequences relative to safe shutdown or mitigating the consequences of the accident. This is because there is no requirement to isolate the letdown line's containment penetration for outside containment breaks. However, if the letdown line itself breaks it may be necessary to isolate the break using Valve ICV8152.

- Valve ICV8152 could be rendered inoperable by a jet from a break in the letdown line. If the CIV inside containment (ICV8160) fails due to single failure criteria, then the letdown line must be isolated by some other means to avoid loss of reactor coolant inventory. Letdown line isolation is accomplished by closing either of the following, inside containment, fail-closed valves: 1CV460 or 1CV459. Hence, letdown line break isolation is not precluded by outside containment breaks.

For these same reasons, if any jet in Zone 11.3H-1 impinges on the power cables associated with Valve ICV8152 and causes them to fail, then isolation is not precluded by these failures.

6.2.8.5 Equipment No. ICV8804A and Cable Nos. 1CV406, 1CV407, 1CV408, 1CV410, and 1CV413

These components are the RHR heat exchanger to charging pump suction crosstie valve and its associated power or control cables. This valve is required only for the recirculation mode of ECCS operation following certain LOCA breaks. This valve is normally closed and is only required to open to effect switchover from the injection mode to the recirculation mode.

Due to the physical location of this valve, it is not impacted by HELB's. The same reasons stated in Subsection 6.2.8.1 also apply to this valve.

Even if jet impingement from a HELB in Zone 11.3H-1 did fail Valve 1CV8804A, it would have no consequence on safe shutdown. Valve 1CV8804A is not required to operate for any outside containment break because switchover to the recirculation mode is only appropriate following a LOCA inside of containment.

For these same reasons, if any jet in Zone 11.3H-1 incapacitates the associated cables to this valve safe shutdown would not be precluded.

6.2.8.6 Equipment Nos. 1RH8716A and 1RH8716B and Cable Nos. 1RH066, 1RH067, 1RH068, 1RH069, 1RH070, 1RH071, and 1RH072

These components are motor-operated isolation valves located in the crosstie piping downstream of the RHR heat exchangers and their associated power and/or control cables. The valves are normally open and fail "as is."

Due to the physical location of these valves, they are not hit by any of the 19 breaks in HELB Zone 11.3H-1. The same reasons stated in Subsection 6.2.8.1 also apply to these valves.

These valves are required during the alignment of the RHR system (for its SI function) for the recirculation phase following a LOCA. Since none of the 19 breaks in HELB Zone 11.3H-1 is a LOCA inside of containment, the recirculation phase of SI operation is not required for any of the 19 breaks postulated in this zone. Therefore, these valves are not required to operate for the HELB's postulated in this zone. Hence, even if jet impingement could fail one or both of these valves, safe shutdown is not precluded by these failures.

For these same reasons, if any jet in Zone 11.3H-1 incapacitates the associated cables to these valves safe shutdown would not be precluded.

6.2.8.7 Cable Nos. 1SI468, 1SI469, and 1SI470

These cables supply three of the four level transmitters in the RWST. Along with one additional level transmitter, these level transmitters are used in a 2/4 logic to provide alarm and some valve actuation signals. It is conservatively assumed that jet impingement effects from the line breaks in Zone 11.3H-1 can simultaneously fail all three of these cables, and this causes failure of RWST level alarms.

These RWST level alarms are only required during LOCA events to effect switchover from the injection mode to recirculation mode. The only breaks in this zone which could become LOCA's are three postulated breaks in the letdown line (Line 1CV01E-3). These breaks would constitute small-break LOCA's only if they were not isolated. Even if these breaks were not isolated, LOCA breaks outside containment do not require switchover to the recirculation mode of safety injection since no break fluid is spilled to the recirculation sump. Thus, the function of these RWST level alarms is not required for the LOCA breaks or any outside containment breaks. Moreover, breaks in the letdown line would be isolated before the RWST empties. Isolation of the letdown line is discussed in Subsection 6.2.8.4. Hence, HELB's in this zone do not require RWST level alarms to safely shut down the plant.

6.2.9 HELB Zone 11.4C-1

This zone is the Letdown Heat Exchanger 1B room. There are no potential block wall failures within this zone. Safe shutdown equipment and instrumentation are not located within the zone boundaries. The safe shutdown cables which are located within this zone are listed in Table 7-6.

The breaks in this zone occur at the inlet and outlet of Letdown Heat Exchanger 1B. These breaks are directed at the heat exchanger itself and the slab at Elevation 383 feet. The effects of the jets will be diminished to essentially zero forces after the fluid strikes the heat exchanger and slab. However, if it is conservatively assumed that all cables in the zone, which are listed in Table 7-6, are failed by a jet in the zone, the following equipment would be rendered inoperable:

1VA06CB: 1A Charging Pump Cubicle Cooler Fan
1VA10J: 1A Charging Pump Cubicle Cooler Control Panel

The loss of operability of the Charging Pump 1A (due to area cooler cable failures) simultaneously with the single failure of the 1B charging pump would render the charging system inoperable. Makeup, if required during shutdown from the letdown breaks under consideration, would have to be accomplished by the positive displacement charging pump (if non-1E power is restored) or by using the safety injection pumps when the primary system pressure has been reduced to below the SI pump shutoff head. Both the safety injection pumps and the positive displacement charging pump are unaffected by jets in Zone 11.4C-1.

6.2.10 HELB Zone 11.4D-0

This zone is the auxiliary steam pipe tunnel which is completely bounded by concrete walls or slabs. Safe shutdown equipment, instrumentation or cables are not located within this zone.

6.2.11 HELB Zone 11.4D-1

This zone is the Letdown Heat Exchanger 1A room. There are no potential block wall failures within this zone. Therefore, the effects of jet impingement, due to breaks in this zone, are totally contained within the zone boundaries. Safe shutdown cables, instrumentation or equipment are not located within the zone.

6.2.12 HELB Zone 11.4E-0

This zone is the seal water filter room located in a valve aisle in the Elevation 391 feet 6 inches general area of the Auxiliary Building. Safe shutdown equipment, instrumentation or cables are not located within this zone. Although block walls are associated with this zone, jets are either not directed at these block walls or jet force magnitudes are so low that block wall failures will not result per Reference 8.3.7. Hence, jet effects are contained within the zone. There are no safe shutdown equipment, instrumentation or cables in this zone.

6.2.13 HELB Zone 11.4F-0

This zone is a segment of the general area valve aisle located on Elevation 383 feet. The zone is located between the Letdown Heat Exchanger IA room and the Seal Water Heat Exchanger room. The boundaries consist of concrete block walls with one boundary defined by the extent of jet influence based on the two-phase jet criteria according to Reference 8.1.4. There is a partial block wall along the west side of the zone which is subjected to a jet. This block wall separates the zone from adjacent HELB zone, 11.4C-1, which is the Letdown Heat Exchanger IB room. Safe shutdown equipment is not located in either of these zones. The safe shutdown cables located in Zone 11.4F-0 are listed in Table 7-7 and are also routed through Zone 11.4C-1.

Hence, the effects of HELB jets in this zone on equipment, instrumentation, cables, and block walls leads to no additional failures beyond the failures discussed in Subsection 6.2.9. This is because the cables failed in Zone 11.4F-0 are also postulated to fail in the assessment of Zone 11.4C-1.

6.2.14 HELB Zone 11.5B-0

This zone is a section of Elevation 401 feet general area in the Auxiliary Building containing auxiliary steam piping. This zone is not bounded by physical barriers with the exception of several concrete walls, a block wall near the Boric Acid Tank and an "L" shaped fire wall. The boundaries of the zone are defined primarily by the zone of jet influence based on the two-phase jet criteria of 10 pipe diameters. This is because the postulated line breaks within the zone occur on auxiliary steam lines which result in two-phase and/or steam jets. According to Reference 8.1.4, there are only three high- energy lines in this zone which can break, and they are all 2- inch diameter pipes. The maximum extent of jet damage is limited to a distance of 20 inches from each respective break location. Hence, the zone boundaries as defined in Figure 2 are an extremely conservative representation of the effects of HELB jets in this zone. For this reason none of the physical boundaries of this zone are actually subjected to jet impingement based on high energy line routings in this zone.

Safe shutdown equipment or instrumentation is not located within this zone. Table 7-8 lists the cables which are routed in the vicinity of the zone. Most of the cables in the vicinity of the zone are routed in cable trays per the 6E-0-3031 and 6E-0-3032 series electrical drawings (References 8.3.1 and 8.3.6). These cable trays are routed between elevations spanning 425 feet 1 inch to 416 feet 6 inches. The remaining cables are routed in conduit based on Drawing 6E-0-3302D04 and its associated hanger drawings (Reference 8.3.6). These conduits contain Cables 1AB002 and 1AB003 and are routed at a minimum Elevation of 408 feet 1 inch at their closest point to the high energy lines under consideration.

The breaks postulated within this zone per Reference 8.1.4 produce very low force jets (200 pounds) and occur on the following lines:

- 0AS94A-2,
- 0ABA6B-2, and
- 0ABA2B-2.

Line 0AS94A-2 is depicted on Drawings M-255 and M-283 and isometric Drawings M-2550-A and M-2554-A (Reference 8.3.6). The low point of this line occurs at Elevation 405 feet near the boric acid batching tank while its highest point is Elevation 422 feet inch near the turbine building wall.

Line 0ABA6B-2 is depicted on Drawings M-2550-A and M-282 (Reference 8.3.6). The low point of this line is Elevation 404 feet 5 inches and the high point is Elevation 405 feet 9 inches both of which occur near the boric acid batching tank.

Line 0ASA2B-2 is depicted on Drawing M-282 (Reference 8.3.6). This line is routed horizontally at the base of the boric acid batching tank below Elevation 405 feet 10 inches.

The maximum elevation of either Line 0ASA2B-2 or OABA6B-2 is 405 feet 10 inches while the minimum elevation of all cables in this zone in the vicinity of these two lines is 408 feet 1 inch. The cables of interest are separated vertically from these lines by at least 2 feet 3 inches. Hence, based solely on vertical separation, potential breaks in these particular lines would not cause jet impingement on any cables in this zone since the separation is larger than the 20-inch zone of jet influence defined for these two-phase line breaks. The remainder of this discussion addresses the remaining line (i.e., 0AS94A-2).

Based on the cable routing drawings indicated previously, the following observations are made:

- The large north-south cable runs are routed in cable trays west of the "N" line. Specifically, these trays are at least 5 feet west of the "N" line.
- All east-west cable runs are routed in cable trays south of the 12 column by at least 16 feet.

These cable runs are compared to the relative position of the remaining high energy line for potential jet effects.

From the isometric drawings indicated previously, Line 0AS94A-2 is routed east of the "N" line by at least 1 foot. The north-south cable trays are routed 5 feet west of the "N" line. It is concluded that these north-south cable runs are separated from line OAS94A-2 by a distance of at least 6 feet, which is larger than the 20-inch zone of jet influence. Hence, these particular cable trays are not subjected to jet impingement based on separation from potential HELB's from Line 0AS94A-2.

Also, as shown on the isometric drawings, Line 0AS94A-2 is routed south of Column 12 by 4 feet 11 inches. Since the east-west cable run is at least 16 feet south of Column 12, this particular cable tray is separated from high-energy line 0AS94A-2 by at least 11 feet. This distance is clearly larger than the 20-inch zone of jet influence. Hence, the cables routed in this east-west tray are not subjected to jet impingement based on separation from the potential HELB's from Line 0AS94A-2.

The remaining cables to be considered in this zone are routed in conduits near the boric acid batching tank or in a short cable tray along the turbine building wall.

The cables routed in conduit are north of Column 16 by at least 6 feet. Piping from Line 0AS94A-2 is routed to a point 2 feet 10 inches south of Column 16. Hence, the conduits are separated from Line 0AS94A-2 by at least 8 feet. These conduits are separated from high-energy Line 0AS94A-2 by distances greater than the 20-inch zone of jet influence defined for these lines. Hence, these cables are not affected by jet impingement based on separation from potential HELB's from Line 0AS94A-2.

The short cable tray along the turbine building wall spans from 23 feet 3 inches to 8 feet 0 inch south of Column 12. The only high-energy line in this vicinity is Line 0AS94A-2 which is routed to a point only 4 feet 11 inches south of Column 12. Therefore, this cable tray is separated horizontally from this high-energy line by more than 3 feet which is clearly outside of the 20-inch zone of jet influence defined for this line. Hence, this cable tray is not affected by jet impingement based on separation from potential HELB's from Line 0AS94A-2.

Thus, it has been demonstrated that all cables within Zone 11.5B-0 are separated from potential line breaks in the zone by distances greater than the 20-inch zone of jet influence. No safe shutdown cables, instrumentation or equipment are impacted by jet impingement in this zone.

6.2.15 HELB Zone 14.3-0

This zone includes the radwaste surface condenser rooms which are separated by block walls. The zone is bounded by concrete partition walls. The block walls are assumed to fail and the entire zone is assumed to be affected by the HELB or wall failure.

Per Reference 8.3.7, two partition walls along the south wall and a portion of the east wall are postulated to fail under jet impingement forces. Jets are assumed to penetrate the zone boundaries in the direction of these failed partition walls. Based on Reference 8.1.4, jets from postulated breaks in this zone are steam or two-phase jets. Hence, the extent of jet damage is limited to a zone of influence of 10 pipe diameters from the break location. Reference 8.1.4 indicates that the largest high energy line in this zone is 20 inches.

A conservative zone of influence corresponding to 200 inches adjacent to either of the failed partition walls was examined for safe shutdown equipment, instrumentation, or cables. Based on examination of piping composite drawings (Reference 8.3.8), the following conclusions were drawn concerning safe shutdown equipment:

- No safe shutdown equipment or instrumentation is located within the zone boundaries.

- No safe shutdown equipment or instrumentation is located adjacent to the zone in the areas where jets could penetrate the failed partition walls.

- The safe shutdown equipment or instrumentation which is located nearest either of the failed partition walls is the Hydrogen Recombiner (0OG085B) which is at least 30 feet from the closest partition wall. Since the maximum extent of jet failure is conservatively 200 inches from the wall, the hydrogen recombiner is unaffected by jet impingement from HELB's occurring in this zone.

Safe shutdown equipment and instrumentation are unaffected by HELB jets in this zone. There are no safe shutdown cables located in this zone or adjacent to the zone in the zone of influence defined for the failed partition walls.

6.2.16 HELB Zone 14.5-0

This zone includes the radwaste evaporator rooms which are separated by block walls. The block walls are assumed to fail. The zone is bounded by concrete walls. Hence, the entire area is considered a damage area. However, no safe shutdown equipment, instrumentation or cables are located within this zone. Since the effects of jets are totally contained within the zone, there are no jet impingement consequences on safe shutdown equipment, instrumentation or cables from HELB's in this zone.

6.2.17 HELB Zone 18.3-1

This zone represents the main steam tunnel exclusive of the valve houses and auxiliary feedwater tunnel. There are no safe shutdown equipment, instrumentation or cables located within this zone. Also, there are no potential block wall failures due to jets or other HELB effects in this zone. The effects of jet impingement due to breaks in this zone are contained totally within the zone boundaries.

7.0 CONCLUSIONS

Based on the preceding jet impingement assessment, all power and control cables outside containment, electrical and mechanical equipment, and instrumentation used to attain a safe shutdown condition are adequately designed to accommodate the effects of HELB jet impingement.

Safe shutdown equipment and instrumentation inside and outside containment and cables outside containment have been examined for safe shutdown consequences from HELB jets with consideration of block wall failures. The block wall failures which were postulated resulted in no additional consequences on safe shutdown equipment, instrumentation or cables.

Equipment, instrumentation and cable failures have been assumed in areas where credit for potential jet deflection and/or jet pressure attenuation could have been taken but was not. If such features were accounted for, some failures could be potentially eliminated.

8.0 REFERENCES

8.1 Generic

8.1.1 NUREG-75/087, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," September 1975.

8.1.2 Westinghouse Letter No. CAW-7434, "Final Pipe Break Locations," from W. Kortier to W. C. Cleff, June 8, 1984.

8.1.3 NUREG/CR-2913, "Two-Phase Jet Loads," January 1983.

8.1.4 DIT-BY-PMD-0001-01, July 18, 1984 which transmitted PMD Calculation No. HELB-WL-2, Rev. 1, "Structural Loading Due to HELB," July 17, 1984.

8.1.5 Byron/Braidwood Stations, Final Safety Analysis Report, Amendment 44, December 1983.

8.1.6 a) Notes of Safe Shutdown Meeting held April 30, 1984 with Westinghouse, Commonwealth Edison Company, and Sargent & Lundy.

b) Notes of Safe Shutdown Instrumentation Meeting held February 17, 1984 with Commonwealth Edison and Sargent & Lundy.

c) Draft Technical Specifications for Byron Station, Unit 1, Docket No. STN 50-454, Section 3/4.4.

8.1.7 Byron/Braidwood Stations, Equipment Environmental Qualification Report, June 1982.

8.1.8 NSLD Calc. No. 3C8-1181-001, Rev. 0, "Survey of Auxiliary Building High Energy Line Breaks," December 21, 1981.

8.1.9 Interoffice Memorandum from K. J. Green to J. W. Ahrens, entitled, "Jet Impingement Study Bases," January 30, 1984.

8.1.10 Electrical Penetration Schedule, S&L Drawing 6E-1-3503, Rev. F, December 22, 1981.

8.2 Inside Containment

8.2.1 Component Cooling System Description, "SD-CAE/CBE-291, Revision 2, April 1983, Page 5.

8.2.2 Sargent & Lundy Electrical Installation Drawings:

Drawings	Sheet	Rev.	Date
6E-1-3553	-----	AE	3-6-84
6E-1-3554	-----	BU	4-17-84

8.2.3 PMD Calc. No. HELB-2, Rev.O "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Cables Inside Containment and Safe Shutdown Instrument Sensing Lines Inside and Outside Containment."

8.2.4 Sargent & Lundy Reactor Building Piping Drawings:

Drawing	Sheet	Rev.	Date
M-155	1	L	03-30-83
M-155	2	J	03-15-82
M-156	1	K	06-30-82
M-156	2	J	03-15-82
M-157	1	N	10-18-83
M-157	2	L	11-18-82
M-158	1	M	09-22-83
M-158	2	K	09-22-83
M-161	1	L	09-22-83
M-162	1	L	09-22-83
M-163	1	N	10-17-83
M-164	1	L	09-22-83
M-165	1	L	09-22-83
M-165	2	K	08-12-82
M-166	1	K	12-22-82
M-166	2	K	08-12-82

Drawing	Sheet	Rev.	Date
M-167	1	P	11-28-83
M-167	2	L	08-12-82
M-168	1	L	06-09-82
M-168	2	H	02-05-82
M-169	1	L	10-26-83
M-170	1	M	10-26-83
M-171	1	L	10-26-83
M-172	1	M	10-26-83
M-173	1	D	11-27-79
M-174	1	D	11-27-79
M-175	1	G	03-09-82
M-176	1	J	07-26-83

8.2.5 Sargent & Lundy Drawings:

Drawing	Sheet	Rev.	Date
A-333	-	P	07-28-83
A-334	-	P	04-28-83
A-335	-	R	07-17-80
A-336	-	M	04-28-83
M-1276	-	P	03-25-83
M-1277	-	T	08-29-83
M-14	-	F	03-27-81
M-54	2	G	12-30-80
M-55	2	H	11-10-80

8.3 Outside Containment

8.3.1 DIT-BY-EPED-0007, dated August 3, 1984 from J.D. Regan to J.W. Ahrens

8.3.2 Sargent & Lundy Drawings:

Drawing	Sheet	Rev.	Date
M-210	1	N	04-30-82
M-210	2	G	03-16-83
M-211	1	M	04-30-82
A-207	-	AM	04-14-83
A-208	-	AU	03-27-84
6E-0-3302 Series	-	BH	05-03-84
S-1550	-	Y	03-02-84

8.3.3 Sargent & Lundy Drawings:

Drawing	Sheet	Rev.	Date
M-222	1	N	05-25-83
M-223	1	M	01-21-83
M-227	1	M	07-29-83

8.3.4 Sargent & Lundy Drawings:

Drawing	Sheet	Rev.	Date
M-228	1	R	05-25-83
M-228	2	D	03-16-83
M-229	1	D	01-21-83
M-230	1	S	05-25-83
M-241	2	D	03-16-83
M-244	1	S	05-25-83

8.3.5 Sargent & Lundy Architectural Drawings:

Drawing	Sheet	Rev.	Date
A-219	1	AF	7-28-83
A-222	1	V	01-31-84
A-223	1	AY	02-29-84
A-225	1	T	12-23-83
A-232	1	AE	02-29-84
A-233	1	AH	02-29-84
A-234	1	AE	01-31-84
A-239	1	AU	02-29-84
A-251	1	AS	02-29-84

8.3.6 Sargent & Lundy Drawings:

Drawing	Sheet	Rev.	Date
6E-0-3031 Series	-	Z	03-30-84
6E-0-3032 Series	-	R	06-30-83
6E-0-3332D04	-	M	04-12-84
M-255	1	R	09-30-83
M-282	1	S	09-30-83
M-283	1	J	11-12-82
M-2550-A	58	4	06-18-83 (as-built)
M-2554-A	15	4	08-28-83 (as-built)

8.3.7 DIT-BB-SED-0011, July 19, 1984 from R. J. Marshalla to K. J. Green/ J. W. Ahrens.

8.3.8 Sargent & Lundy Drawings:

Drawing	Sheet	Rev.	Date
M-248	1	M	11-12-83
M-249	1	L	07-29-83
M-252	1	T	07-29-83
M-253	1	P	05-25-83

Table 1-1

Equipment Inside Containment Used for Safe Shutdown

Equipment Number	Equipment Name	Disposition Section
T1 thru T33	Division 11 Core Exit Thermocouples	5.23
T34 thru T65	Division 12 Core Exit Thermocouples	5.23
1CC9416	Gate Isol. Valve, 6", Motor Op.	5.10
1CC9438	Gate Isol. Valve, 4", Motor Op.	5.10
1CV8112	Globe Isol. Valve, 2", Motor Op.	5.11
1CV8160	Globe Isol. Valve, 3", Solenoid	5.12
1FP011	Globe Isol. Valve, Solenoid	5.6
1IA066	Globe Isol. Valve, Solenoid	5.5
1LT-459	Pressurizer Level Transmitter	5.15
1LT-460	Pressurizer Level Transmitter	5.15
1LT-461	Pressurizer Level Transmitter	5.15
1LT-517	Stm Gen Narrow Range Level Transmitter	5.22
1LT-518	Stm Gen Narrow Range Level Transmitter	5.22
1LT-519	Stm Gen Narrow Range Level Transmitter	5.22
1LT-527	Stm Gen Narrow Range Level Transmitter	5.22
1LT-528	Stm Gen Narrow Range Level Transmitter	5.22
1LT-529	Stm Gen Narrow Range Level Transmitter	5.22
1LT-537	Stm Gen Narrow Range Level Transmitter	5.22
1LT-538	Stm Gen Narrow Range Level Transmitter	5.22
1LT-539	Stm Gen Narrow Range Level Transmitter	5.22
1LT-547	Stm Gen Narrow Range Level Transmitter	5.22
1LT-548	Stm Gen Narrow Range Level Transmitter	5.22
1LT-549	Stm Gen Narrow Range Level Transmitter	5.22
1LT-556	Stm Gen Narrow Range Level Transmitter	5.22
1LT-557	Stm Gen Narrow Range Level Transmitter	5.22
1LT-558	Stm Gen Narrow Range Level Transmitter	5.22
1LT-559	Stm Gen Narrow Range Level Transmitter	5.22
1OG057A	Butterfly Isol. Valve, Motor Op.	5.9
1OG079	Butterfly Isol. Valve, 3", Motor Op.	5.9
1OG080	Butterfly Isol. Valve, 3", Motor Op.	5.9
1OG081	Butterfly Isol. Valve, 3", Motor Op.	5.9
1PS9354A	Globe Isol. Valve, 3/8", Solenoid	5.7
1PS9355A	Globe Isol. Valve, 3/8", Solenoid	5.7
1PS9356A	Globe Isol. Valve, 3/8", Solenoid	5.7
1PS9357A	Globe Isol. Valve, 3/8", Solenoid	5.7

Table 1-1 (continued)

*Equipment Inside Containment
Used for Safe Shutdown*

Equipment Number	Equipment Name	Disposition Section
1PT-403	RC Pressure Transmitter	5.16
1PT-405	RC Pressure Transmitter	5.16
1PT-455	Pressurizer Pressure Transmitter	5.25
1PT-456	Pressurizer Pressure Transmitter	5.25
1PT-457	Pressurizer Pressure Transmitter	5.25
1PT-458	Pressurizer Pressure Transmitter	5.25
1RC014A	Globe Valve, 1"	5.3
1RC014B	Globe Valve, 1"	5.3
1RC014C	Globe Valve, 1"	5.3
1RC014D	Globe Valve, 1"	5.3
1RC01BA	Steam Generator 1A	5.17
1RC01BB	Steam Generator 1B	5.17
1RC01BC	Steam Generator 1C	5.17
1RC01BD	Steam Generator 1D	5.17
1RC01R	Reactor Vessel	5.21
1RE-AR011	Cnmt Radiation Monitor	5.27
1RE-AR012	Cnmt Radiation Monitor	5.27
1RE1003	Diaph. Isol. Valve, 3", 2 Solenoids	5.8
1RE9159A	Diaph. Isol. Valve, 3/4", Solenoid	5.8
1RE9160A	Diaph. Isol. Valve, 1", Solenoid	5.8
1RF026	Plug Valve, 2", Solenoid	5.8
1RH8701A	Gate Isol. Valve, 12", Motor Op.	5.13
1RH8701B	Gate Valve, 12", Motor Op.	5.13
1RH8702A	Gate Isol. Valve, 12", Motor Op.	5.13
1RH8702B	Gate Valve, 12", Motor Op.	5.13
1RY01S	Pressurizer	5.20
1RY20MA	PORV Nitrogen Accumulator Tank	5.19
1RY20MB	PORV Nitrogen Accumulator Tank	5.19
1RY455A	PORV, 2 Solenoids	5.4
1RY456	PORV, 2 Solenoids	5.4
1RY8000A	Gate Valve, 3", Motor Op.	5.4
1RY8000B	Gate Valve, 3", Motor Op.	5.4
1RY8026	Globe Isol. Valve, 3/8", Solenoid	5.14
1SA033	Globe Isol. Valve, Solenoid	5.5
1SI04TA	Accumulator	5.18
1SI04TB	Accumulator	5.18
1SI04TC	Accumulator	5.18

Table 1-1 (continued)

*Equipment Inside Containment
Used for Safe Shutdown*

Equipment Number	Equipment Name	Disposition Section
1SI04TD	Accumulator	5.18
1TE-411A	Narrow Range Reactor Coolant RTD	5.26
1TE-411B	Narrow Range Reactor Coolant RTD	5.26
1TE-421A	Narrow Range Reactor Coolant RTD	5.26
1TE-421B	Narrow Range Reactor Coolant RTD	5.26
1TE-431A	Narrow Range Reactor Coolant RTD	5.26
1TE-431B	Narrow Range Reactor Coolant RTD	5.26
1TE-441A	Narrow Range Reactor Coolant RTD	5.26
1TE-441B	Narrow Range Reactor Coolant RTD	5.26
1VP01AA	Cnmt Ess'l Service Water Coil 1A (RCFC)	5.1
1VP01AB	Cnmt Ess'l Service Water Coil 1B (RCFC)	5.1
1VP01AC	Cnmt Ess'l Service Water Coil 1C (RCFC)	5.1
1VP01AD	Cnmt Ess'l Service Water Coil 1D (RCFC)	5.1
1VP01CA	Prim. Cnmt. Vent System RCFC Fan, Motor	5.1
1VP01CB	Prim. Cnmt. Vent System RCFC Fan, Motor	5.1
1VP01CC	Prim. Cnmt. Vent System RCFC Fan, Motor	5.1
1VP01CD	Prim. Cnmt. Vent System RCFC Fan, Motor	5.1
1VQ001A	Butterfly Isol. Valve, Actuator	5.2
1VQ002A	Butterfly Isol. Valve, Actuator	5.2
1VQ004A	Butterfly Isol. Valve, Solenoid	5.2
1VQ005A	Butterfly Isol. Valve, Solenoid	5.2
1WO056A	Gate Control Isol Valve, 10"	5.24
1WO056B	Gate Control Isol Valve, 10"	5.24

Table 1-2

Equipment Outside Containment Used for Safe Shutdown

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
0AB03P	Shared Boric Acid Transfer Pump	11. 5 -0	6.1.1
1AB03P	Unit 1 Boric Acid Transfer Pump	11. 5 -0	6.1.1
1AB03T	Boric Acid Tank	11. 5 -0	6.1.1
1AF006A	Ess'l Service Water to AF Pump Suc Valve	11. 4A-1	6.1.1
1AF006B	Ess'l Service Water to AF Pump Suc Valve	11. 4A-1	6.1.1
1AF017A	Ess'l Service Water to AF Pump Suc Valve	11. 4 -0	6.1.1
1AF017B	Ess'l Service Water to AF Pump Suc Valve	11. 4A-1	6.1.1
1AF01AA	Motor Driven AF Oil Cooler	11. 4 -0	6.1.1
1AF01AB	Diesel AF Pump Oil Cooler	11. 4A-1	6.1.1
1AF01PA-1	Aux Feedwater Pump 1A (Motor Driven)	11. 4 -0	6.1.1
1AF01PA-A	Lube Oil Pump for AF 1A	11. 4 -0	6.1.1
1AF01PB-2	Aux Feedwater Pump 1B (Diesel Driven)	11. 4A-1	6.1.1
1AF01PB-A	Lube Oil Pump for AF 1B	11. 4 -1	6.1.1
1AP05E	4160v Switchgear - ESF Div 11	5. 2 -1	6.1.1
1AP06E	4160v Switchgear - ESF Div 12	5. 1 -1	6.1.1
1AP10E	480v Switchgear (131X, 131Z)	5. 2 -1	6.1.1
1AP10E	480v Switchgear (131X, 131Z)	18.14B-1	6.1.1
1AP12E	480v Switchgear (132X, 132Z)	5. 1 -1	6.1.1
1AP12E	480v Switchgear (132X, 132Z)	18.14A-1	6.1.1
1AP21E	480v MCC 131X1	11. 3 -1	6.1.1
1AP22E	480v MCC 131X3	11. 4 -0	6.1.1
1AP23E	480v MCC 132X1	11. 3 -0	6.1.1
1AP24E	480v MCC 132X3	11. 4 -0	6.1.1
1AP26E	480v MCC 131X4	11. 5A-1	6.1.1
1AP28E	480v MCC 132X4	11. 6 -1	6.1.1
1AP30E	480v MCC 131X5	11. 6 -0	6.1.1
1AP32E	480v MCC 132X5	11. 6 -0	6.1.1
1AP42E	480v MCC 133X3	11. 5 -0	6.1.1
1AP43E	480v MCC 134V3	11. 5 -0	6.1.1
0CC01A	Comp Cooling Hx	11. 3 -0	6.1.1
1CC01A	Comp Cooling Hx	11. 3 -0	6.1.1
0CC01P	"O" Comp. Cooling Pump	11. 3 -0	6.1.1
1CC01PA	1A Comp. Cooling Pump	11. 3 -0	6.1.1
1CC01PB	1B Comp. Cooling Pump	11. 3 -0	6.1.1
1CC01T	Comp Cooling Surge Tank	11. 6 -0	6.1.1
1CC685	Gate MO Valve (Cnmt Isol)	11. 3 -1	6.1.1
1CC9412A	1A RHR Hx Outlet Valve	11. 3 -0	6.1.1
1CC9412B	1B RHR HX Outlet Valve	11. 3 -0	6.1.1
1CC9413A	Gate MO Valve (Cnmt Isol)	11. 3 -1	6.1.1
1CC9413B	Gate MO Valve (Cnmt Isol)	11. 3 -1	6.1.1

Table 1-2 (continued)

*Equipment Outside Containment
Used for Safe Shutdown*

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1CC9414	Gate MO valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CC9422B	Relief Valve		11. 3 -0	6.1.1
1CC9437A	Globe AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CC9437B	Globe AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CD01T	Condensate Storage Tank		18.23 -0	6.1.1
1CS001A	MO Globe Valve		11. 3H-1	6.1.2
1CS001B	MO Globe Valve		11. 3 -1	6.1.1
1CS007A	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CS007B	Gate Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CS009A	Gate Valve and Motor Op		11. 2B-1	6.1.1
1CS009B	Gate Valve and Motor Op		11. 2C-1	6.1.1
1CS019A	Gate Valve		11. 2B-1	6.1.1
1CS019B	Gate Isolation Valve & Motor Op		11. 2C-1	6.1.1
1CS01PA	Cnmt Spray Pump 1A and Motor		11. 2B-1	6.1.1
1CS01PB	Cnmt Spray Pump 1B and Motor		11. 2C-1	6.1.1
1CS01T	Spray Additive Tank		11. 3 -1	6.1.1
1CV01PA	Ch'g Pump 1A and Motor		11. 3D-1	6.2.6
1CV01PA-A	Ch'g Pump 1A Lube Oil Pump		11. 3D-1	6.2.6
1CV01PB	Ch'g Pump 1B and Motor		11. 3G-1	6.2.7
1CV01PB-A	Ch'g Pump 1B Lube Oil Pump		11. 3G-1	6.2.7
1CV01T	Vol Control Tank		11. 6A-1	6.1.1
1CV02SA	Ch'g Pump 1A Gear Cooler		11. 3D-1	6.2.6
1CV02SB	Ch'g Pump 1B Gear Cooler		11. 3G-1	6.2.7
1CV03SA	Ch'g Pump 1A Lube Oil Cooler		11. 3D-1	6.2.6
1CV03SB	Ch'g Pump 1B Lube Oil Cooler		11. 3G-1	6.2.7
1CV112B	Gate Valve and Motor Op		11. 6A-1	6.1.1
1CV112C	Gate Valve and Motor Op		11. 6A-1	6.1.1
1CV112D	MO Gate Valve		11. 3H-1	6.2.8
1CV112E	MO Gate Valve		11. 3H-1	6.2.8
1CV8100	MO Globe Isolation Valve		11. 3H-1	6.2.8
1CV8104	Gate Valve and Motor Op		11. 6A-1	6.1.1
1CV8105	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8106	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8110	Ch'g Pump Miniflow Valve		11. 3H-1	6.2.8
1CV8111	Ch'g Pump Miniflow Valve		11. 3H-1	6.2.8
1CV8152	AO Globe Isolation Valve		11. 3H-1	6.2.8
1CV8355A	Globe MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CV8355B	Globe MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8355C	Globe MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8355D	Globe MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CV8804A	MO Gate Valve		11. 3H-1	6.2.8

Table 1-2 (continued)

Equipment Outside Containment Used for Safe Shutdown

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1DC01E	115v Battery 111 Div 11	5. 6 -1	6.1.1
1DC02E	125v Battery 112 Div 12	5. 4 -1	6.1.1
1DC03E	Battery Charger 111 Div 11	5. 6 -1	6.1.1
1DC04E	Battery Charger 112 Div 12	5. 4 -1	6.1.1
1DC05E	125v DC Bus 121 ESF Div 11	5. 6 -1	6.1.1
1DC06E	125v DC Bus 111 ESF Div 12	5. 4 -1	6.1.1
1DG01KA	Diesel Generator 1A and Hx	9. 2 -1	6.1.1
1DG01KB	Diesel Generator 1B and Hx	9. 1 -1	6.1.1
1DO01PA	1A Fuel Oil Transfer Pump	10. 2 -1	6.1.1
1DO01PB	1B Fuel Oil Transfer Pump	10. 1 -1	6.1.1
1DO01PC	1C Fuel Oil Transfer Pump	10. 2 -1	6.1.1
1DO01PD	1D Fuel Oil Transfer Pump	10. 1 -1	6.1.1
1DO01TA	DG Storage Tank	10. 2 -1	6.1.1
1DO01TB	DG Storage Tank	10. 1 -1	6.1.1
1DO01TC	DG Storage Tank	10. 2 -1	6.1.1
1DO01TD	DG Storage Tank	10. 1 -1	6.1.1
1DO02TA	DG Day Tank 1A	9. 3 -1	6.1.1
1DO02TB	DG Day Tank 1B	9. 4 -1	6.1.1
0DO08TA	Ess'l Service Water Makeup Diesel Tank 0A	18.11 -2	6.1.1
0DO08TB	Ess'l Service Water Makeup Diesel Tank 0B	18.11 -1	6.1.1
1DO10T	AF Diesel Day Tank	11. 4A-1	6.1.1
0FE-VA003	Flow Element	11. 7 -0	6.1.1
0FE-VA004	Flow Element	11. 7 -0	6.1.1
0FE-VA005	Flow Element	11. 7 -0	6.1.1
0FE-VA006	Flow Element	11. 7 -0	6.1.1
0FE-VA007	Flow Element	11. 7 -0	6.1.1
0FE-VA008	Flow Element	11. 7 -0	6.1.1
0FE-VA009	Flow Element	11. 7 -0	6.1.1
0FE-VA010	Flow Element	11. 7 -0	6.1.1
1FP010	Globe Valve (Cnmt Isol)	11. 3 -1	6.1.1
1FW009A	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1FW009B	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1FW009C	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1FW009D	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1FW035A	Control Valve & Solenoid	18. 3A-1	6.1.1
1FW035B	Control Valve & Solenoid	18. 3A-1	6.1.1
1FW035C	Control Valve & Solenoid	18. 3A-1	6.1.1
1FW035D	Control Valve & Solenoid	18. 3A-1	6.1.1
1FW043A	Control Isolation Valve & Solenoid	18. 3A-1	6.1.1

07/24/84
11:12:12

Table 1-2 (continued)

Equipment Outside Containment
Used for Safe Shutdown

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1FW043B	Control Isolation Valve & Solenoid	18. 3A-1	6.1.1
1FW043C	Control Isolation Valve & Solenoid	18. 3A-1	6.1.1
1FW043D	Control Isolation Valve & Solenoid	18. 3A-1	6.1.1
1IA065	Globe Valve (Cnmt Isol)	11. 3H-1	6.1.2
1LS-DO033	Diesel Oil Day Tank Level Switch	9. 2 -1	6.1.1
1LS-DO036	Diesel Oil Day Tank Level Switch	9. 1 -1	6.1.1
1LT-930	RWST Level Transmitters	16. 1 -1	6.1.1
1LT-931	RWST Level Transmitters	16. 1 -1	6.1.1
1LT-932	RWST Level Transmitters	16. 1 -1	6.1.1
1LT-933	RWST Level Transmitters	16. 1 -1	6.1.1
1MS001A	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS001B	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS001C	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS001D	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS013A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS013B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS013C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS013D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS014A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS014B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS014C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS014D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS015A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS015B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS015C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS015D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS016A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS016B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS016C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS016D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS017A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS017B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS017C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS017D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS018A	SG Atm Relief Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS018B	SG Atm Relief Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS018C	SG Atm Relief Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS018D	SG Atm Relief Valve & Hydraulic Op	18. 3A-1	6.1.1
0OG059	Butterfly Valve, 3"	11. 5 -0	6.1.1

Table 1-2 (continued)

Equipment Outside Containment
Used for Safe Shutdown

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
00G060	Butterfly Valve, 3"		11. 5 -0	6.1.1
00G061	Butterfly Valve, 3"		11. 5 -0	6.1.1
00G062	Butterfly Valve, 3"		11. 5 -0	6.1.1
00G063	Butterfly Valve, 3"		11. 5 -0	6.1.1
00G064	Butterfly Valve, 3"		11. 5 -0	6.1.1
10G082	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
10G083	Butterfly Valve	(Cnmt Isol)	11. 3H-1	6.1.2
10G084	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
10G085	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
00G08SA	Hydrogen Recombiner		11. 5 -0	6.1.1
00G08SB	Hydrogen Recombiner		11. 5 -0	6.1.1
1PA27J	Aux Safeguard Relay Cabinet (A)		5. 5 -1	6.1.1
1PA28J	Aux Safeguard Relay Cabinet (B)		5. 5 -1	6.1.1
1PL04J	Remote Control Panel		11. 4C-0	6.1.1
1PL05J	Remote Control Panel		11. 4C-0	6.1.1
1PL06J	Remote Control Panel		11. 4C-0	6.1.1
1PL07J	Diesel Control Panel		9. 2 -1	6.1.1
1PL08J	Diesel Control Panel		9. 1 -1	6.1.1
1PLS-AF051	Aux Feedwater Pump 1A Switch		11. 4 -0	6.1.1
1PLS-AF055	Aux Feedwater Pump 1B Switch		11. 4A-1	6.1.1
1PM05J	Main Control Panel		2. 1 -0	6.1.1
1PM06J	Main Control Panel		2. 1 -0	6.1.1
1PR001A	Control Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PR001B	Control Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PR066	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS-CV032	Ch'g Pump 1A Pressure Switch		11. 3D-1	6.2.6
1PS-CV033	Ch'g Pump 1B Pressure Switch		11. 3G-1	6.2.7
1PS228A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS228B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS229A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS229B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS230A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS230B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9354B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9355B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9356B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9357B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PT-514	Loop 1A (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1

Table 1-2 (continued)

*Equipment Outside Containment
Used for Safe Shutdown*

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1PT-515	Loop 1A (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-516	Loop 1A (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-524	Loop 1B (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-525	Loop 1B (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-526	Loop 1B (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-534	Loop 1C (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-535	Loop 1C (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-536	Loop 1C (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-544	Loop 1D (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-545	Loop 1D (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-546	Loop 1D (Stm Gen) MS Pressure Transmitter		18. 3A-1	6.1.1
1PT-934	Cnmt Pressure Transmitter		11. 6 -1	6.1.1
1PT-935	Cnmt Pressure Transmitter		11. 7 -1	6.1.1
1PT-936	Cnmt Pressure Transmitter		11. 7 -1	6.1.1
1PT-937	Cnmt Pressure Transmitter		11. 6 -1	6.1.1
1RE9157	Diaph Seat AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RE9159B	Diaph AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RE9160B	Diaph AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RE9170	3" Diaphragm Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RF027	Plug Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RH01PA	RHR Pump 1A and Motor		11. 2A-1	6.1.1
1RH01PB	RHR Pump 1A and Motor		11. 2D-1	6.1.1
1RH01SA	Sump Valve Cnmt Assy	(Cnmt Isol)	11. 3H-1	6.1.2
1RH01SB	Sump Valve Cnmt Assy	(Cnmt Isol)	11. 3F-1	6.1.1
1RH02AA	RHR Hx 1A		11. 3B-1	6.1.1
1RH02AB	RHR Hx 1B		11. 3E-1	6.1.1
1RH606	HX Discharge Valve		11. 3B-1	6.1.1
1RH607	HX Discharge Valve		11. 3E-1	6.1.1
1RH610	RHR Pump Miniflow Valve		11. 3B-1	6.1.1
1RH611	RHR Pump Miniflow Valve		11. 3E-1	6.1.1
1RH618	HX Bypass Valve		11. 3B-1	6.1.1
1RH619	HX Bypass Valve		11. 3E-1	6.1.1
1RH8716A	MO Globe Valve		11. 3H-1	6.2.8
1RH8716B	MO Globe Valve		11. 3H-1	6.2.8
1RY8025	Globe AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RY8028	Diaph AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RY8033	Diaph AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SA032	Globe Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SD002A	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1

Table 1-2 (continued)

*Equipment Outside Containment
Used for Safe Shutdown*

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1SD002B	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD002C	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD002D	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD002E	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD002F	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD002G	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD002H	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD005A	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD005B	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD005C	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SD005D	Angle Isolation Valve & Solenoid		18. 3A-1	6.1.1
1SI01PA	Safety Injection Pump 1A and Motor		11. 3A-1	6.1.1
1SI01PB	Safety Injection Pump 1B and Motor		11. 3F-1	6.1.1
1SI01SA	Safety Injection Pump 1A Oil Cooler		11. 3A-1	6.1.1
1SI01SB	Safety Injection Pump 1B Oil Cooler		11. 3F-1	6.1.1
1SI01T	Refueling Water Storage Tank		16. 1 -1	6.1.1
1SI8801A	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8801B	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8802A	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8802B	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8804B	Gate Valve and Motor Op		11. 3F-1	6.1.1
1SI8806	8" MO Gate Valve		11. 3F-1	6.1.1
1SI8807A	6" MO Gate Valve		11. 3A-1	6.1.1
1SI8807B	6" MO Gate Valve		11. 3A-1	6.1.1
1SI8809A	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8809B	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8811A	Gate Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8811B	Gate Isolation Valve	(Cnmt Isol)	11. 3F-1	6.1.1
1SI8812A	MO Gate Valve		11. 2B-1	6.1.1
1SI8812B	MO Gate Valve		11. 2D-1	6.1.1
1SI8814	MO Globe Valve		11. 3A-1	6.1.1
1SI8821A	MO Globe Valve		11. 3H-1	6.1.2
1SI8821B	MO Globe Valve		11. 3H-1	6.1.2
1SI8835	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8840	Gat MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8888	Globe AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8920	MO Globe Valve		11. 3F-1	6.1.1
1SI8923A	MO Gate Valve		11. 3A-1	6.1.1
1SI8923B	Gate Valve and Motor Op		11. 3F-1	6.1.1
1SI8924	MO Gate Valve		11. 3A-1	6.1.1
1SX005	Pump Disch. to Comp. Cooling Hx "O" Valve		11. 1B-0	6.1.1
1SX016A	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1

Table 1-2 (continued)

*Equipment Outside Containment
Used for Safe Shutdown*

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1SX016B	Butterfly Valve (Cnmt Isol)	11. 3 -1	6.1.1
1SX01AA	Ess'l Service Water Pump 1A Oil Cooler	11. 1A-0	6.1.1
1SX01AB	Ess'l Service Water Pump 1B Oil Cooler	11. 1B-0	6.1.1
1SX01FA-1	Ess'l Service Water Strainer	11. 1A-0	6.1.1
1SX01FB-2	Ess'l Service Water Strainer	11. 1B-0	6.1.1
1SX01K	Diesel AF Closed Cycle Hx	11. 4A-1	6.1.1
1SX01PA	1A Ess'l Service Water Pump	11. 1A-0	6.1.1
1SX01PB	1B Ess'l Service Water Pump	11. 1B-0	6.1.1
1SX027A	Butterfly Valve (Cnmt Isol)	11. 3 -1	6.1.1
1SX027B	Butterfly Valve (Cnmt Isol)	11. 3 -1	6.1.1
0SX02AA	Ess'l Service Water Cooling Tower A	17. 2 -1	6.1.1
0SX02AB	Ess'l Service Water Cooling Tower B	17. 2 -2	6.1.1
1SX02K	AF Gear Drive Lube Oil Cooler	11. 4A-1	6.1.1
0SX02PA	Ess'l Service Water Makeup Pump	18.11 -0	6.1.1
0SX02PB	Ess'l Service Water Makeup Pump	18.11 -0	6.1.1
0SX04AA	Ess'l Service Water Makeup Pump Cooler 0A	18.11 -0	6.1.1
0SX04AB	Ess'l Service Water Makeup Pump Cooler 0B	18.11 -0	6.1.1
1SX04P	AF Pump Cooling Water Pump	11. 4A-1	6.1.1
1SX101A	Aux FW Pump Oil Cooler Valve	11. 4 -0	6.1.1
0SX146	Comp. Cooling Hx "0" Valve	11. 2 -0	6.1.1
0SX147	Component Cooling Hx "0" Valve	11. 2 -0	6.1.1
1SX169A	DG 1A Hx Outlet Valve	9. 1 -1	6.1.1
1SX169B	DG 1B Hx Outlet Valve	9. 2 -1	6.1.1
1SX173	Ess'l Service Water to Ch'g Pump Suc Valve	11. 4A-1	6.1.1
1SX178	Ess'l Service Water to Ch'g Pump Suc Valve	11. 4A-1	6.1.1
0VA01CA	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
1VA01CA	SX Pump 1A Cubicle Cooler Fan, Motor	11. 1A-0	6.1.1
1VA01CB	SX Pump 1A Cubicle Cooler Fan, Motor	11. 1A-0	6.1.1
0VA01CB	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
0VA01CC	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
1VA01CC	SX Pump 1A Cubicle Cooler Fan, Motor	11. 1A-0	6.1.1
1VA01CD	SX Pump 1A Cubicle Cooler Fan, Motor	11. 1A-0	6.1.1
0VA01CD	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
1VA01CE	SX Pump 1B Cubicle Cooler Fan	11. 1B-0	6.1.1
1VA01CF	SX Pump 1B Cubicle Cooler Fan	11. 1B-0	6.1.1
1VA01CG	SX Pump 1B Cubicle Cooler Fan	11. 1B-0	6.1.1
1VA01CH	SX Pump 1B Cubicle Cooler Fan	11. 1B-0	6.1.1
1VA01J	SX Pump 1A Cubicle Cooler Local Panel	11. 1A-0	6.1.1
1VA01SA	Ess'l Service Water Pump 1A Cooler	11. 1A-0	6.1.1
1VA01SB	Ess'l Service Water Pump 1B Cooler	11. 1B-0	6.1.1
0VA022YA	Damper	11. 7 -0	6.1.1
0VA022YB	Damper	11. 7 -0	6.1.1
0VA023YA	Damper	11. 7 -0	6.1.1

Table 1-2 (continued)

*Equipment Outside Containment
Used for Safe Shutdown*

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
OVA023YB	Damper	11. 7 -0	6.1.1
OVA024YA	Damper	11. 7 -0	6.1.1
OVA024YB	Damper	11. 7 -0	6.1.1
OVA025YA	Damper	11. 7 -0	6.1.1
OVA025YB	Damper	11. 7 -0	6.1.1
1VA02CA	RHR Pump 1A Cubicle Cooler Fan and Motor	11. 2A-1	6.1.1
OVA02CA	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA02CB	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
1VA02CB	RHR Pump 1A Cubicle Cooler Fan and Motor	11. 2A-1	6.1.1
1VA02CC	RHR Pump 1B Cubicle Cooler Fan and Motor	11. 2D-1	6.1.1
OVA02CC	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA02CD	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
1VA02CD	RHR Pump 1B Cubicle Cooler Fan and Motor	11. 2D-1	6.1.1
1VA02J	SX Pump 1B Cubicle Cooler Local Panel	11. 1B-0	6.1.1
1VA02SA	RHR Pump 1A Cubicle Cooler	11. 2A-1	6.1.1
1VA02SB	RHR Pump 1B Cubicle Cooler	11. 2D-1	6.1.1
1VA03CA	CS Pump 1A Cubicle Cooler Fan, Motor	11. 2B-1	6.1.1
OVA03CA	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CB	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
1VA03CB	CS Pump 1A Cubicle Cooler Fan, Motor	11. 2B-1	6.1.1
1VA03CC	CS Pump 1A Cubicle Cooler Fan, Motor	11. 2B-1	6.1.1
OVA03CC	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CD	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
1VA03CD	CS Pump 1A Cubicle Cooler Fan, Motor	11. 2B-1	6.1.1
1VA03CE	CS Pump 1B Cubicle Cooler Fan and Motor	11. 2C-1	6.1.1
OVA03CE	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CF	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
1VA03CF	CS Pump 1B Cubicle Cooler Fan and Motor	11. 2C-1	6.1.1
1VA03CG	CS Pump 1B Cubicle Cooler Fan and Motor	11. 2C-1	6.1.1
1VA03CH	CS Pump 1B Cubicle Cooler Fan and Motor	11. 2C-1	6.1.1
1VA03J	Cubicle Cooler Local Panel	11. 2A-1	6.1.1
1VA03SA	CS Pump 1A Cubicle Cooler	11. 2B-1	6.1.1
1VA03SB	CS Pump 1B Cubicle Cooler	11. 2C-1	6.1.1
1VA04CA	SI Pump 1A Cubicle Cooler Fan, Motor	11. 3A-1	6.1.1
OVA04CA	Fuel Hdlg Bldg Charcoal Booster Fan	11. 7 -0	6.1.1
OVA04CB	Fuel Hdlg Bldg Charcoal Booster Fan	11. 7 -0	6.1.1
1VA04CB	SI Pump 1A Cubicle Cooler Fan, Motor	11. 3A-1	6.1.1
1VA04CC	SI Pump 1B Cubicle Cooler Fan and Motor	11. 3F-1	6.1.1
1VA04CD	SI Pump 1B Cubicle Cooler Fan and Motor	11. 3F-1	6.1.1
1VA04J	Cubicle Cooler Local Panel	11. 2D-1	6.1.1
1VA04SA	Safety Injection Pump 1A Cubicle Cooler	11. 3A-1	6.1.1
1VA04SB	Safety Injection Pump 1B Cubicle Cooler	11. 3F-1	6.1.1
OVA053YA	Damper	11. 7 -0	6.1.1
OVA053YB	Damper	11. 7 -0	6.1.1

Table 1-2 (continued)

Equipment Outside Containment
Used for Safe Shutdown

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
0VA053YC	Damper	11. 7 -0	6.1.1
0VA054YA	Damper	11. 7 -0	6.1.1
0VA054YB	Damper	11. 7 -0	6.1.1
0VA057Y	Damper	11. 7 -0	6.1.1
0VA058YA	Damper	11. 7 -0	6.1.1
0VA058YB	Damper	11. 7 -0	6.1.1
0VA058YC	Damper	11. 7 -0	6.1.1
0VA059YA	Damper	11. 7 -0	6.1.1
0VA059YB	Damper	11. 7 -0	6.1.1
0VA062Y	Damper	11. 7 -0	6.1.1
0VA067YA	Damper	11. 7 -0	6.1.1
0VA067YB	Damper	11. 7 -0	6.1.1
1VA06CA	Ch'g Pump 1A Cubicle Cooler Fan and Motor	11. 3D-1	6.2.6
1VA06CB	Ch'g Pump 1A Cubicle Cooler Fan and Motor	11. 3D-1	6.2.6
1VA06CC	Ch'g Pump 1B Cubicle Cooler Fan and Motor	11. 3G-1	6.2.7
1VA06CD	Ch'g Pump 1B Cubicle Cooler Fan and Motor	11. 3G-1	6.2.7
1VA06SA	Ch'g Pump 1A Cubicle Cooler	11. 3D-1	6.2.6
1VA06SB	Ch'g Pump 1B Cubicle Cooler	11. 3G-1	6.2.7
0VA072YA	Damper	11. 7 -0	6.1.1
0VA072YB	Damper	11. 7 -0	6.1.1
0VA079YA	Damper	11. 7 -0	6.1.1
0VA079YB	Damper	11. 7 -0	6.1.1
1VA07CA	Fuel Hdlg Bldg Cubicle Cooler Fan, Motor	12. 1 -0	6.1.1
1VA07CB	Fuel Hdlg Bldg Cubicle Cooler Fan, Motor	12. 1 -0	6.1.1
1VA07S	Fuel Hdlg Bldg Cubicle Cooler	12. 1 -0	6.1.1
0VA084YA	Damper	11. 7 -0	6.1.1
0VA084YB	Damper	11. 7 -0	6.1.1
0VA085YA	Damper	11. 7 -0	6.1.1
0VA085YB	Damper	11. 7 -0	6.1.1
0VA086YA	Damper	11. 7 -0	6.1.1
0VA086YB	Damper	11. 7 -0	6.1.1
0VA087YA	Damper	11. 7 -0	6.1.1
0VA087YB	Damper	11. 7 -0	6.1.1
0VA088YA	Damper	11. 7 -0	6.1.1
0VA088YB	Damper	11. 7 -0	6.1.1
0VA089YA	Damper	11. 7 -0	6.1.1
0VA089YB	Damper	11. 7 -0	6.1.1
1VA08CA	AF Pump Cubicle Cooler Fan, Motor	11. 4A-1	6.1.1
1VA08CB	AF Pump Cubicle Cooler Fan, Motor	11. 4A-1	6.1.1
1VA08S	AF Pump Cubicle Cooler	11. 4A-1	6.1.1
0VA099YA	Damper	11. 7 -0	6.1.1
0VA099YB	Damper	11. 7 -0	6.1.1
0VA100YA	Damper	11. 7 -0	6.1.1
0VA100YB	Damper	11. 7 -0	6.1.1

Table 1-2 (continued)

Equipment Outside Containment
Used for Safe Shutdown

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1VA10J	Ch'g Pump 1A Cubicle Cooler Panel		11. 3D-1	6.2.6
1VA11J	Ch'g Pump 1B Cubicle Cooler Panel		11. 3G-1	6.2.7
0VA424YA	Damper		11. 7 -0	6.1.1
0VA424YB	Damper		11. 7 -0	6.1.1
0VA425YA	Damper		11. 7 -0	6.1.1
0VA425YB	Damper		11. 7 -0	6.1.1
0VA427YA	Damper		11. 7 -0	6.1.1
0VA427YB	Damper		11. 7 -0	6.1.1
0VC01AA	Control Room HVAC Coil		18. 4 -1	6.1.1
0VC01AB	Control Room HVAC Coil		18. 4 -2	6.1.1
0VC01CA	Control Room HVAC Fan		18. 4 -1	6.1.1
0VC01CB	Control Room HVAC Fan		18. 4 -2	6.1.1
0VC01JA	Local Control Panel		18. 4 -1	6.1.1
0VC01JB	Local Control Panel		18. 4 -2	6.1.1
0VC02CA	Control Room HVAC Fan		18. 4 -1	6.1.1
0VC02CB	Control Room HVAC Fan		18. 4 -2	6.1.1
0VC03CA	Control Room HVAC Fan		3. 3A-1	6.1.1
0VC03CB	Control Room HVAC Fan		3. 3A-2	6.1.1
1VD01CA	Diesel Generator Room Fan		18. 2 -1	6.1.1
1VD01CB	Diesel Generator Room Fan		18. 1 -1	6.1.1
1VD03CA	Diesel Generator Room Fan		9. 2 -1	6.1.1
1VD03CB	Diesel Generator Room Fan		9. 1 -1	6.1.1
1VE01C-2	Misc Electric Equip Room Fan		5. 4 -1	6.1.1
1VE01J	Local Control Panel		18. 2 -1	6.1.1
1VE02C-2	Misc Electric Equip Room Fan		5. 4 -1	6.1.1
1VE03C-1	Misc Electric Equip Room Fan		5. 6 -1	6.1.1
1VE04C-1	Misc Electric Equip Room Fan		5. 6 -1	6.1.1
1VQ01S	Post LOCA Purge Filter		11. 7 -1	6.1.1
1VX01C	ESF Switchgear Room Fan		5. 1 -1	6.1.1
1VX01J	Local Control Panel		5. 2 -1	6.1.1
1VX02J	Local Control Panel		5. 1 -1	6.1.1
1VX04C	ESF Switchgear Room Fan		18. 2 -1	6.1.1
1WO006A	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1WO006B	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
0WO01CA	Control Room Refrig Unit		11. 4A-0	6.1.1
0WO01CB	Control Room Refrig Unit		11. 4A-0	6.1.1
1WO020A	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1WO020B	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1

Table 1-2 (continued)

*Equipment Outside Containment
Used for Safe Shutdown*

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
OWO028A	Relief Valve	11. 4A-0	6.1.1
OWO028B	Relief Valve	11. 4A-0	6.1.1
OWO14MA	Control Room HVAC Air Separator	11. 4A-0	6.1.1
OWO14MB	Control Room HVAC Air Separator	11. 4A-0	6.1.1
OWO20MA	Control Room HVAC Standpipe	11. 4A-0	6.1.1
OWO20MB	Control Room HVAC Standpipe	11. 4A-0	6.1.1

Table 2

Hazard Zones Outside Containment Containing HELB Jets

Zone	Floor Elev	Description	Safe Shutdown Equipment	Safe Shutdown Cable	Disp. Section
11. 2A-0	346'	Recycle Evaporator Rooms	NO	YES	6.2.1
11. 2B-0	346'	Letdown Reheat Hx Room	NO	NO	6.2.2
11. 3A-0	364'	SG Blowdown Piping Area	NO	NO	6.2.3
11. 3B-0	364'	Blowdown Condenser Room	NO	NO	6.2.4
11. 3C-1	364'	Pos Displ Ch Pump Room	NO	YES	6.2.5
11. 3D-1	364'	Cent Ch Pump 1A Room	YES	YES	6.2.6
11. 3G-1	364'	Cent Ch Pump 1B Room	YES	YES	6.2.7
11. 3H-1	364'	Cnmt Penetration Area	YES	YES	6.2.8
11. 4C-1	383'	Letdown Hx 1B Room	NO	YES	6.2.9
11. 4D-0	394'	Auxiliary Steam Tunnel	NO	NO	6.2.10
11. 4D-1	383'	Letdown Hx 1A Room	NO	NO	6.2.11
11. 4E-0	383'	Valve Aisle	NO	NO	6.2.12
11. 4F-0	383'	Valve Aisle	NO	YES	6.2.13
11. 5B-0	401'	Gen'l Area (AS lines)	NO	YES	6.2.14
14. 3 -0	401'	Surface Condenser Rooms	NO	NO	6.2.15
14. 5 -0	414'	Radwaste Evap Rooms	NO	NO	6.2.16
18. 3 -1	377'	Main Steam Tunnel	NO	NO	6.2.17

Table 3

Equipment Outside Containment Located in Zones Containing No HELB's

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1PM05J	Main Control Panel	2. 1 -0	6.1.1
1PM06J	Main Control Panel	2. 1 -0	6.1.1
0VC03CA	Control Room HVAC Fan	3. 3A-1	6.1.1
0VC03CB	Control Room HVAC Fan	3. 3A-2	6.1.1
1AP06E	4160v Switchgear - ESF Div 12	5. 1 -1	6.1.1
1AP12E	480v Switchgear (132X, 132Z)	5. 1 -1	6.1.1
1VX01C	ESF Switchgear Room Fan	5. 1 -1	6.1.1
1VX02J	Local Control Panel	5. 1 -1	6.1.1
1AP05E	4160v Switchgear - ESF Div 11	5. 2 -1	6.1.1
1AP10E	480v Switchgear (131X, 131Z)	5. 2 -1	6.1.1
1VX01J	Local Control Panel	5. 2 -1	6.1.1
1DC02E	125v Battery 112 Div 12	5. 4 -1	6.1.1
1DC04E	Battery Charger 112 Div 12	5. 4 -1	6.1.1
1DC06E	125v DC Bus 111 ESF Div 12	5. 4 -1	6.1.1
1VE01C-2	Misc Electric Equip Room Fan	5. 4 -1	6.1.1
1VE02C-2	Misc Electric Equip Room Fan	5. 4 -1	6.1.1
1PA27J	Aux Safeguard Relay Cabinet (A)	5. 5 -1	6.1.1
1PA28J	Aux Safeguard Relay Cabinet (B)	5. 5 -1	6.1.1
1DC01E	115v Battery 111 Div 11	5. 6 -1	6.1.1
1DC03E	Battery Charger 111 Div 11	5. 6 -1	6.1.1
1DC05E	125v DC Bus 121 ESF Div 11	5. 6 -1	6.1.1
1VE03C-1	Misc Electric Equip Room Fan	5. 6 -1	6.1.1
1VE04C-1	Misc Electric Equip Room Fan	5. 6 -1	6.1.1
1DG01KB	Diesel Generator 1B and Hx	9. 1 -1	6.1.1
1LS-DO036	Diesel Oil Day Tank Level Switch	9. 1 -1	6.1.1
1PL08J	Diesel Control Panel	9. 1 -1	6.1.1
1SX169A	DG 1A Hx Outlet Valve	9. 1 -1	6.1.1
1VD03CB	Diesel Generator Room Fan	9. 1 -1	6.1.1
1DG01KA	Diesel Generator 1A and Hx	9. 2 -1	6.1.1
1LS-DO033	Diesel Oil Day Tank Level Switch	9. 2 -1	6.1.1
1PL07J	Diesel Control Panel	9. 2 -1	6.1.1
1SX169B	DG 1B Hx Outlet Valve	9. 2 -1	6.1.1
1VD03CA	Diesel Generator Room Fan	9. 2 -1	6.1.1
1DO02TA	DG Day Tank 1A	9. 3 -1	6.1.1

Table 3 (continued)

Equipment Outside Containment
Located in Zones Containing No HELB's

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1DO02TB	DG Day Tank 1B	9. 4 -1	6.1.1
1DO01PB	1B Fuel Oil Transfer Pump	10. 1 -1	6.1.1
1DO01PD	1D Fuel Oil Transfer Pump	10. 1 -1	6.1.1
1DO01TB	DG Storage Tank	10. 1 -1	6.1.1
1DO01TD	DG Storage Tank	10. 1 -1	6.1.1
1DO01PA	1A Fuel Oil Transfer Pump	10. 2 -1	6.1.1
1DO01PC	1C Fuel Oil Transfer Pump	10. 2 -1	6.1.1
1DO01TA	DG Storage Tank	10. 2 -1	6.1.1
1DO01TC	DG Storage Tank	10. 2 -1	6.1.1
1SX01AA	Ess'l Service Water Pump 1A Oil Cooler	11. 1A-0	6.1.1
1SX01FA-1	Ess'l Service Water Strainer	11. 1A-0	6.1.1
1SX01PA	1A Ess'l Service Water Pump	11. 1A-0	6.1.1
1VA01CA	SX Pump 1A Cubicle Cooler Fan, Motor	11. 1A-0	6.1.1
1VA01CB	SX Pump 1A Cubicle Cooler Fan, Motor	11. 1A-0	6.1.1
1VA01CC	SX Pump 1A Cubicle Cooler Fan, Motor	11. 1A-0	6.1.1
1VA01CD	SX Pump 1A Cubicle Cooler Fan, Motor	11. 1A-0	6.1.1
1VA01J	SX Pump 1A Cubicle Cooler Local Panel	11. 1A-0	6.1.1
1VA01SA	Ess'l Service Water Pump 1A Cooler	11. 1A-0	6.1.1
1SX005	Pump Disch. to Comp. Cooling Hx "O" Valve	11. 1B-0	6.1.1
1SX01AB	Ess'l Service Water Pump 1B Oil Cooler	11. 1B-0	6.1.1
1SX01FB-2	Ess'l Service Water Strainer	11. 1B-0	6.1.1
1SX01PB	1B Ess'l Service Water Pump	11. 1B-0	6.1.1
1VA01CE	SX Pump 1B Cubicle Cooler Fan	11. 1B-0	6.1.1
1VA01CF	SX Pump 1B Cubicle Cooler Fan	11. 1B-0	6.1.1
1VA01CG	SX Pump 1B Cubicle Cooler Fan	11. 1B-0	6.1.1
1VA01CH	SX Pump 1B Cubicle Cooler Fan	11. 1B-0	6.1.1
1VA01SB	Ess'l Service Water Pump 1B Cooler	11. 1B-0	6.1.1
1VA02J	SX Pump 1B Cubicle Cooler Local Panel	11. 1B-0	6.1.1
0SX146	Comp. Cooling Hx "O" Valve	11. 2 -0	6.1.1
0SX147	Component Cooling Hx "O" Valve	11. 2 -0	6.1.1
1RH01PA	RHR Pump 1A and Motor	11. 2A-1	6.1.1
1VA02CA	RHR Pump 1A Cubicle Cooler Fan and Motor	11. 2A-1	6.1.1
1VA02CB	RHR Pump 1A Cubicle Cooler Fan and Motor	11. 2A-1	6.1.1
1VA02SA	RHR Pump 1A Cubicle Cooler	11. 2A-1	6.1.1
1VA03J	Cubicle Cooler Local Panel	11. 2A-1	6.1.1
1CS009A	Gate Valve and Motor Op	11. 2B-1	6.1.1
1CS019A	Gate Valve	11. 2B-1	6.1.1

Table 3 (continued)

Equipment Outside Containment
Located in Zones Containing No HELB's

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1CS01PA	Cnmt Spray Pump 1A and Motor		11. 2B-1	6.1.1
1SI8812A	MO Gate Valve		11. 2B-1	6.1.1
1VA03CA	CS Pump 1A Cubicle Cooler Fan, Motor		11. 2B-1	6.1.1
1VA03CB	CS Pump 1A Cubicle Cooler Fan, Motor		11. 2B-1	6.1.1
1VA03CC	CS Pump 1A Cubicle Cooler Fan, Motor		11. 2B-1	6.1.1
1VA03CD	CS Pump 1A Cubicle Cooler Fan, Motor		11. 2B-1	6.1.1
1VA03SA	CS Pump 1A Cubicle Cooler		11. 2B-1	6.1.1
1CS009B	Gate Valve and Motor Op		11. 2C-1	6.1.1
1CS019B	Gate Isolation Valve & Motor Op		11. 2C-1	6.1.1
1CS01PB	Cnmt Spray Pump 1B and Motor		11. 2C-1	6.1.1
1VA03CE	CS Pump 1B Cubicle Cooler Fan and Motor		11. 2C-1	6.1.1
1VA03CF	CS Pump 1B Cubicle Cooler Fan and Motor		11. 2C-1	6.1.1
1VA03CG	CS Pump 1B Cubicle Cooler Fan and Motor		11. 2C-1	6.1.1
1VA03CH	CS Pump 1B Cubicle Cooler Fan and Motor		11. 2C-1	6.1.1
1VA03SB	CS Pump 1B Cubicle Cooler		11. 2C-1	6.1.1
1RH01PB	RHR Pump 1A and Motor		11. 2D-1	6.1.1
1SI8812B	MO Gate Valve		11. 2D-1	6.1.1
1VA02CC	RHR Pump 1B Cubicle Cooler Fan and Motor		11. 2D-1	6.1.1
1VA02CD	RHR Pump 1B Cubicle Cooler Fan and Motor		11. 2D-1	6.1.1
1VA02SB	RHR Pump 1B Cubicle Cooler		11. 2D-1	6.1.1
1VA04J	Cubicle Cooler Local Panel		11. 2D-1	6.1.1
1AP23E	480v MCC 132X1		11. 3 -0	6.1.1
0CC01A	Comp Cooling Hx		11. 3 -0	6.1.1
1CC01A	Comp Cooling Hx		11. 3 -0	6.1.1
0CC01P	"O" Comp. Cooling Pump		11. 3 -0	6.1.1
1CC01PA	1A Comp. Cooling Pump		11. 3 -0	6.1.1
1CC01PB	1B Comp. Cooling Pump		11. 3 -0	6.1.1
1CC9412A	1A RHR Hx Outlet Valve		11. 3 -0	6.1.1
1CC9412B	1B RHR HX Outlet Valve		11. 3 -0	6.1.1
1CC9422B	Relief Valve		11. 3 -0	6.1.1
1AP21E	480v MCC 131X1		11. 3 -1	6.1.1
1CC685	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CC9413A	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CC9413B	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CC9414	Gate MO valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CC9437A	Globe AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CC9437B	Globe AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CS001B	MO Globe Valve		11. 3 -1	6.1.1
1CS007A	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CS01T	Spray Additive Tank		11. 3 -1	6.1.1

Table 3 (continued)

*Equipment Outside Containment
Located in Zones Containing No HELB's*

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1CV8355A	Globe MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1CV8355D	Globe MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1FP010	Globe Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1OG082	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1OG084	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1OG085	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RE9157	Diaph Seat AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RE9159B	Diaph AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RE9160B	Diaph AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RE9170	3" Diaphragm Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RF027	Plug Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RY8025	Globe AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1RY8028	Diaph AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8801A	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8801B	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8802A	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8809A	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8835	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8840	Gate MO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI8888	Globe AO Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SX016A	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SX016B	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SX027A	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SX027B	Butterfly Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1WO006A	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1WO006B	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1WO020A	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1WO020B	Gate Valve	(Cnmt Isol)	11. 3 -1	6.1.1
1SI01PA	Safety Injection Pump 1A and Motor		11. 3A-1	6.1.1
1SI01SA	Safety Injection Pump 1A Oil Cooler		11. 3A-1	6.1.1
1SI8807A	6" MO Gate Valve		11. 3A-1	6.1.1
1SI8807B	6" MO Gate Valve		11. 3A-1	6.1.1
1SI8814	MO Globe Valve		11. 3A-1	6.1.1
1SI8923A	MO Gate Valve		11. 3A-1	6.1.1
1SI8924	MO Gate Valve		11. 3A-1	6.1.1
1VA04CA	SI Pump 1A Cubicle Cooler Fan, Motor		11. 3A-1	6.1.1
1VA04CB	SI Pump 1A Cubicle Cooler Fan, Motor		11. 3A-1	6.1.1
1VA04SA	Safety Injection Pump 1A Cubicle Cooler		11. 3A-1	6.1.1
1RH02AA	RHR Hx 1A		11. 3B-1	6.1.1
1RH606	HX Discharge Valve		11. 3B-1	6.1.1
1RH610	RHR Pump Miniflow Valve		11. 3B-1	6.1.1
1RH618	HX Bypass Valve		11. 3B-1	6.1.1

Table 3 (continued)

Equipment Outside Containment
Located in Zones Containing No HELB's

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1RH02AB	RHR Hx 1B	11. 3E-1	6.1.1
1RH607	HX Discharge Valve	11. 3E-1	6.1.1
1RH611	RHR Pump Miniflow Valve	11. 3E-1	6.1.1
1RH619	HX Bypass Valve	11. 3E-1	6.1.1
1RH01SB	Sump Valve Cnmt Assy (Cnmt Isol)	11. 3F-1	6.1.1
1SI01PB	Safety Injection Pump 1B and Motor	11. 3F-1	6.1.1
1SI01SB	Safety Injection Pump 1B Oil Cooler	11. 3F-1	6.1.1
1SI8804B	Gate Valve and Motor Op	11. 3F-1	6.1.1
1SI8806	8" MO Gate Valve	11. 3F-1	6.1.1
1SI8811B	Gate Isolation Valve (Cnmt Isol)	11. 3F-1	6.1.1
1SI8920	MO Globe Valve	11. 3F-1	6.1.1
1SI8923B	Gate Valve and Motor Op	11. 3F-1	6.1.1
1VA04CC	SI Pump 1B Cubicle Cooler Fan and Motor	11. 3F-1	6.1.1
1VA04CD	SI Pump 1B Cubicle Cooler Fan and Motor	11. 3F-1	6.1.1
1VA04SB	Safety Injection Pump 1B Cubicle Cooler	11. 3F-1	6.1.1
1AF017A	Ess'l Service Water to AF Pump Suc Valve	11. 4 -0	6.1.1
1AF01AA	Motor Driven AF Oil Cooler	11. 4 -0	6.1.1
1AF01PA-1	Aux Feedwater Pump 1A (Motor Driven)	11. 4 -0	6.1.1
1AF01PA-A	Lube Oil Pump for AF 1A	11. 4 -0	6.1.1
1AP22E	480v MCC 131X3	11. 4 -0	6.1.1
1AP24E	480v MCC 132X3	11. 4 -0	6.1.1
1PLS-AF051	Aux Feedwater Pump 1A Switch	11. 4 -0	6.1.1
1SX101A	Aux FW Pump Oil Cooler Valve	11. 4 -0	6.1.1
1AF01PB-A	Lube Oil Pump for AF 1B	11. 4 -1	6.1.1
0WO01CA	Control Room Refrig Unit	11. 4A-0	6.1.1
0WO01CB	Control Room Refrig Unit	11. 4A-0	6.1.1
0WO028A	Relief Valve	11. 4A-0	6.1.1
0WO028B	Relief Valve	11. 4A-0	6.1.1
0WO14MA	Control Room HVAC Air Separator	11. 4A-0	6.1.1
0WO14MB	Control Room HVAC Air Separator	11. 4A-0	6.1.1
0WO20MA	Control Room HVAC Standpipe	11. 4A-0	6.1.1
0WO20MB	Control Room HVAC Standpipe	11. 4A-0	6.1.1
1AF006A	Ess'l Service Water to AF Pump Suc Valve	11. 4A-1	6.1.1
1AF006B	Ess'l Service Water to AF Pump Suc Valve	11. 4A-1	6.1.1
1AF017B	Ess'l Service Water to AF Pump Suc Valve	11. 4A-1	6.1.1
1AF01AB	Diesel AF Pump Oil Cooler	11. 4A-1	6.1.1
1AF01PB-2	Aux Feedwater Pump 1B (Diesel Driven)	11. 4A-1	6.1.1
1DO10T	AF Diesel Day Tank	11. 4A-1	6.1.1
1PLS-AF055	Aux Feedwater Pump 1B Switch	11. 4A-1	6.1.1

Table 3 (continued)

Equipment Outside Containment
Located in Zones Containing No HELB's

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1SX01K	Diesel AF Closed Cycle Hx	11. 4A-1	6.1.1
1SX02K	AF Gear Drive Lube Oil Cooler	11. 4A-1	6.1.1
1SX04P	AF Pump Cooling Water Pump	11. 4A-1	6.1.1
1SX173	Ess'l Service Water to Ch'g Pump Suc Valve	11. 4A-1	6.1.1
1SX178	Ess'l Service Water to Ch'g Pump Suc Valve	11. 4A-1	6.1.1
1VA08CA	AF Pump Cubicle Cooler Fan, Motor	11. 4A-1	6.1.1
1VA08CB	AF Pump Cubicle Cooler Fan, Motor	11. 4A-1	6.1.1
1VA08S	AF Pump Cubicle Cooler	11. 4A-1	6.1.1
1PL04J	Remote Control Panel	11. 4C-0	6.1.1
1PL05J	Remote Control Panel	11. 4C-0	6.1.1
1PL06J	Remote Control Panel	11. 4C-0	6.1.1
0AB03P	Shared Boric Acid Transfer Pump	11. 5 -0	6.1.1
1AB03P	Unit 1 Boric Acid Transfer Pump	11. 5 -0	6.1.1
1AB03T	Boric Acid Tank	11. 5 -0	6.1.1
1AP42E	480v MCC 133X3	11. 5 -0	6.1.1
1AP43E	480v MCC 134V3	11. 5 -0	6.1.1
0OG059	Butterfly Valve, 3"	11. 5 -0	6.1.1
0OG060	Butterfly Valve, 3"	11. 5 -0	6.1.1
0OG061	Butterfly Valve, 3"	11. 5 -0	6.1.1
0OG062	Butterfly Valve, 3"	11. 5 -0	6.1.1
0OG063	Butterfly Valve, 3"	11. 5 -0	6.1.1
0OG064	Butterfly Valve, 3"	11. 5 -0	6.1.1
0OG08SA	Hydrogen Recombiner	11. 5 -0	6.1.1
0OG08SB	Hydrogen Recombiner	11. 5 -0	6.1.1
1AP26E	480v MCC 131X4	11. 5A-1	6.1.1
1AP30E	480v MCC 131X5	11. 6 -0	6.1.1
1AP32E	480v MCC 132X5	11. 6 -0	6.1.1
1CC01T	Comp Cooling Surge Tank	11. 6 -0	6.1.1
1AP28E	480v MCC 132X4	11. 6 -1	6.1.1
1PT-934	Cnmt Pressure Transmitter	11. 6 -1	6.1.1
1PT-937	Cnmt Pressure Transmitter	11. 6 -1	6.1.1
1CV01T	Vol Control Tank	11. 6A-1	6.1.1
1CV112B	Gate Valve and Motor Op	11. 6A-1	6.1.1
1CV112C	Gate Valve and Motor Op	11. 6A-1	6.1.1
1CV8104	Gate Valve and Motor Op	11. 6A-1	6.1.1
0FE-VA003	Flow Element	11. 7 -0	6.1.1
0FE-VA004	Flow Element	11. 7 -0	6.1.1

Table 3 (continued)

*Equipment Outside Containment
Located in Zones Containing No HELB's*

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
OFE-VA005	Flow Element	11. 7 -0	6.1.1
OFE-VA006	Flow Element	11. 7 -0	6.1.1
OFE-VA007	Flow Element	11. 7 -0	6.1.1
OFE-VA008	Flow Element	11. 7 -0	6.1.1
OFE-VA009	Flow Element	11. 7 -0	6.1.1
OFE-VA010	Flow Element	11. 7 -0	6.1.1
OVA01CA	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA01CB	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA01CC	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA01CD	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA022YA	Damper	11. 7 -0	6.1.1
OVA022YB	Damper	11. 7 -0	6.1.1
OVA023YA	Damper	11. 7 -0	6.1.1
OVA023YB	Damper	11. 7 -0	6.1.1
OVA024YA	Damper	11. 7 -0	6.1.1
OVA024YB	Damper	11. 7 -0	6.1.1
OVA025YA	Damper	11. 7 -0	6.1.1
OVA025YB	Damper	11. 7 -0	6.1.1
OVA02CA	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA02CB	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA02CC	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA02CD	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CA	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CB	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CC	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CD	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CE	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA03CF	Aux. Bldg. HVAC Fan and Motor	11. 7 -0	6.1.1
OVA04CA	Fuel Hdlg Bldg Charcoal Booster Fan	11. 7 -0	6.1.1
OVA04CB	Fuel Hdlg Bldg Charcoal Booster Fan	11. 7 -0	6.1.1
OVA053YA	Damper	11. 7 -0	6.1.1
OVA053YB	Damper	11. 7 -0	6.1.1
OVA053YC	Damper	11. 7 -0	6.1.1
OVA054YA	Damper	11. 7 -0	6.1.1
OVA054YB	Damper	11. 7 -0	6.1.1
OVA057Y	Damper	11. 7 -0	6.1.1
OVA058YA	Damper	11. 7 -0	6.1.1
OVA058YB	Damper	11. 7 -0	6.1.1
OVA058YC	Damper	11. 7 -0	6.1.1
OVA059YA	Damper	11. 7 -0	6.1.1
OVA059YB	Damper	11. 7 -0	6.1.1
OVA062Y	Damper	11. 7 -0	6.1.1
OVA067YA	Damper	11. 7 -0	6.1.1
OVA067YB	Damper	11. 7 -0	6.1.1

Table 3 (continued)

*Equipment Outside Containment
Located in Zones Containing No HELB's*

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
0VA072YA	Damper	11. 7 -0	6.1.1
0VA072YB	Damper	11. 7 -0	6.1.1
0VA079YA	Damper	11. 7 -0	6.1.1
0VA079YB	Damper	11. 7 -0	6.1.1
0VA084YA	Damper	11. 7 -0	6.1.1
0VA084YB	Damper	11. 7 -0	6.1.1
0VA085YA	Damper	11. 7 -0	6.1.1
0VA085YB	Damper	11. 7 -0	6.1.1
0VA086YA	Damper	11. 7 -0	6.1.1
0VA086YB	Damper	11. 7 -0	6.1.1
0VA087YA	Damper	11. 7 -0	6.1.1
0VA087YB	Damper	11. 7 -0	6.1.1
0VA088YA	Damper	11. 7 -0	6.1.1
0VA088YB	Damper	11. 7 -0	6.1.1
0VA089YA	Damper	11. 7 -0	6.1.1
0VA089YB	Damper	11. 7 -0	6.1.1
0VA099YA	Damper	11. 7 -0	6.1.1
0VA099YB	Damper	11. 7 -0	6.1.1
0VA100YA	Damper	11. 7 -0	6.1.1
0VA100YB	Damper	11. 7 -0	6.1.1
0VA424YA	Damper	11. 7 -0	6.1.1
0VA424YB	Damper	11. 7 -0	6.1.1
0VA425YA	Damper	11. 7 -0	6.1.1
0VA425YB	Damper	11. 7 -0	6.1.1
0VA427YA	Damper	11. 7 -0	6.1.1
0VA427YB	Damper	11. 7 -0	6.1.1
1PT-935	Cnmt Pressure Transmitter	11. 7 -1	6.1.1
1PT-936	Cnmt Pressure Transmitter	11. 7 -1	6.1.1
1VQ01S	Post LOCA Purge Filter	11. 7 -1	6.1.1
1VA07CA	Fuel Hdlg Bldg Cubicle Cooler Fan, Motor	12. 1 -0	6.1.1
1VA07CB	Fuel Hdlg Bldg Cubicle Cooler Fan, Motor	12. 1 -0	6.1.1
1VA07S	Fuel Hdlg Bldg Cubicle Cooler	12. 1 -0	6.1.1
1LT-930	RWST Level Transmitters	16. 1 -1	6.1.1
1LT-931	RWST Level Transmitters	16. 1 -1	6.1.1
1LT-932	RWST Level Transmitters	16. 1 -1	6.1.1
1LT-933	RWST Level Transmitters	16. 1 -1	6.1.1
1SI01T	Refueling Water Storage Tank	16. 1 -1	6.1.1
0SX02AA	Ess'l Service Water Cooling Tower A	17. 2 -1	6.1.1
0SX02AB	Ess'l Service Water Cooling Tower B	17. 2 -2	6.1.1

Table 3 (continued)

Equipment Outside Containment
Located in Zones Containing No HELB's

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1VD01CB	Diesel Generator Room Fan	18. 1 -1	6.1.1
1VD01CA	Diesel Generator Room Fan	18. 2 -1	6.1.1
1VE01J	Local Control Panel	18. 2 -1	6.1.1
1VX04C	ESF Switchgear Room Fan	18. 2 -1	6.1.1
1FW009A	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1FW009B	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1FW009C	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1FW009D	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1FW035A	Control Valve & Solenoid	18. 3A-1	6.1.1
1FW035B	Control Valve & Solenoid	18. 3A-1	6.1.1
1FW035C	Control Valve & Solenoid	18. 3A-1	6.1.1
1FW035D	Control Valve & Solenoid	18. 3A-1	6.1.1
1FW043A	Control Isolation Valve & Solenoid	18. 3A-1	6.1.1
1FW043B	Control Isolation Valve & Solenoid	18. 3A-1	6.1.1
1FW043C	Control Isolation Valve & Solenoid	18. 3A-1	6.1.1
1FW043D	Control Isolation Valve & Solenoid	18. 3A-1	6.1.1
1MS001A	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS001B	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS001C	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS001D	Gate Isolation Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS013A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS013B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS013C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS013D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS014A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS014B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS014C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS014D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS015A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS015B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS015C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS015D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS016A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS016B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS016C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS016D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS017A	Relief Isolation Valve	18. 3A-1	6.1.1
1MS017B	Relief Isolation Valve	18. 3A-1	6.1.1
1MS017C	Relief Isolation Valve	18. 3A-1	6.1.1
1MS017D	Relief Isolation Valve	18. 3A-1	6.1.1
1MS018A	SG Atm Relief Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS018B	SG Atm Relief Valve & Hydraulic Op	18. 3A-1	6.1.1

Table 3 (continued)

*Equipment Outside Containment
Located in Zones Containing No HELB's*

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1MS018C	SG Atm Relief Valve & Hydraulic Op	18. 3A-1	6.1.1
1MS018D	SG Atm Relief Valve & Hydraulic Op	18. 3A-1	6.1.1
1PT-514	Loop 1A (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-515	Loop 1A (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-516	Loop 1A (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-524	Loop 1B (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-525	Loop 1B (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-526	Loop 1B (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-534	Loop 1C (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-535	Loop 1C (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-536	Loop 1C (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-544	Loop 1D (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-545	Loop 1D (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1PT-546	Loop 1D (Stm Gen) MS Pressure Transmitter	18. 3A-1	6.1.1
1SD002A	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD002B	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD002C	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD002D	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD002E	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD002F	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD002G	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD002H	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD005A	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD005B	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD005C	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
1SD005D	Angle Isolation Valve & Solenoid	18. 3A-1	6.1.1
0VC01AA	Control Room HVAC Coil	18. 4 -1	6.1.1
0VC01CA	Control Room HVAC Fan	18. 4 -1	6.1.1
0VC01JA	Local Control Panel	18. 4 -1	6.1.1
0VC02CA	Control Room HVAC Fan	18. 4 -1	6.1.1
0VC01AB	Control Room HVAC Coil	18. 4 -2	6.1.1
0VC01CB	Control Room HVAC Fan	18. 4 -2	6.1.1
0VC01JB	Local Control Panel	18. 4 -2	6.1.1
0VC02CB	Control Room HVAC Fan	18. 4 -2	6.1.1
0SX02PA	Ess'l Service Water Makeup Pump	18.11 -0	6.1.1
0SX02PB	Ess'l Service Water Makeup Pump	18.11 -0	6.1.1
0SX04AA	Ess'l Service Water Makeup Pump Cooler 0A	18.11 -0	6.1.1
0SX04AB	Ess'l Service Water Makeup Pump Cooler 0B	18.11 -0	6.1.1
0DO08TB	Ess'l Service Water Makeup Diesel Tank 0B	18.11 -1	6.1.1
0DO08TA	Ess'l Service Water Makeup Diesel Tank 0A	18.11 -2	6.1.1

Table 3 (continued)

*Equipment Outside Containment
Located in Zones Containing No HELB's*

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1AP12E	480v Switchgear (132X, 132Z)	18.14A-1	6.1.1
1AP10E	480v Switchgear (131X, 131Z)	18.14B-1	6.1.1
1CD01T	Condensate Storage Tank	18.23 -0	6.1.1

Table 4-1

Equipment Outside Containment Located in HELB Zones

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1CV01PA	Ch'g Pump 1A and Motor		11. 3D-1	6.2.6
1CV01PA-A	Ch'g Pump 1A Lube Oil Pump		11. 3D-1	6.2.6
1CV02SA	Ch'g Pump 1A Gear Cooler		11. 3D-1	6.2.6
1CV03SA	Ch'g Pump 1A Lube Oil Cooler		11. 3D-1	6.2.6
1PS-CV032	Ch'g Pump 1A Pressure Switch		11. 3D-1	6.2.6
1VA06CA	Ch'g Pump 1A Cubicle Cooler Fan and Motor		11. 3D-1	6.2.6
1VA06CB	Ch'g Pump 1A Cubicle Cooler Fan and Motor		11. 3D-1	6.2.6
1VA06SA	Ch'g Pump 1A Cubicle Cooler		11. 3D-1	6.2.6
1VA10J	Ch'g Pump 1A Cubicle Cooler Panel		11. 3D-1	6.2.6
1CV01PB	Ch'g Pump 1B and Motor		11. 3G-1	6.2.7
1CV01PB-A	Ch'g Pump 1B Lube Oil Pump		11. 3G-1	6.2.7
1CV02SB	Ch'g Pump 1B Gear Cooler		11. 3G-1	6.2.7
1CV03SB	Ch'g Pump 1B Lube Oil Cooler		11. 3G-1	6.2.7
1PS-CV033	Ch'g Pump 1B Pressure Switch		11. 3G-1	6.2.7
1VA06CC	Ch'g Pump 1B Cubicle Cooler Fan and Motor		11. 3G-1	6.2.7
1VA06CD	Ch'g Pump 1B Cubicle Cooler Fan and Motor		11. 3G-1	6.2.7
1VA06SB	Ch'g Pump 1B Cubicle Cooler		11. 3G-1	6.2.7
1VA11J	Ch'g Pump 1B Cubicle Cooler Panel		11. 3G-1	6.2.7
1CS001A	MO Globe Valve		11. 3H-1	6.1.2
1CS007B	Gate Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV112D	MO Gate Valve		11. 3H-1	6.2.8
1CV112E	MO Gate Valve		11. 3H-1	6.2.8
1CV8100	MO Globe Isolation Valve		11. 3H-1	6.2.8
1CV8105	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8106	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8110	Ch'g Pump Miniflow Valve		11. 3H-1	6.2.8
1CV8111	Ch'g Pump Miniflow Valve		11. 3H-1	6.2.8
1CV8152	AO Globe Isolation Valve		11. 3H-1	6.2.8
1CV8355B	Globe MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8355C	Globe MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8804A	MO Gate Valve		11. 3H-1	6.2.8
1IA065	Globe Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1OG083	Butterfly Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PR001A	Control Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PR001B	Control Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PR066	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS228A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS228B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS229A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS229B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS230A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2

Table 4-1 (continued)

Equipment Outside Containment Located in HELB Zones

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1PS230B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9354B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9355B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9356B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9357B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1RH01SA	Sump Valve Cnmt Assy	(Cnmt Isol)	11. 3H-1	6.1.2
1RH8716A	MO Globe Valve		11. 3H-1	6.2.8
1RH8716B	MO Globe Valve		11. 3H-1	6.2.8
1RY8033	Diaph AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SA032	Globe Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8802B	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8809B	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8811A	Gate Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8821A	MO Globe Valve		11. 3H-1	6.1.2
1SI8821B	MO Globe Valve		11. 3H-1	6.1.2

Table 4-2

Cables in HELB Zones
Supporting Equipment Used for Safe Shutdown

Cable Number	Cable Zone	Equip. Number	Disp. Sec.	Cable Number	Cable Zone	Equip. Number	Disp. Sec.
1SX036	11. 2A-0	1SX01PB	6.2.1	1CV058	11. 3H-1	1CV8110	6.2.8
1VA138	11. 3C-1	1VA10J	6.2.5	1CV059	11. 3H-1	1CV8110	6.2.8
1CV001	11. 3D-1	1CV01PA	6.2.6	1CV061	11. 3H-1	1CV8111	6.2.8
1CV027	11. 3D-1	1CV01PA-A	6.2.6	1CV062	11. 3H-1	1CV8111	6.2.8
1CV029	11. 3D-1	1PS-CV032	6.2.6	1CV077	11. 3H-1	1CV112D	6.2.8
1VA051	11. 3D-1	1VA06CA	6.2.6	1CV078	11. 3H-1	1CV112D	6.2.8
1VA136	11. 3D-1	1VA06CB	6.2.6	1CV082	11. 3H-1	1CV112E	6.2.8
1VA139	11. 3D-1	1VA10J	6.2.6	1CV084	11. 3H-1	1CV112E	6.2.8
1VA821	11. 3D-1	1VA06CB	6.2.6	1CV323	11. 3H-1	1CV8152	6.2.8
1VA823	11. 3D-1	1VA10J	6.2.6	1CV325	11. 3H-1	1CV8152	6.2.8
1CV011	11. 3G-1	1CV01PB	6.2.7	1CV326	11. 3H-1	1CV8152	6.2.8
1CV031	11. 3G-1	1CV01PB-A	6.2.7	1CV327	11. 3H-1	1CV8152	6.2.8
1CV032	11. 3G-1	1PS-CV033	6.2.7	1CV406	11. 3H-1	1CV8804A	6.2.8
1VA055	11. 3G-1	1VA06CC	6.2.7	1CV407	11. 3H-1	1CV8804A	6.2.8
1VA140	11. 3G-1	1VA06CD	6.2.7	1CV408	11. 3H-1	1CV8804A	6.2.8
1CS031	11. 3H-1	1CS007B	6.1.2	1CV410	11. 3H-1	1CV8804A	6.2.8
1CS032	11. 3H-1	1CS007B	6.1.2	1CV413	11. 3H-1	1CV8804A	6.2.8
1CS033	11. 3H-1	1CS007B	6.1.2	1CV545	11. 3H-1	1CV112D	6.2.8
1CS041	11. 3H-1	1CS01PA	6.1.2	1CV572	11. 3H-1	1CV112E	6.2.8
1CV035	11. 3H-1	1CV8100	6.2.8	1RH066	11. 3H-1	1RH8716A	6.2.8
1CV036	11. 3H-1	1CV8100	6.2.8	1RH067	11. 3H-1	1RH8716A	6.2.8
1CV057	11. 3H-1	1CV8110	6.2.8	1RH068	11. 3H-1	1RH8716A	6.2.8

Table 4-2 (continued)

Cables in HELB Zones
Supporting Equipment Used for Safe Shutdown

Cable Number	Cable Zone	Equip. Number	Disp. Sec.
1RH069	11. 3H-1	1RH8716A	6.2.8
1RH070	11. 3H-1	1RH8716B	6.2.8
1RH071	11. 3H-1	1RH8716B	6.2.8
1RH072	11. 3H-1	1RH8716B	6.2.8
1SI468	11. 3H-1	1LT-931	6.2.8
1SI469	11. 3H-1	1LT-932	6.2.8
1SI470	11. 3H-1	1LT-933	6.2.8
1SX052	11. 3H-1	1SX016A	6.1.2
1SX058	11. 3H-1	1SX027A	6.1.2
1VA821	11. 4C-1	1VA06CB	6.2.9
1VA823	11. 4C-1	1VA10J	6.2.9
1VA821	11. 4F-0	1VA06CB	6.2.13
1VA823	11. 4F-0	1VA10J	6.2.13
1AB001	11. 5B-0	1AB03P	6.2.14
1AB002	11. 5B-0	1AB03P	6.2.14
1AB003	11. 5B-0	0AB03P	6.2.14
1AB049	11. 5B-0	1AB03P	6.2.14
1AF001	11. 5B-0	1AF01PA-1	6.2.14
1AF056	11. 5B-0	1AF006A	6.2.14
1AF056	11. 5B-0	1AF017A	6.2.14
1AF056	11. 5B-0	1AF01PA-1	6.2.14
1AP147	11. 5B-0	0WO01CA	6.2.14
1AP147	11. 5B-0	1AF006A	6.2.14
1AP147	11. 5B-0	1AF017A	6.2.14
1AP147	11. 5B-0	1AF01PA-A	6.2.14
1AP147	11. 5B-0	1VA01CA	6.2.14
1AP147	11. 5B-0	1VA01CB	6.2.14
1AP147	11. 5B-0	1VA03CC	6.2.14
1AP147	11. 5B-0	1VA03CD	6.2.14
1AP147	11. 5B-0	1VA04CB	6.2.14
1AP147	11. 5B-0	1VD03CA	6.2.14
1AP149	11. 5B-0	0SX146	6.2.14
1AP149	11. 5B-0	1CC9412B	6.2.14
1AP149	11. 5B-0	1RH611	6.2.14
1AP149	11. 5B-0	1SI8924	6.2.14
1AP149	11. 5B-0	1SX005	6.2.14
1AP149	11. 5B-0	1SX01PB	6.2.14
1AP149	11. 5B-0	1VA03CE	6.2.14
1AP149	11. 5B-0	1VA03CF	6.2.14
1AP149	11. 5B-0	1VA04CC	6.2.14
1AP149	11. 5B-0	1VA06CC	6.2.14
1AP149	11. 5B-0	1VX01C	6.2.14
1AP152	11. 5B-0	0OG062	6.2.14
1AP152	11. 5B-0	0WO01CB	6.2.14
1AP152	11. 5B-0	1AF006B	6.2.14
1AP152	11. 5B-0	1AF017B	6.2.14
1AP152	11. 5B-0	1AF01PB-A	6.2.14
1AP152	11. 5B-0	1VA01CG	6.2.14
1AP152	11. 5B-C	1VA01CH	6.2.14
1AP152	11. 5B-0	1VA04CD	6.2.14
1AP152	11. 5B-0	1VA06CD	6.2.14
1AP152	11. 5B-0	1VD03CB	6.2.14
1AP154	11. 5B-0	0OG060	6.2.14
1AP154	11. 5B-0	0OG064	6.2.14
1AP154	11. 5B-0	0VA04CB	6.2.14
1AP154	11. 5B-0	0VC02CB	6.2.14
1AP154	11. 5B-0	1CC9413B	6.2.14
1AP154	11. 5B-0	1CC9414	6.2.14
1AP154	11. 5B-0	1CV112C	6.2.14
1AP154	11. 5B-0	1CV8104	6.2.14
1AP154	11. 5B-0	1DO01PD	6.2.14
1AP154	11. 5B-0	1MS018C	6.2.14
1AP154	11. 5B-0	1OG082	6.2.14
1AP154	11. 5B-0	1OG084	6.2.14
1AP154	11. 5B-0	1SI8801B	6.2.14

Table 4-2 (continued)

*Cables in HELB Zones
Supporting Equipment Used for Safe Shutdown*

Cable Number	Cable Zone	Equip. Number	Disp. Sec.	Cable Number	Cable Zone	Equip. Number	Disp. Sec.
1AP166	11. 5B-0	1SX01PB	6.2.14				
1AP254	11. 5B-0	0SX146	6.2.14				
1AP254	11. 5B-0	1CC9412B	6.2.14				
1AP254	11. 5B-0	1RH611	6.2.14				
1AP254	11. 5B-0	1SI8924	6.2.14				
1AP254	11. 5B-0	1SX005	6.2.14				
1AP254	11. 5B-0	1SX01PB	6.2.14				
1AP254	11. 5B-0	1VA03CE	6.2.14				
1AP254	11. 5B-0	1VA03CF	6.2.14				
1AP254	11. 5B-0	1VA04CC	6.2.14				
1AP254	11. 5B-0	1VA06CC	6.2.14				
1AP254	11. 5B-0	1VX01C	6.2.14				
1CC001	11. 5B-0	1CC01PA	6.2.14				
1CC019	11. 5B-0	0CC01P	6.2.14				
1CS051	11. 5B-0	1CS001B	6.1.2				
1CS052	11. 5B-0	1CS001B	6.1.2				
1FW217	11. 5B-0	1FW009B	6.2.14				
1MS628	11. 5B-0	1MS018C	6.2.14				
1SX034	11. 5B-0	1SX01PA	6.2.14				
1VA124	11. 5B-0	0VA04CB	6.2.14				
1VA157	11. 5B-0	1VA03CD	6.2.14				
1VD085	11. 5B-0	1VD03CB	6.2.14				
1VX006	11. 5B-0	1VX01C	6.2.14				

Table 5-1

Equipment Located in HELB Zones
and Not Used for a HELB Outside Containment

Equipment Number	Equipment Name		Hazard Zone	Disposition Section
1CS001A	MO Globe Valve		11. 3H-1	6.1.2
1CS007B	Gate Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8105	Gate AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8106	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8355B	Globe MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1CV8355C	Globe MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1IA065	Globe Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1OG083	Butterfly Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PR001A	Control Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PR001B	Control Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PR066	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS228A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS228B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS229A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS229B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS230A	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS230B	Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9354B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9355B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9356B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1PS9357B	Globe AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1RH01SA	Sump Valve Cnmt Assy	(Cnmt Isol)	11. 3H-1	6.1.2
1RY8033	Diaph AO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SA032	Globe Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8802B	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8809B	Gate MO Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8811A	Gate Valve	(Cnmt Isol)	11. 3H-1	6.1.2
1SI8821A	MO Globe Valve		11. 3H-1	6.1.2
1SI8821B	MO Globe Valve		11. 3H-1	6.1.2

Table 5-2

Cables Located in HELB Zones and Not Used for a HELB Outside Containment

Cable Number	Cable Zone	Equip. Number	Disp. Sec.	Cable Number	Cable Zone	Equip. Number	Disp. Sec.
1CS031	11. [illegible]-1	1CS007B	6.1.2				
1CS032	11. 3H-1	1CS007B	6.1.2				
1CS033	11. 3H-1	1CS007B	6.1.2				
1CS041	11. 3H-1	1CS01PA	6.1.2				
1SX052	11. 3H-1	1SX016A	6.1.2				
1SX058	11. 3H-1	1SX027A	6.1.2				
1CS051	11. 5B-0	1CS001B	6.1.2				
1CS052	11. 5B-0	1CS001B	6.1.2				

Table 6-1

Equipment Outside Containment
Located in HELB Zones and Used Following The HELB

Equipment Number	Equipment Name	Hazard Zone	Disposition Section
1CV01PA	Ch'g Pump 1A and Motor	11. 3D-1	6.2.6
1CV01PA-A	Ch'g Pump 1A Lube Oil Pump	11. 3D-1	6.2.6
1CV02SA	Ch'g Pump 1A Gear Cooler	11. 3D-1	6.2.6
1CV03SA	Ch'g Pump 1A Lube Oil Cooler	11. 3D-1	6.2.6
1PS-CV032	Ch'g Pump 1A Pressure Switch	11. 3D-1	6.2.6
1VA06CA	Ch'g Pump 1A Cubicle Cooler Fan and Motor	11. 3D-1	6.2.6
1VA06CB	Ch'g Pump 1A Cubicle Cooler Fan and Motor	11. 3D-1	6.2.6
1VA06SA	Ch'g Pump 1A Cubicle Cooler	11. 3D-1	6.2.6
1VA10J	Ch'g Pump 1A Cubicle Cooler Panel	11. 3D-1	6.2.6
1CV01PB	Ch'g Pump 1B and Motor	11. 3G-1	6.2.7
1CV01PB-A	Ch'g Pump 1B Lube Oil Pump	11. 3G-1	6.2.7
1CV02SB	Ch'g Pump 1B Gear Cooler	11. 3G-1	6.2.7
1CV03SB	Ch'g Pump 1B Lube Oil Cooler	11. 3G-1	6.2.7
1PS-CV033	Ch'g Pump 1B Pressure Switch	11. 3G-1	6.2.7
1VA06CC	Ch'g Pump 1B Cubicle Cooler Fan and Motor	11. 3G-1	6.2.7
1VA06CD	Ch'g Pump 1B Cubicle Cooler Fan and Motor	11. 3G-1	6.2.7
1VA06SB	Ch'g Pump 1B Cubicle Cooler	11. 3G-1	6.2.7
1VA11J	Ch'g Pump 1B Cubicle Cooler Panel	11. 3G-1	6.2.7
1CV112D	MO Gate Valve	11. 3H-1	6.2.8
1CV112E	MO Gate Valve	11. 3H-1	6.2.8
1CV8100	MO Globe Isolation Valve	11. 3H-1	6.2.8
1CV8110	Ch'g Pump Miniflow Valve	11. 3H-1	6.2.8
1CV8111	Ch'g Pump Miniflow Valve	11. 3H-1	6.2.8
1CV8152	AO Globe Isolation Valve	11. 3H-1	6.2.8
1CV8804A	MO Gate Valve	11. 3H-1	6.2.8
1RH8716A	MO Globe Valve	11. 3H-1	6.2.8
1RH8716B	MO Globe Valve	11. 3H-1	6.2.8

Table 6-2

*Cables Outside Containment
Located in HELB Zones and Used Following the HELB*

Cable Number	Cable Zone	Equip. Number	Disp. Sec.	Cable Number	Cable Zone	Equip. Number	Disp. Sec.
1SX036	11. 2A-0	1SX01PB	6.2.1	1CV077	11. 3H-1	1CV112D	6.2.8
1VA138	11. 3C-1	1VA10J	6.2.5	1CV078	11. 3H-1	1CV112D	6.2.8
1CV001	11. 3D-1	1CV01PA	6.2.6	1CV082	11. 3H-1	1CV112E	6.2.8
1CV027	11. 3D-1	1CV01PA-A	6.2.6	1CV084	11. 3H-1	1CV112E	6.2.8
1CV029	11. 3D-1	1PS-CV032	6.2.6	1CV323	11. 3H-1	1CV8152	6.2.8
1VA051	11. 3D-1	1VA06CA	6.2.6	1CV325	11. 3H-1	1CV8152	6.2.8
1VA136	11. 3D-1	1VA06CB	6.2.6	1CV326	11. 3H-1	1CV8152	6.2.8
1VA139	11. 3D-1	1VA10J	6.2.6	1CV327	11. 3H-1	1CV8152	6.2.8
1VA821	11. 3D-1	1VA06CB	6.2.6	1CV406	11. 3H-1	1CV8804A	6.2.8
1VA823	11. 3D-1	1VA10J	6.2.6	1CV407	11. 3H-1	1CV8804A	6.2.8
1CV011	11. 3G-1	1CV01PB	6.2.7	1CV408	11. 3H-1	1CV8804A	6.2.8
1CV031	11. 3G-1	1CV01PB-A	6.2.7	1CV410	11. 3H-1	1CV8804A	6.2.8
1CV032	11. 3G-1	1PS-CV033	6.2.7	1CV413	11. 3H-1	1CV8804A	6.2.8
1VA055	11. 3G-1	1VA06CC	6.2.7	1CV545	11. 3H-1	1CV112D	6.2.8
1VA140	11. 3G-1	1VA06CD	6.2.7	1CV572	11. 3H-1	1CV112E	6.2.8
1CV035	11. 3H-1	1CV8100	6.2.8	1RH066	11. 3H-1	1RH8716A	6.2.8
1CV036	11. 3H-1	1CV8100	6.2.8	1RH067	11. 3H-1	1RH8716A	6.2.8
1CV057	11. 3H-1	1CV8110	6.2.8	1RH068	11. 3H-1	1RH8716A	6.2.8
1CV058	11. 3H-1	1CV8110	6.2.8	1RH069	11. 3H-1	1RH8716A	6.2.8
1CV059	11. 3H-1	1CV8110	6.2.8	1RH070	11. 3H-1	1RH8716B	6.2.8
1CV061	11. 3H-1	1CV8111	6.2.8	1RH071	11. 3H-1	1RH8716B	6.2.8
1CV062	11. 3H-1	1CV8111	6.2.8	1RH072	11. 3H-1	1RH8716B	6.2.8

Table 6-2 (continued)

*Cables Outside Containment
Located in HELB Zones and Used Following the HELB*

Cable Number	Cable Zone	Equip. Number	Disp. Sec.
1SI468	11. 3H-1	1LT-931	6.2.8
1SI469	11. 3H-1	1LT-932	6.2.8
1SI470	11. 3H-1	1LT-933	6.2.8
1VA821	11. 4C-1	1VA06CB	6.2.9
1VA823	11. 4C-1	1VA10J	6.2.9
1VA821	11. 4F-0	1VA06CB	6.2.13
1VA823	11. 4F-0	1VA10J	6.2.13
1AB001	11. 5B-0	1AB03P	6.2.14
1AB002	11. 5B-0	1AB03P	6.2.14
1AB003	11. 5B-0	0AB03P	6.2.14
1AB049	11. 5B-0	1AB03P	6.2.14
1AF001	11. 5B-0	1AF01PA-1	6.2.14
1AF056	11. 5B-0	1AF006A	6.2.14
1AF056	11. 5B-0	1AF017A	6.2.14
1AF056	11. 5B-0	1AF01PA-1	6.2.14
1AP147	11. 5B-0	0WO01CA	6.2.14
1AP147	11. 5B-0	1AF006A	6.2.14
1AP147	11. 5B-0	1AF017A	6.2.14
1AP147	11. 5B-0	1AF01PA-A	6.2.14
1AP147	11. 5B-0	1VA01CA	6.2.14
1AP147	11. 5B-0	1VA01CB	6.2.14
1AP147	11. 5B-0	1VA03CC	6.2.14
1AP147	11. 5B-0	1VA03CD	6.2.14
1AP147	11. 5B-0	1VA04CB	6.2.14
1AP147	11. 5B-0	1VD03CA	6.2.14
1AP149	11. 5B-0	0SX146	6.2.14
1AP149	11. 5B-0	1CC9412B	6.2.14
1AP149	11. 5B-0	1RH611	6.2.14
1AP149	11. 5B-0	1SI8924	6.2.14
1AP149	11. 5B-0	1SX005	6.2.14

Cable Number	Cable Zone	Equip. Number	Disp. Sec.
1AP149	11. 5B-0	1SX01PB	6.2.14
1AP149	11. 5B-0	1VA03CE	6.2.14
1AP149	11. 5B-0	1VA03CF	6.2.14
1AP149	11. 5B-0	1VA04CC	6.2.14
1AP149	11. 5B-0	1VA06CC	6.2.14
1AP149	11. 5B-0	1VX01C	6.2.14
1AP152	11. 5B-0	0OG062	6.2.14
1AP152	11. 5B-0	0WO01CB	6.2.14
1AP152	11. 5B-0	1AF006B	6.2.14
1AP152	11. 5B-0	1AF017B	6.2.14
1AP152	11. 5B-0	1AF01PB-A	6.2.14
1AP152	11. 5B-0	1VA01CG	6.2.14
1AP152	11. 5B-0	1VA01CH	6.2.14
1AP152	11. 5B-0	1VA04CD	6.2.14
1AP152	11. 5B-0	1VA06CD	6.2.14
1AP152	11. 5B-0	1VD03CB	6.2.14
1AP154	11. 5B-0	0OG060	6.2.14
1AP154	11. 5B-0	0OG064	6.2.14
1AP154	11. 5B-0	0VA04CB	6.2.14
1AP154	11. 5B-0	0VC02CB	6.2.14
1AP154	11. 5B-0	1CC9413B	6.2.14
1AP154	11. 5B-0	1CC9414	6.2.14
1AP154	11. 5B-0	1CV112C	6.2.14
1AP154	11. 5B-0	1CV8104	6.2.14
1AP154	11. 5B-0	1DO01PD	6.2.14
1AP154	11. 5B-0	1MS018C	6.2.14
1AP154	11. 5B-0	1OG082	6.2.14
1AP154	11. 5B-0	1OG084	6.2.14
1AP154	11. 5B-0	1SI8801B	6.2.14
1AP166	11. 5B-0	1SX01PB	6.2.14
1AP254	11. 5B-0	0SX146	6.2.14
1AP254	11. 5B-0	1CC9412B	6.2.14
1AP254	11. 5B-0	1RH611	6.2.14
1AP254	11. 5B-0	1SI8924	6.2.14
1AP254	11. 5B-0	1SX005	6.2.14
1AP254	11. 5B-0	1SX01PB	6.2.14
1AP254	11. 5B-0	1VA03CE	6.2.14
1AP254	11. 5B-0	1VA03CF	6.2.14
1AP254	11. 5B-0	1VA04CC	6.2.14
1AP254	11. 5B-0	1VA06CC	6.2.14

Table 6-2 (continued)

Cables Outside Containment
Located in HELB Zones and Used Following the HELB

Cable Number	Cable Zone	Equip. Number	Disp. Sec.	Cable Number	Cable Zone	Equip. Number	Disp. Sec.
1AP254	11. 5B-0	1VX01C	6.2.14				
1CC001	11. 5B-0	1CC01PA	6.2.14				
1CC019	11. 5B-0	0CC01P	6.2.14				
1FW217	11. 5B-0	1FW009B	6.2.14				
1MS628	11. 5B-0	1MS018C	6.2.14				
1SX034	11. 5B-0	1SX01PA	6.2.14				
1VA124	11. 5B-0	0VA04CB	6.2.14				
1VA157	11. 5B-0	1VA03CD	6.2.14				
1VD085	11. 5B-0	1VD03CB	6.2.14				
1VX006	11. 5B-0	1VX01C	6.2.14				

Table 7-1

Safe Shutdown Equipment and/or Cables Located in HELB Zone 11.2A-0

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
(1SX01PB)	1SX036	1B Ess'l Service Water Pump

* Located outside of zone but adjacent to block walls.

07/24/84
11:12:12

Table 7-2

Safe Shutdown Equipment and/or Cables Located in HELB Zone 11.3C-1

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
(1VA10J)	1VA138	Ch'g Pump 1A Cubicle Cooler Panel

Table 7-3

Safe Shutdown Equipment and/or Cables Located in HELB Zone 11.3D-1

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
1CV01PA		Ch'g Pump 1A and Motor
1CV01PA-A		Ch'g Pump 1A Lube Oil Pump
1CV02SA		Ch'g Pump 1A Gear Cooler
1CV03SA		Ch'g Pump 1A Lube Oil Cooler
1PS-CV032		Ch'g Pump 1A Pressure Switch
1VA06CA		Ch'g Pump 1A Cubicle Cooler Fan and Motor
1VA06CB		Ch'g Pump 1A Cubicle Cooler Fan and Motor
1VA06SA		Ch'g Pump 1A Cubicle Cooler
1VA10J		Ch'g Pump 1A Cubicle Cooler Panel
(1CV01PA)	1CV001	Ch'g Pump 1A and Motor
(1CV01PA-A)	1CV027	Ch'g Pump 1A Lube Oil Pump
(1PS-CV032)	1CV029	Ch'g Pump 1A Pressure Switch
(1VA06CA)	1VA051	Ch'g Pump 1A Cubicle Cooler Fan and Motor
(1VA06CB)	1VA136	Ch'g Pump 1A Cubicle Cooler Fan and Motor
(1VA10J)	1VA139	Ch'g Pump 1A Cubicle Cooler Panel
(1VA06CB)	1VA821	Ch'g Pump 1A Cubicle Cooler Fan and Motor
(1VA10J)	1VA823	Ch'g Pump 1A Cubicle Cooler Panel

Table 7-4

Safe Shutdown Equipment and/or Cables Located in HELB Zone 11.3G-1

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
1CV01PB		Ch'g Pump 1B and Motor
1CV01PB-A		Ch'g Pump 1B Lube Oil Pump
1CV02SB		Ch'g Pump 1B Gear Cooler
1CV03SB		Ch'g Pump 1B Lube Oil Cooler
1PS-CV033		Ch'g Pump 1B Pressure Switch
1VA06CC		Ch'g Pump 1B Cubicle Cooler Fan and Motor
1VA06CD		Ch'g Pump 1B Cubicle Cooler Fan and Motor
1VA06SB		Ch'g Pump 1B Cubicle Cooler
1VA11J		Ch'g Pump 1B Cubicle Cooler Panel
(1CV01PB)	1CV011	Ch'g Pump 1B and Motor
(1CV01PB-A)	1CV031	Ch'g Pump 1B Lube Oil Pump
(1PS-CV033)	1CV032	Ch'g Pump 1B Pressure Switch
(1VA06CC)	1VA055	Ch'g Pump 1B Cubicle Cooler Fan and Motor
(1VA06CD)	1VA140	Ch'g Pump 1B Cubicle Cooler Fan and Motor

Table 7-5

Safe Shutdown Equipment and/or Cables Located in HELB Zone 11.3H-1

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
1CV112D		MO Gate Valve
1CV112E		MO Gate Valve
1CV8100		MO Globe Isolation Valve
1CV8110		Ch'g Pump Miniflow Valve
1CV8111		Ch'g Pump Miniflow Valve
1CV8152		AO Globe Isolation Valve
1CV8804A		MO Gate Valve
1RH8716A		MO Globe Valve
1RH8716B		MO Globe Valve
(1CV8100)	1CV035	MO Globe Isolation Valve
(1CV8100)	1CV036	MO Globe Isolation Valve
(1CV8110)	1CV057	Ch'g Pump Miniflow Valve
(1CV8110)	1CV058	Ch'g Pump Miniflow Valve
(1CV8110)	1CV059	Ch'g Pump Miniflow Valve
(1CV8111)	1CV061	Ch'g Pump Miniflow Valve
(1CV8111)	1CV062	Ch'g Pump Miniflow Valve
(1CV112D)	1CV077	MO Gate Valve
(1CV112D)	1CV078	MO Gate Valve
(1CV112E)	1CV082	MO Gate Valve
(1CV112E)	1CV084	MO Gate Valve
(1CV8152)	1CV323	AO Globe Isolation Valve
(1CV8152)	1CV325	AO Globe Isolation Valve
(1CV8152)	1CV326	AO Globe Isolation Valve
(1CV8152)	1CV327	AO Globe Isolation Valve
(1CV8804A)	1CV406	MO Gate Valve
(1CV8804A)	1CV407	MO Gate Valve
(1CV8804A)	1CV408	MO Gate Valve
(1CV8804A)	1CV410	MO Gate Valve
(1CV8804A)	1CV413	MO Gate Valve
(1CV112D)	1CV545	MO Gate Valve
(1CV112E)	1CV572	MO Gate Valve
(1RH8716A)	1RH066	MO Globe Valve
(1RH8716A)	1RH067	MO Globe Valve
(1RH8716A)	1RH068	MO Globe Valve
(1RH8716A)	1RH069	MO Globe Valve
(1RH8716B)	1RH070	MO Globe Valve
(1RH8716B)	1RH071	MO Globe Valve
(1RH8716B)	1RH072	MO Globe Valve
(1LT-931)	1SI468	RWST Level Transmitters

Table 7-5 (continued)

*Safe Shutdown Equipment and/or Cables
Located in HELB Zone 11.3H-1*

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
(1LT-932)	1SI469	RWST Level Transmitters
(1LT-933)	1SI470	RWST Level Transmitters

Table 7-6

Safe Shutdown Equipment and/or Cables
Located in HELB Zone 11.4C-1

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
(1VA06CB)	1VA821	Ch'g Pump 1A Cubicle Cooler Fan and Motor
(1VA10J)	1VA823	Ch'g Pump 1A Cubicle Cooler Panel

Table 7-7

Safe Shutdown Equipment and/or Cables Located in HELB Zone 11.4F-0

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
(1VA06CB)	1VA821	Ch'g Pump 1A Cubicle Cooler Fan and Motor
(1VA10J)	1VA823	Ch'g Pump 1A Cubicle Cooler Panel

Table 7-8

Safe Shutdown Equipment and/or Cables Located in HELB Zone 11.5B-0

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
(1AB03P)	1AB001	Unit 1 Boric Acid Transfer Pump
(1AB03P)	1AB002	Unit 1 Boric Acid Transfer Pump
(0AB03P)	1AB003	Shared Boric Acid Transfer Pump
(1AB03P)	1AB049	Unit 1 Boric Acid Transfer Pump
(1AF01PA-1)	1AF001	Aux Feedwater Pump 1A (Motor Driven)
(1AF006A)	1AF056	Ess'l Service Water to AF Pump Suc Valve
(1AF017A)	1AF056	Ess'l Service Water to AF Pump Suc Valve
(1AF01PA-1)	1AF056	Aux Feedwater Pump 1A (Motor Driven)
(0WO01CA)	1AP147	Control Room Refrig Unit
(1AF006A)	1AP147	Ess'l Service Water to AF Pump Suc Valve
(1AF017A)	1AP147	Ess'l Service Water to AF Pump Suc Valve
(1AF01PA-A)	1AP147	Lube Oil Pump for AF 1A
(1VA01CA)	1AP147	SX Pump 1A Cubicle Cooler Fan, Motor
(1VA01CB)	1AP147	SX Pump 1A Cubicle Cooler Fan, Motor
(1VA03CC)	1AP147	CS Pump 1A Cubicle Cooler Fan, Motor
(1VA03CD)	1AP147	CS Pump 1A Cubicle Cooler Fan, Motor
(1VA04CB)	1AP147	SI Pump 1A Cubicle Cooler Fan, Motor
(1VD03CA)	1AP147	Diesel Generator Room Fan
(0SX146)	1AP149	Comp. Cooling Hx "O" Valve
(1CC9412B)	1AP149	1B RHR HX Outlet Valve
(1RH611)	1AP149	RHR Pump Miniflow Valve
(1SI8924)	1AP149	MO Gate Valve
(1SX005)	1AP149	Pump Disch. to Comp. Cooling Hx "O" Valve
(1SX01PB)	1AP149	1B Ess'l Service Water Pump
(1VA03CE)	1AP149	CS Pump 1B Cubicle Cooler Fan and Motor
(1VA03CF)	1AP149	CS Pump 1B Cubicle Cooler Fan and Motor
(1VA04CC)	1AP149	SI Pump 1B Cubicle Cooler Fan and Motor
(1VA06CC)	1AP149	Ch'g Pump 1B Cubicle Cooler Fan and Motor
(1VX01C)	1AP149	ESF Switchgear Room Fan
(0OG062)	1AP152	Butterfly Valve, 3"
(0WO01CB)	1AP152	Control Room Refrig Unit

Table 7-8 (continued)

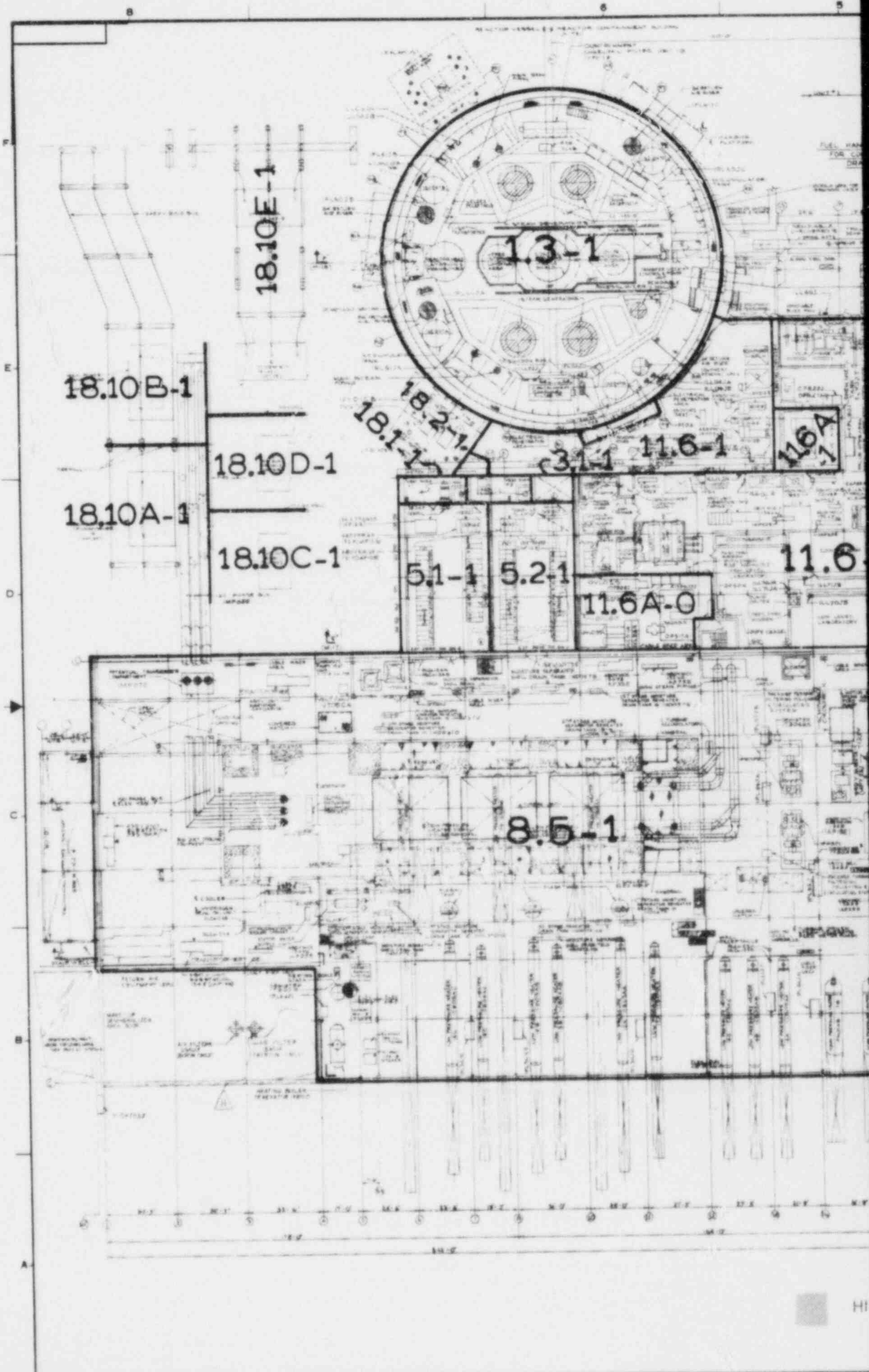
*Safe Shutdown Equipment and/or Cables
Located in HELB Zone 11.5B-0*

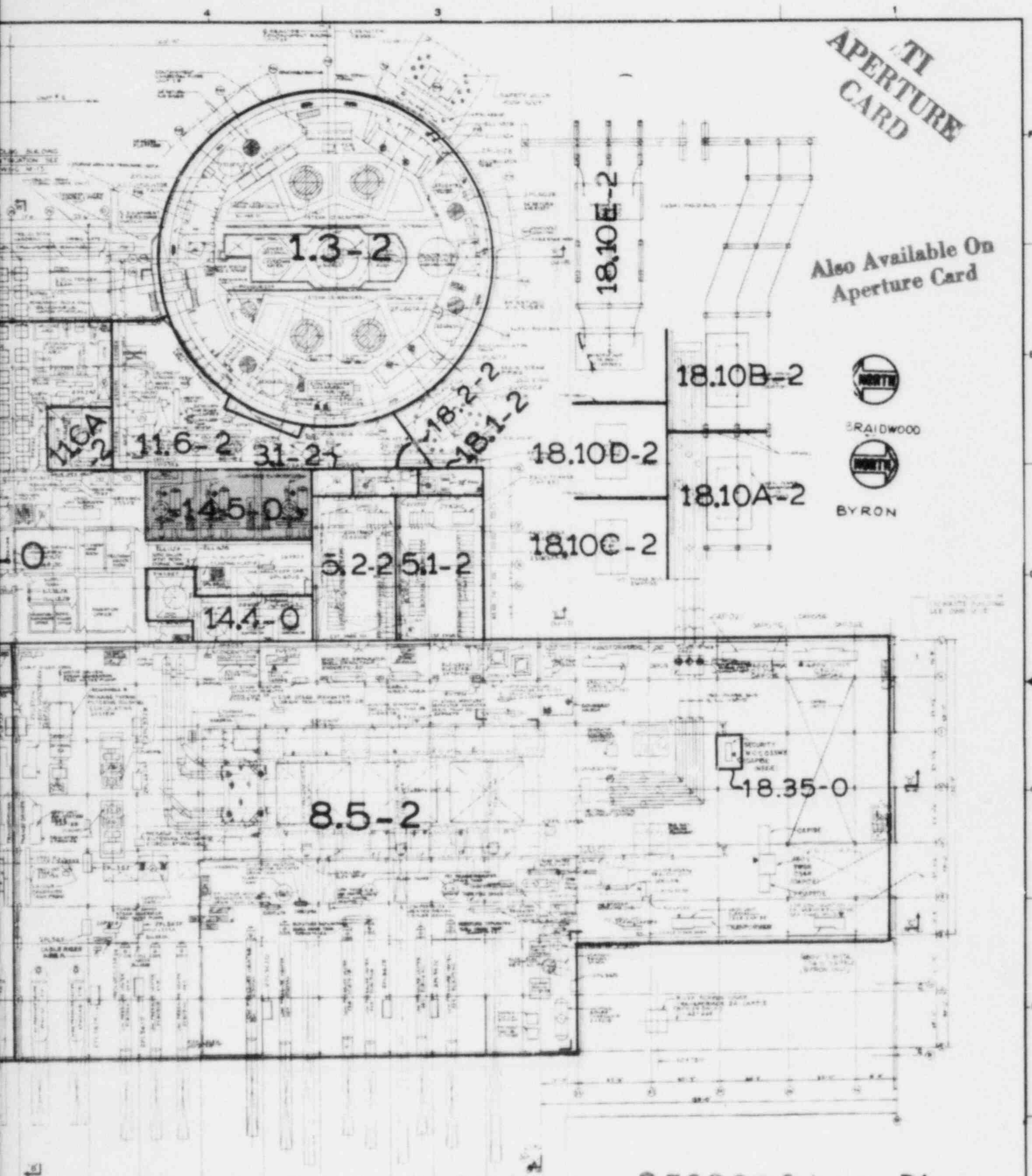
Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
(1AF006B)	1AP152	Ess'l Service Water to AF Pump Suc Valve
(1AF017B)	1AP152	Ess'l Service Water to AF Pump Suc Valve
(1AF01PB-A)	1AP152	Lube Oil Pump for AF 1B
(1VA01CG)	1AP152	SX Pump 1B Cubicle Cooler Fan
(1VA01CH)	1AP152	SX Pump 1B Cubicle Cooler Fan
(1VA04CD)	1AP152	SI Pump 1B Cubicle Cooler Fan and Motor
(1VA06CD)	1AP152	Ch'g Pump 1B Cubicle Cooler Fan and Motor
(1VD03CB)	1AP152	Diesel Generator Room Fan
(0OG060)	1AP154	Butterfly Valve, 3"
(0OG064)	1AP154	Butterfly Valve, 3"
(0VA04CB)	1AP154	Fuel Hdlg Bldg Charcoal Booster Fan
(0VC02CB)	1AP154	Control Room HVAC Fan
(1CC9413B)	1AP154	Gate MO Valve (Cnmt Isol)
(1CC9414)	1AP154	Gate MO valve (Cnmt Isol)
(1CV112C)	1AP154	Gate Valve and Motor Op
(1CV8104)	1AP154	Gate Valve and Motor Op
(1DO01PD)	1AP154	1D Fuel Oil Transfer Pump
(1MS018C)	1AP154	SG Atm Relief Valve & Hydraulic Op
(1OG082)	1AP154	Butterfly Valve (Cnmt Isol)
(1OG084)	1AP154	Butterfly Valve (Cnmt Isol)
(1SI8801B)	1AP154	Gate MO Valve (Cnmt Isol)
(1SX01PB)	1AP166	1B Ess'l Service Water Pump
(0SX146)	1AP254	Comp. Cooling Hx "O" Valve
(1CC9412B)	1AP254	1B RHR HX Outlet Valve
(1RH611)	1AP254	RHR Pump Miniflow Valve
(1SI8924)	1AP254	MO Gate Valve
(1SX005)	1AP254	Pump Disch. to Comp. Cooling Hx "O" Valve
(1SX01PB)	1AP254	1B Ess'l Service Water Pump
(1VA03CE)	1AP254	CS Pump 1B Cubicle Cooler Fan and Motor
(1VA03CF)	1AP254	CS Pump 1B Cubicle Cooler Fan and Motor
(1VA04CC)	1AP254	SI Pump 1B Cubicle Cooler Fan and Motor

Table 7-8 (continued)

Safe Shutdown Equipment and/or Cables Located in HELB Zone 11.5B-0

Equipment Number	Cable Number	Equipment Description (or Equipment Served by Cable)
(1VA06CC)	1AP254	Ch'g Pump 1B Cubicle Cooler Fan and Motor
(1VX01C)	1AP254	ESF Switchgear Room Fan
(1CC01PA)	1CC001	1A Comp. Cooling Pump
(0CC01P)	1CC019	"O" Comp. Cooling Pump
(1FW009B)	1FW217	Gate Isolation Valve & Hydraulic Op
(1MS018C)	1MS628	SG Atm Relief Valve & Hydraulic Op
(1SX01PA)	1SX034	1A Ess'l Service Water Pump
(0VA04CB)	1VA124	Fuel Hdlg Bldg Charcoal Booster Fan
(1VA03CD)	1VA157	CS Pump 1A Cubicle Cooler Fan, Motor
(1VD03CB)	1VD085	Diesel Generator Room Fan
(1VX01C)	1VX006	ESF Switchgear Room Fan


1.3-1
18.10E-1
18.10B-1
18.2-1
18.1-1
18.10D-1
18.10A-1
18.10C-1
3.1-1
11.6-1
11.6A-1
5.1-1
5.2-1
11.6A-0
8.5-1

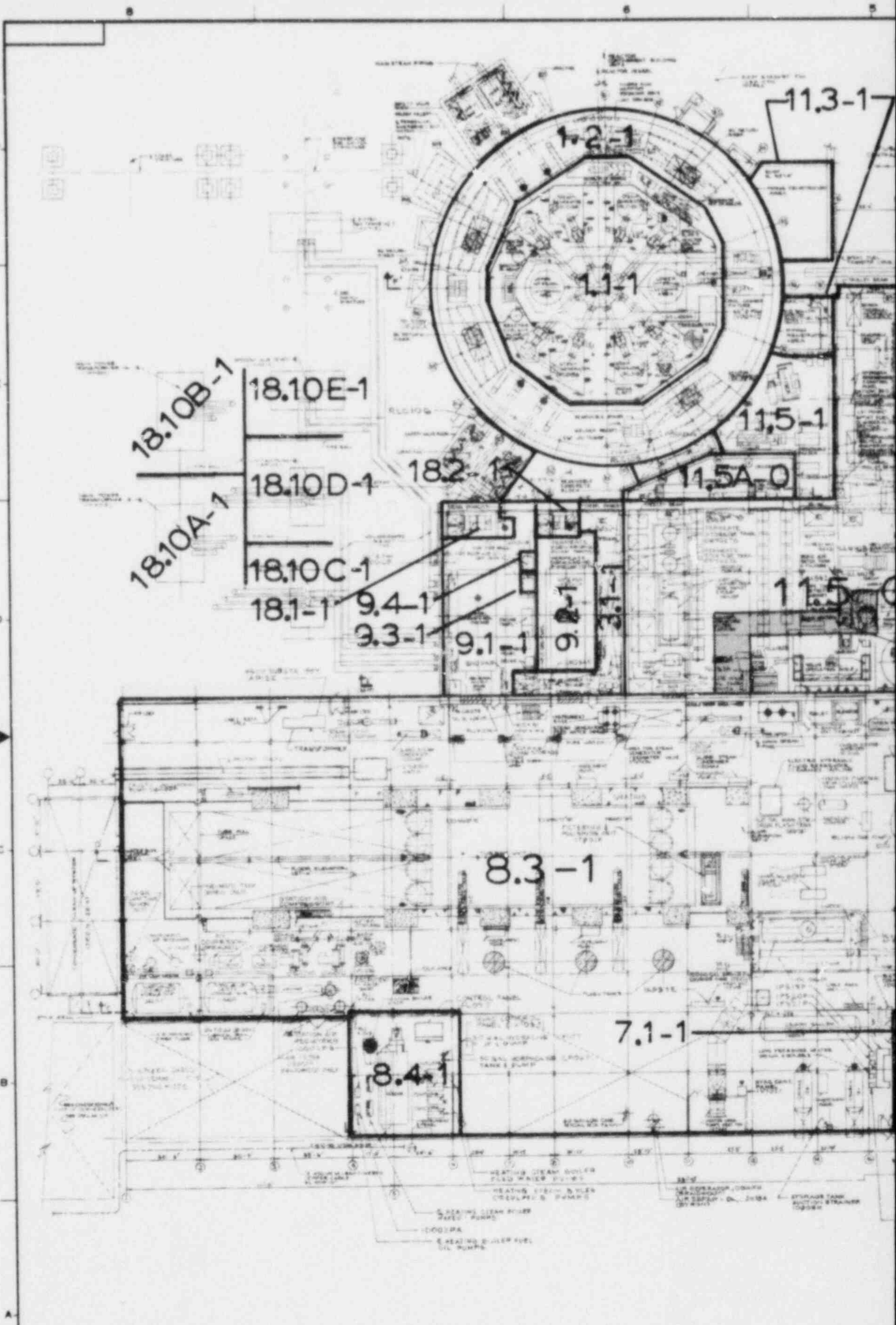


8502280446-01

FIGURE 1

GENERAL ARRANGEMENT
MEZZANINE FLOOR AT ELEVATION
426 FT 0 IN.

GH ENERGY LINE BREAK HAZARD ZONES



HIGH ENERGY LINE BREAK HAZARD ZONES

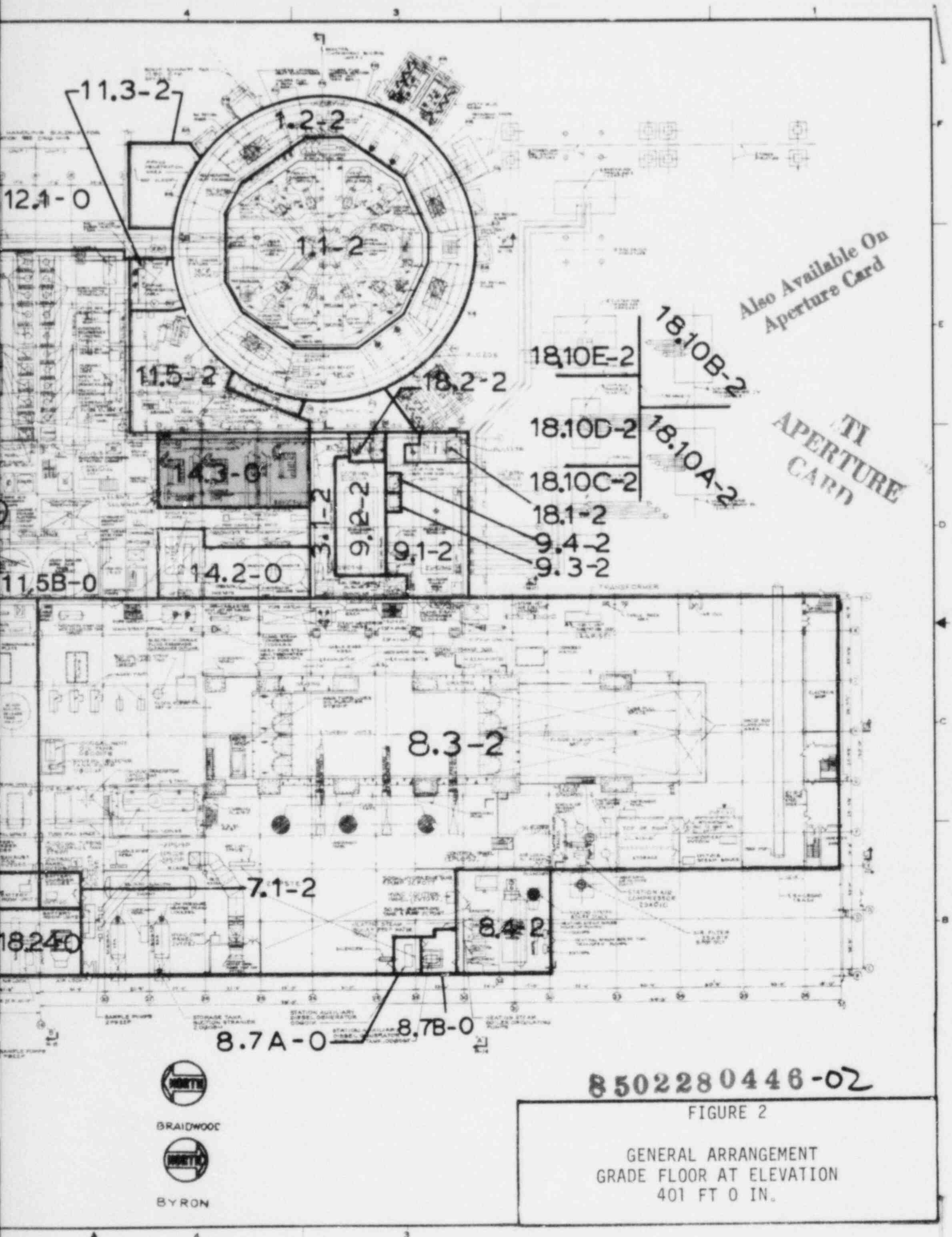
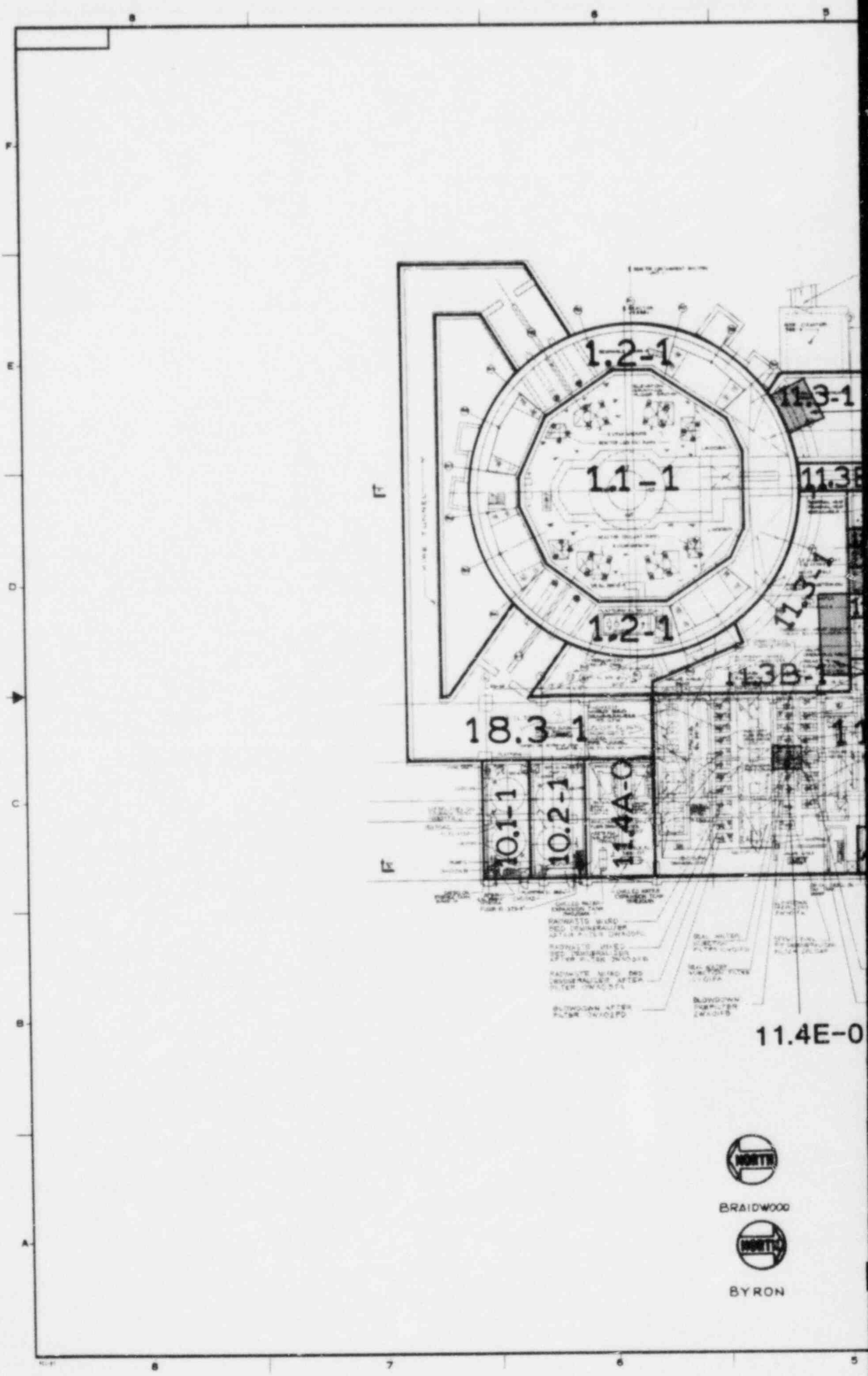
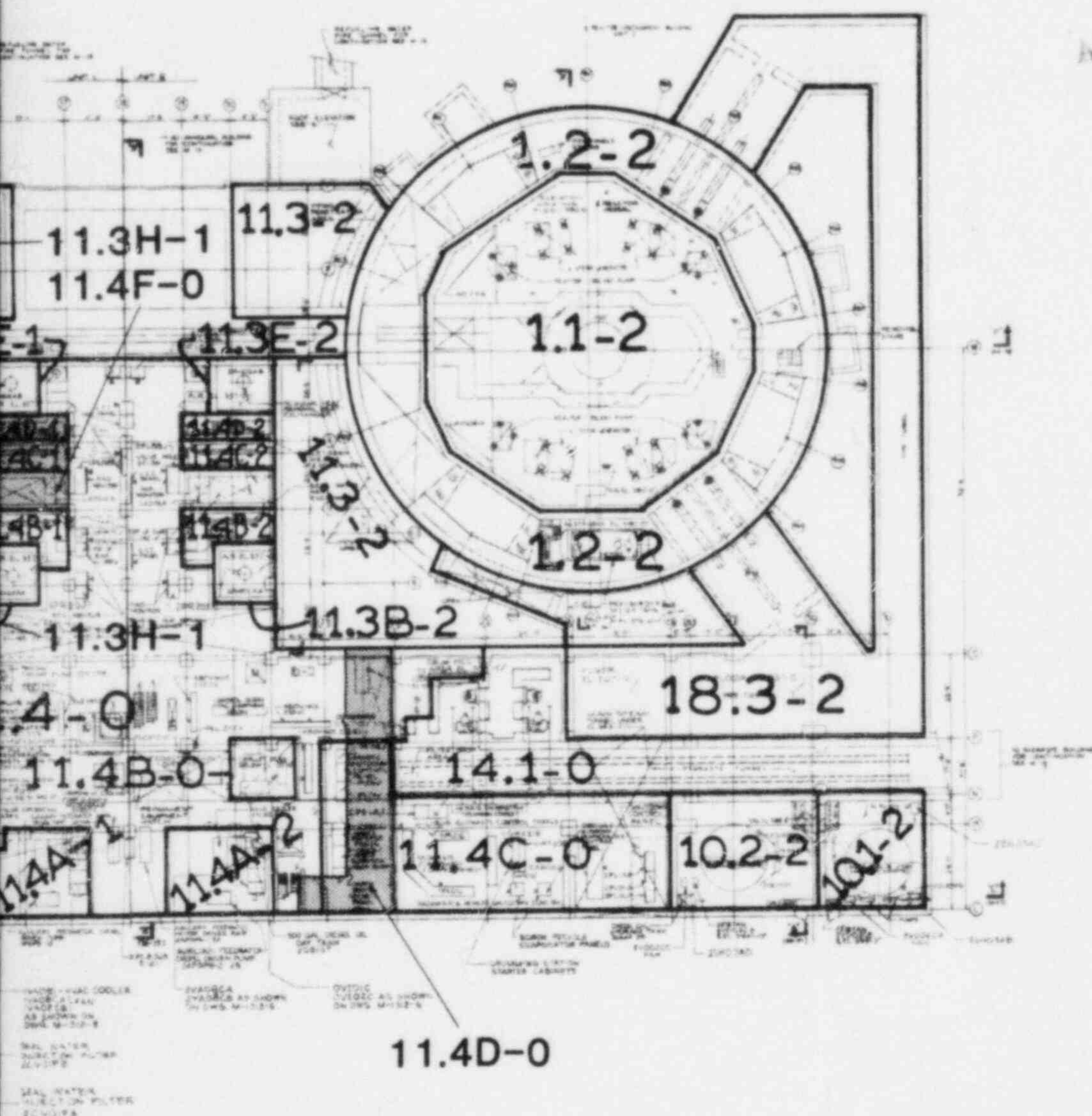


FIGURE 2

GENERAL ARRANGEMENT
GRADE FLOOR AT ELEVATION
401 FT 0 IN.



1.2-1
11.3-1
1.1-1
11.3B
11.3-1
1.2-1
11.3B-1
18.3-1
10.1-1
10.2-1
11.4A-0
11.4E-0
BRAIDWOOD
BYRON



Also Available On Aperture Card

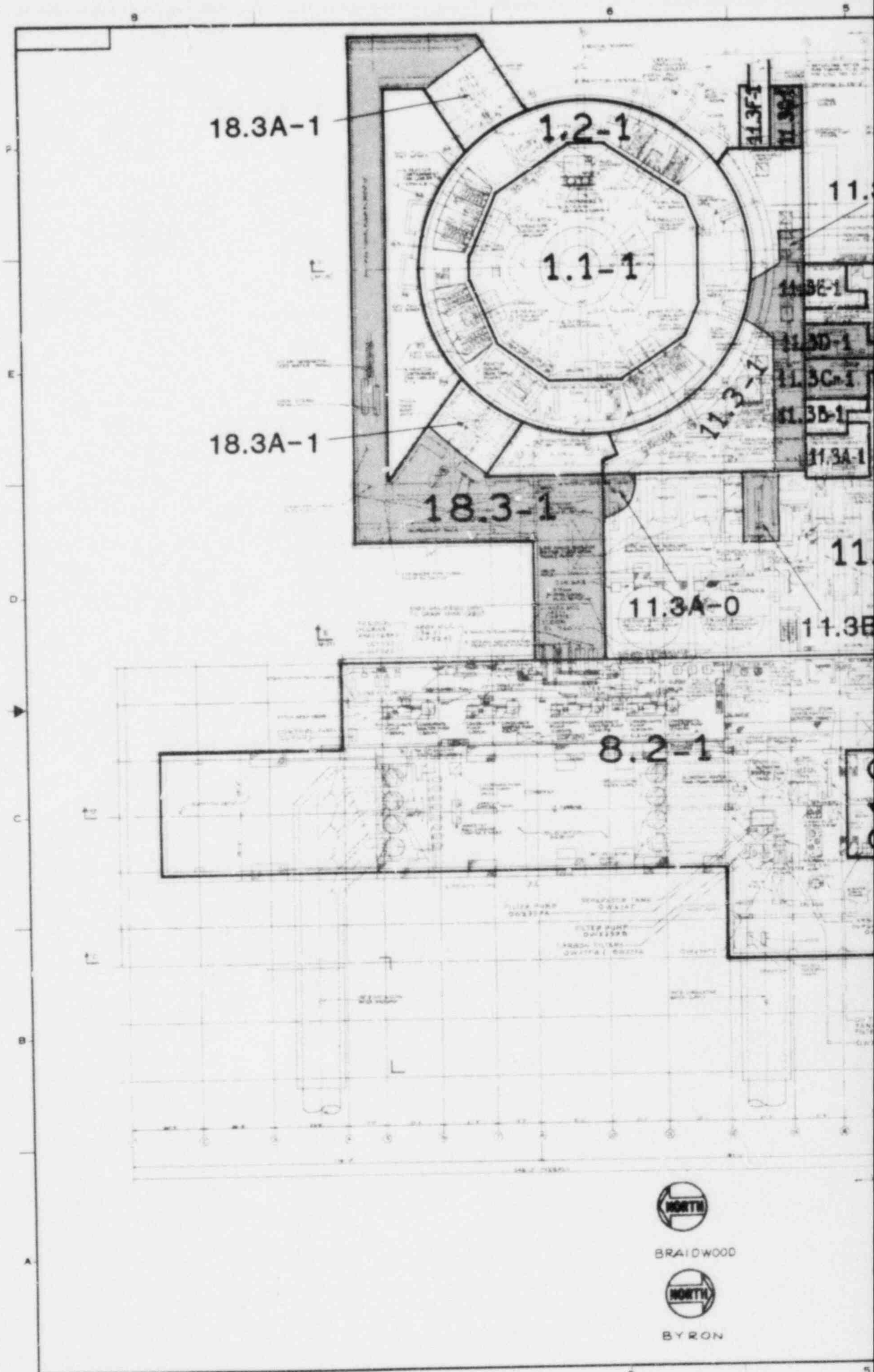
TI APERTURE CARD

8502280446-03

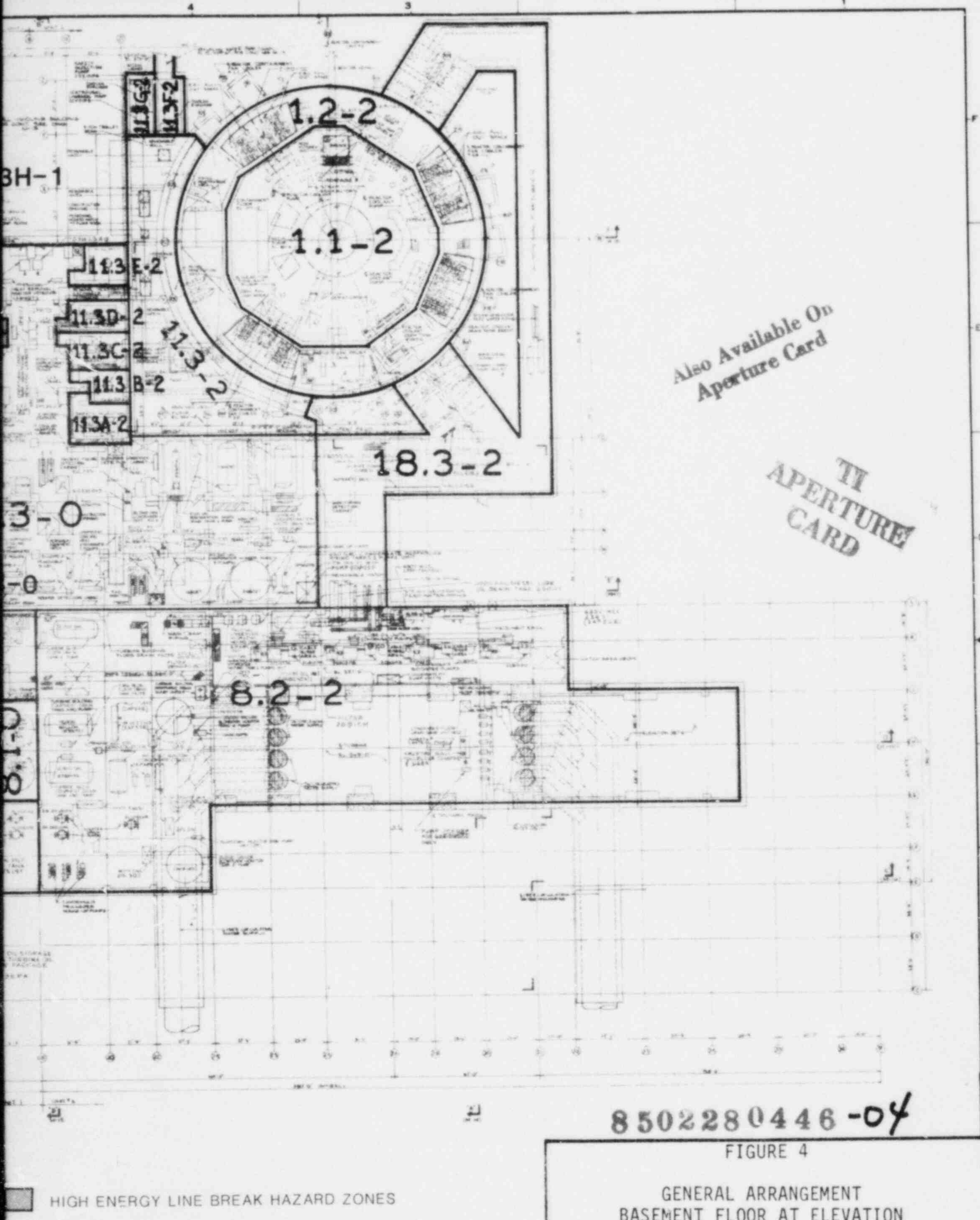
HIGH ENERGY LINE BREAK HAZARD ZONES

FIGURE 3

GENERAL ARRANGEMENT
FLOOR PLAN AT ELEVATION
383 FT 0 IN.



18.3A-1
1.2-1
1.1-1
18.3A-1
18.3-1
11.3-1
11.3D-1
11.3C-1
11.3B-1
11.3A-1
11.3A-0
8.2-1
NORTH
BRAIDWOOD
NORTH
BYRON



Also Available On Aperture Card

TI APERTURE CARD

8502280446-04

FIGURE 4

GENERAL ARRANGEMENT
BASEMENT FLOOR AT ELEVATION
364 FT 0 IN.

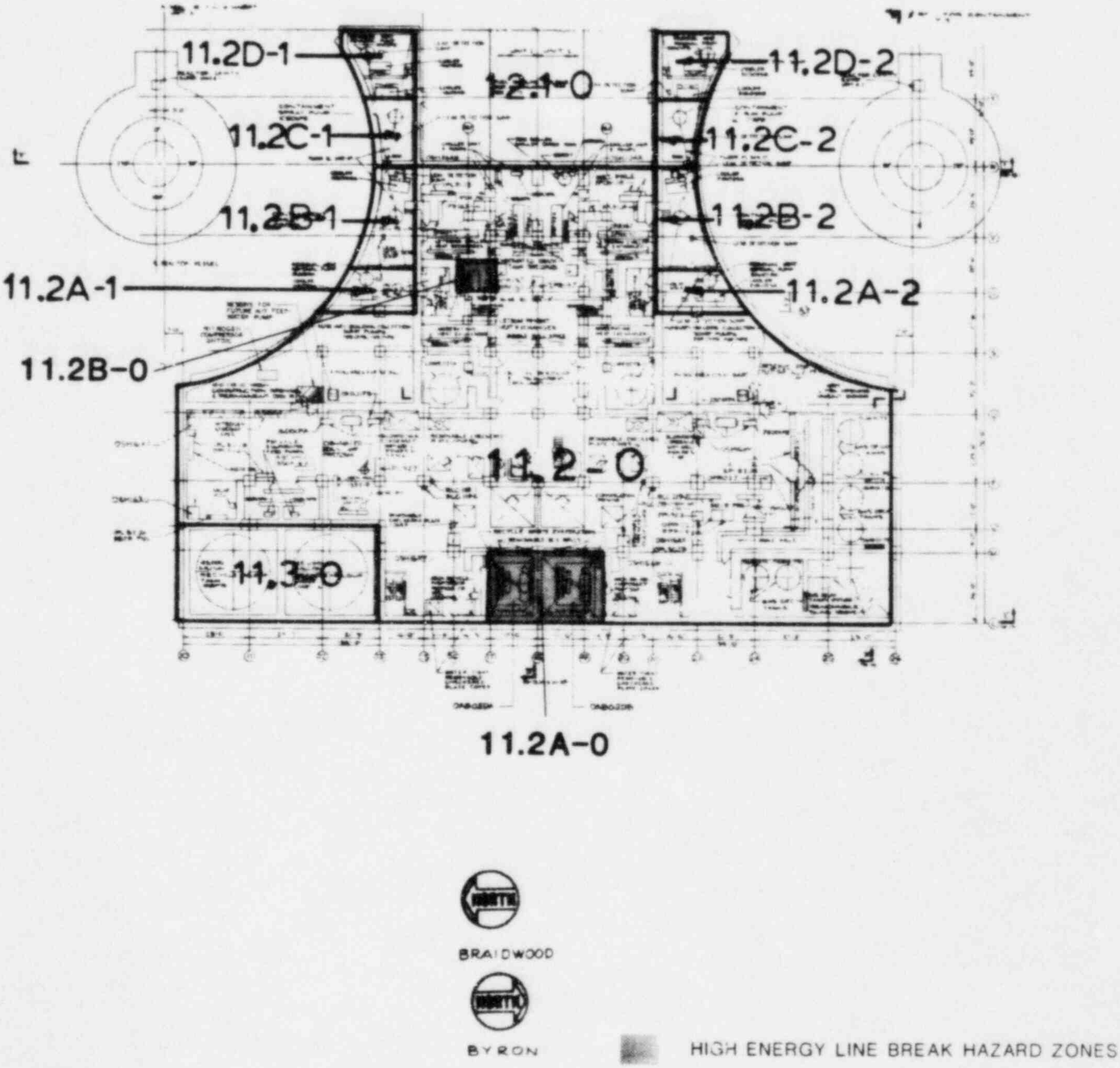


FIGURE 5

GENERAL ARRANGEMENT
FLOOR PLAN AT ELEVATION
346 FT 0 IN.

APPENDIX B

VERIFICATION OF HIGH ENERGY LINE BREAK DESIGN APPROACH FOR JET IMPINGEMENT EFFECTS ON SAFE SHUTDOWN CABLES INSIDE CONTAINMENT AND SAFE SHUTDOWN INSTRUMENT SENSING LINES INSIDE AND OUTSIDE CONTAINMENT

Commonwealth Edison Company
Byron Unit 1
Project No. 4391-00
Project File No. 19.1

TABLE OF CONTENTS

Table of Contents (Cont'd)

Table of Contents (Cont'd)

Table of Contents (Cont'd)

Table of Contents (Cont'd)

Table of Contents (Cont'd)

Table of Contents (Cont'd)

LIST OF TABLES

B.1.0 PURPOSE

The purpose of this design assessment is to confirm that an adequate design approach relative to High Energy Line Break (HELB) jet impingement effects and single failure for safe shutdown cabling located inside containment and safe shutdown instrument sensing lines located inside and outside containment, has been accomplished and meets the objectives of SRP Sections 3.6.1 and 3.6.2. The scope of this assessment is limited to the cables and sensing lines described above since jet impingement effects on cables located outside containment, safe shutdown equipment, piping and structures are discussed in the Summary Report and Appendices listed below.

1. Summary Report- "Verification of Design Adequacy for Jet Impingement Effects"
2. Appendix A - "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Equipment, Instrumentation and Cables"
3. Appendix B - "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Cables Inside Containment and Safe Shutdown Instrument Sensing Lines Inside and Outside Containment"
4. Appendix C - "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Piping"
5. Appendix D - "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Structures"

Note:

The reader should review the Summary Report prior to interpreting the contents of this assessment.

B.2.0 METHOD OF ANALYSIS

B.2.1 General Methodology

The analysis was performed by examination of cable and sensing line locations in relation to HELB jet zones of influence. The jet zones of influence for two phase and steam jets are based on conservative application of NUREG/CR-2913 (Reference B.5.5). The zones of influence for "cold water" jets are based on jet impedence due to structures and piping orientation. The zones of influence are not calculated for each jet. Influence zones are determined by examination of drawings and conservative visual application of jet criteria referenced above. Each functional group of cables and/or sensing lines is analyzed separately to ensure that their safe shutdown functions will be available after consideration of jet impingement effects. For instance, if four redundant instruments can be used to monitor one process variable, their cables and sensing lines are analyzed as a functional group to ensure that the monitoring function can be achieved. The functional groups of cables and sensing lines are evaluated in terms of HELB jet impingement effects using one or more of the following logic statements:

1. The functional group of cables and/or sensing lines is outside the zone of influence of all HELB jets.

2. The functional group of cables and/or sensing lines is not required to be functional for safe shutdown after the specific HELB scenario which could disable them.

3. An adequate number of redundant cables and/or sensing lines within the functional group remain undamaged and can perform their specific safe shutdown functions after certain cables and/or sensing lines within the functional group are disabled by jet impingement.

4. Diverse means outside the functional group are available for achieving the safe shutdown functions of the cables and/or sensing lines damaged by jet impingement.

Throughout the sensing line and cable analyses, structural barriers such as the missile shield walls, steam generator enclosures, pressurizer enclosure and fuel pool enclosure are identified as physical barriers which separate HELB jets from safe shutdown cables and sensing lines. Portions of the analyses also refer to the Elevation 412' and 426' floors outside the missile shield wall to denote separation from HELB jets. These floors are not consistent structural barriers since metal gratings and openings exist in some areas in lieu of concrete. Based on examination of HELB Location Drawings (Reference B.5.3), and application of NUREG/CR-2913, no two phase or steam jets emanating from HELB's located below the Elevation 412' and 426' floors have zones of influence which extend above the Elevation 412' and 426' floors respectively. Similarly, no two phase or steam jets emanating from HELB's located above the Elevation 412' and 426' floors have zones of influence which extend below the Elevation 412' and 426' floors respectively. Based on the location and orientation of the safety injection HELB's and the concrete floors that do exist in these HELB areas, use of the floors as jet influence zone boundaries is also valid for "cold water" jets.

In essence, the floors serve as HELB jet influence zone boundaries for all HELB jets outside the missile shield wall. These boundaries are useful in performing the analysis for two reasons. First, fewer HELB jets require consideration for each sensing line and cable analyzed. Secondly, plan views of HELB Location Drawings (Reference B.5.3), Instrument Location Drawings (Reference B.5.1) and Electrical Installation Drawings (Reference B.5.2) used in the analyses are divided at these two floor elevations. Again, the floors designate jet influence zone boundaries and do not imply existence of consistent concrete floors which serve as jet barriers.

B.2.2 Cables/Sensing Lines Analyzed

The electrical cables analyzed in this assessment are located inside containment and support the safe shutdown components located inside containment. Table B.2.2.1 lists these components and the supporting cables and references the subsection numbers within this assessment which discuss jet impingement effects on the cabling. The components listed in Table B.2.2.1 are a subset of the total list of safe shutdown components inside containment which is listed in Table 1-1 of Sargent & Lundy Calculation Number 3C8-1083-001 Revision 2 (Reference B.5.9).

The instrument sensing lines analyzed in this assessment support safe shutdown instruments located inside and outside of containment. Table B.2.2.1 and Table B.2.2.2 list these instruments and the supporting sensing lines and reference the assessment subsection numbers which contain a discussion of jet impingement effects on the sensing lines. The items listed on Table B.2.2.1 and B.2.2.2 are a subset of the safe shutdown equipment in Tables 1-1 and 1-2 of Sargent & Lundy Calculation Number 3C8-1083-001 Revision 2 (Reference B.5.9).

TABLE B.2.2.1

COMPONENTS INSIDE CONTAINMENT EMPLOYED FOR SAFE SHUTDOWN WHICH ARE DEPENDENT ON CABLES OR SENSING LINES

Component No.	Component Name	Sensing Line No. (if applicable)	Cable No. (if applicable)	Analysis Subsection No.
T1 thru T33	Div. 11 Core Exit Thermocouples	N/A	1IT308 thru 340 1IT343/344/425	B.3.7
T34 thru T65	Div. 12 Core Exit Thermocouples	N/A	1IT351 thru 382 1IT347/348/427	B.3.7
1CC9416	Gate Isol. Valve, 6", Motor Op.	N/A	1CC124/125	B.3.14
1CC9438	Gate Isol. Valve, 4", Motor Op.	N/A	1CC035/039	B.3.14
1CV8112	Globe Isol. Valve, 2", Motor Op.	N/A	1CV040/042	B.3.17
1CV8160	Globe Isol. Valve, 3", Solenoid	N/A	(See Note 1)	B.3.1
1FP011	Globe Isol. Valve, Solenoid	N/A	(See Note 1)	B.3.1
1IA066	Globe Isol. Valve, Solenoid	N/A	(See Note 1)	B.3.1
1LT-459	Pressurizer Level Transmitter	1RY34AA/AB/DA/DB/DD, 1RY82A, 1RY98A	1RY201	B.3.2
1LT-460	Pressurizer Level Transmitter	1RY34BA/BB/EA/EB/EC	1RY205	B.3.2
1LT-461	Pressurizer Level Transmitter	1RY34CA/CB/CC/CD/CE/CF/CG/FA/FB/FC/FD, 1RY99A	1RY209	B.3.2
1LT-517	Stm Gen Narrow Range Lev. Trans.	1FW13AA/AB/EA/EB	1FW059	B.3.3
1LT-518	Stm Gen Narrow Range Lev. Trans.	1FW14AA/AB/EA/EB	1FW051	B.3.3
1LT-519	Stm Gen Narrow Range Lev. Trans.	1FW15AA/AB/EA/EB	1FW044	B.3.3
1LT-527	Stm Gen Narrow Range Lev. Trans.	1FW13BA/BB/FA/FB	1FW061	B.3.3
1LT-528	Stm Gen Narrow Range Lev. Trans.	1FW14BA/BB/FA/FB	1FW053	B.3.3
1LT-529	Stm Gen Narrow Range Lev. Trans.	1FW15BA/BB/FA/FB	1FW035	B.3.3

TABLE B.2.2.1

COMPONENTS INSIDE CONTAINMENT EMPLOYED FOR SAFE SHUTDOWN WHICH ARE DEPENDENT ON CABLES OR SENSING LINES

(continued)

Component No.	Component Name	Sensing Line No. (if applicable)	Cable No. (if applicable)	Analysis Subsection No.
1LT-537	Stm Gen Narrow Range Lev. Trans.	1FW13CA/GA/GB, 1FW74CB, 1FW112A	1FW063	B.3.3
1LT-538	Stm Gen Narrow Range Lev. Trans.	1FW14CA/CB, 1FW14GA/GB	1FW055	B.3.3
1LT-539	Stm Gen Narrow Range Lev. Trans.	1FW15CA/CB, 1FW15GA/GB	1FW039	B.3.3
1LT-547	Stm Gen Narrow Range Lev. Trans.	1FW13DA/DB/HA/HB	1FW065	B.3.3
1LT-548	Stm Gen Narrow Range Lev. Trans.	1FW14DA/DB/HA/HB, 1FW74DB	1FW057	B.3.3
1LT-549	Stm Gen Narrow Range Lev. Trans.	1FW15DA/DB/HA/HB	1FW049	B.3.3
1LT-556	Stm Gen Narrow Range Lev. Trans.	1FW91AA/AB/EA/EB, 1FW74AB	1FW700	B.3.3
1LT-557	Stm Gen Narrow Range Lev. Trans.	1FW91BA/BB/FA/FB, 1FW74BB	1FW703	B.3.3
1LT-558	Stm Gen Narrow Range Lev. Trans.	1FW91CA/CB/GA/GB	1FW702	B.3.3
1LT-559	Stm Gen Narrow Range Lev. Trans.	1FW91DA/DB/HA/HB, 1FW103A	1FW701	B.3.3
1ØG057A	Butterfly Isol. Valve, Motor Op.	N/A	1ØG092/093	B.3.15
1ØG079	Butterfly Isol. Valve, 3" Mot. Op.	N/A	1ØG156/203	B.3.15
1ØG080	Butterfly Isol. Valve, 3" Mot. Op.	N/A	1ØG162/164	B.3.15
1ØG081	Butterfly Isol. Valve, 3" Mot. Op.	N/A	1ØG167/169	B.3.15
1PT455	Pressurizer Pressure Transmitter	1RY34AA/AB/DD, 1RY82A, 1RY98A	1RY199	B.3.4
1PT456	Pressurizer Pressure Transmitter	1RY34BA/BB/EC	1RY203	B.3.4
1PT457	Pressurizer Pressure Transmitter	1RY34CA/CB/CC/CD/CE/CF/CG	1RY207	B.3.4
1PT458	Pressurizer Pressure Transmitter	1RY34CA/CB/CC/CD/CE/CF/CG	1RY211	B.3.4
1PS9354A	Globe Isol. Valve, 3/8" Solenoid	N/A	(See Note 1)	B.3.1
1PS9355A	Globe Isol. Valve, 3/8" Solenoid	N/A	(See Note 1)	B.3.1
1PS9356A	Globe Isol. Valve, 3/8" Solenoid	N/A	(See Note 1)	B.3.1
1PS9357A	Globe Isol. Valve, 3/8" Solenoid	N/A	(See Note 1)	B.3.1

TABLE B.2.2.1

COMPONENTS INSIDE CONTAINMENT EMPLOYED FOR SAFE SHUTDOWN WHICH ARE DEPENDENT ON CABLES OR SENSING LINES

(continued)

Component No.	Component Name	Sensing Line No. (if applicable)	Cable No. (if applicable)	Analysis Subsection No.
1TE-411A	RCS Narrow Range Temp.	N/A	1RC340/341	B.3.6
1TE-411B	RCS Narrow Range Temp.	N/A	1RC346/347	B.3.6
1TE-421A	RCS Narrow Range Temp.	N/A	1RC381/382	B.3.6
1TE-421B	RCS Narrow Range Temp.	N/A	1RC387/388	B.3.6
1TE-431A	RCS Narrow Range Temp.	N/A	1RC415/416	B.3.6
1TE-431B	RCS Narrow Range Temp.	N/A	1RC421/422	B.3.6
1TE-441A	RCS Narrow Range Temp.	N/A	1RC433/434	B.3.6
1TE-441B	RCS Narrow Range Temp.	N/A	1RC439/440	B.3.6
1PT-403	RC Pressure Transmitter	1RC42AB	1RC224	B.3.5
1PT-405	RC Pressure Transmitter	1RC42BB	1RC226	B.3.5
1PT-406	RC Pressure Transmitter	(See Note 2)	(See Note 2)	B.3.5
1PT-407	RC Pressure Transmitter	(See Note 2)	(See Note 2)	B.3.5
1PT-408	RC Pressure Transmitter	(See Note 2)	(See Note 2)	B.3.5
1PT-409	RC Pressure Transmitter	(See Note 2)	(See Note 2)	B.3.5
1RC014A	Globe Valve, 1"	N/A	1RC620/621	B.3.16
1RC014B	Globe Valve, 1"	N/A	1RC623/624	B.3.16
1RC014C	Globe Valve, 1"	N/A	1RC626/627	B.3.16
1RC014D	Globe Valve, 1"	N/A	1RC629/630	B.3.16
1RE1003	Diaph. Isol. Valve, 3", 2 Solenoid	N/A	(See Note 1)	B.3.1
1RE9159A	Diaph. Isol. Valve, 3/4" Solenoid	N/A	(See Note 1)	B.3.1
1RE9160A	Diaph. Isol. Valve, 1" Solenoid	N/A	(See Note 1)	B.3.1
1RF026	Plug Valve, 2" Solenoid	N/A	(See Note 1)	B.3.1

TABLE B.2.2.1

COMPONENTS INSIDE CONTAINMENT EMPLOYED FOR SAFE SHUTDOWN WHICH ARE DEPENDENT ON CABLES OR SENSING LINES

(continued)

Component No.	Component Name	Sensing Line No. (if applicable)	Cable No. (if applicable)	Analysis Subsection No.
1RH8701A	Gate Isol. Valve, 12" Motor Op.	N/A	1RH024/027/028	B.3.19
1RH8701B	Gate Valve, 12" Motor Op.	N/A	1RH033/037	B.3.19
1RH8702A	Gate Isol. Valve, 12" Motor Op.	N/A	1RH045/049	B.3.19
1RH8702B	Gate Valve, 12" Motor Op.	N/A	1RH060/061/057	B.3.19
1RY455A	PORV, 2 Solenoids	N/A	1RY246/247/248/ 249/388/426	B.3.18
1RY456	PORV, 2 Solenoids	N/A	1RY252/253/254/ 255/389/427	B.3.18
1RY8000A	Gate Valve, 3" Motor Op.	N/A	1RY002/004/401	B.3.18
1RY8000B	Gate Valve, 3" Motor Op.	N/A	1RY007/009/403	B.3.18
1RY8026	Globe Isol. Valve, 3/8" Solenoid	N/A	(See Note 1)	B.3.1
1SA033	Globe Isol. Valve, Solenoid	N/A	(See Note 1)	B.3.1
1VP01CA	Prim. Cnmt. Vent System RCFC Fan, Motor	N/A	1VP002/004	B.3.11
1VP01CB	Prim. Cnmt. Vent System RCFC Fan, Motor	N/A	1VP024/026	B.3.11
1VP01CC	Prim. Cnmt. Vent System RCFC Fan, Motor	N/A	1VP046/048	B.3.11
1VP01CD	Prim. Cnmt. Vent System RCFC Fan, Motor	N/A	1VP068/070	B.3.11

TABLE B.2.2.1

COMPONENTS INSIDE CONTAINMENT EMPLOYED FOR SAFE SHUTDOWN WHICH ARE DEPENDENT ON CABLES OR SENSING LINES

(continued)

Component No.	Component Name	Sensing Line No. (if applicable)	Cable No (if applicable)	Analysis Subsection No.
1VQ001A	Butterfly Isol. Valve, Actuator	N/A	1VQ086/263/264/266/088/271/233/091/272	B.3.12
1VQ002A	Butterfly Isol. Valve, Actuator	N/A	1VQ113/282/283/284/114/289/290/122/238	B.3.12
1VQ004A	Butterfly Isol. Valve, Solenoid	N/A	(See Note 1)	B.3.1
1VQ005A	Butterfly Isol. Valve, Solenoid	N/A	(See Note 1)	B.3.1
1WO056A	Gate Control Isol. Valve, 10"	N/A	1WØ187/189	B.3.13
1WO056B	Gate Control Isol. Valve, 10"	N/A	1WØ192/194	B.3.13
1RE-AR011	Containment Radiation Monitor	N/A	1AR022	B.3.20
1RE-AR012	Containment Radiation Monitor	N/A	1AR028	B.3.20

(Notes 1 & 2)

Note 1: Cable numbers are not listed. Failure of these cables due to jet impingement will result in the valves failing in their safe shutdown position.

Note 2: These transmitters are scheduled for installation at the first Byron Unit 1 refueling outage.

TABLE B.2.2.2

INSTRUMENTS OUTSIDE CONTAINMENT EMPLOYED FOR SAFE SHUTDOWN WHICH ARE DEPENDENT ON SENSING LINES

Instrument Number	Instrument Name	Sensing Line Numbers	Analysis Subsection No.
IPT-514	Main Steam Pressure Transmitter	1MS72AB	B.3.8
IPT-515	Main Steam Pressure Transmitter	1MS72EB	B.3.8
IPT-516	Main Steam Pressure Transmitter	1MS72JB	B.3.8
IPT-524	Main Steam Pressure Transmitter	1MS72BB	B.3.8
IPT-525	Main Steam Pressure Transmitter	1MS72FB	B.3.8
IPT-526	Main Steam Pressure Transmitter	1MS72KB	B.3.8
IPT-534	Main Steam Pressure Transmitter	1MS72CB	B.3.8
IPT-535	Main Steam Pressure Transmitter	1MS72GB	B.3.8
IPT-536	Main Steam Pressure Transmitter	1MS72LB	B.3.8
IPT-544	Main Steam Pressure Transmitter	1MS72DB	B.3.8
IPT-545	Main Steam Pressure Transmitter	1MS72HB	B.3.8
IPT-546	Main Steam Pressure Transmitter	1MS72MB	B.3.8
ILT-930	RWST Level Transmitter	1SI99DA/DB	B.3.9
ILT-931	RWST Level Transmitter	1SI99CA/CB	B.3.9
ILT-932	RWST Level Transmitter	1SI99BA/BB	B.3.9
ILT-933	RWST Level Transmitter	1SI99AA/AB	B.3.9
IPT-934	Containment Pressure Transmitter	Not Numbered	B.3.10
IPT-935	Containment Pressure Transmitter	Not Numbered	B.3.10
IPT-936	Containment Pressure Transmitter	Not Numbered	B.3.10
IPT-937	Containment Pressure Transmitter	Not Numbered	B.3.10
1LS-DO033	Diesel Oil Level Switch	1DOA1AA/CA, 1DOA2AA/CA, 1DOA3AA/AB	B.3.21

TABLE B.2.2.2

INSTRUMENTS OUTSIDE CONTAINMENT EMPLOYED FOR SAFE SHUTDOWN WHICH ARE DEPENDENT ON SENSING LINES

(continued)

Instrument Number	Instrument Name	Sensing Line Numbers	Analysis Subsection No.
1LS-DO036	Diesel Oil Level Switch	1DOA1BA/DA, 1DOA2BA/CA 1DOA3BA/BB	B.3.21
1PSL-AF051	Auxiliary Feedwater Pressure Switch	1AF07AB/1AF18AA/1AF19AA	B.3.23
1PSL-AF055	Auxiliary Feedwater Pressure Switch	1AF07BB/1AF18BA/1AF19BA	B.3.23
1FE-VA003	HVAC Flow Element	Not Numbered	B.3.22
1FE-VA004	HVAC Flow Element	Not Numbered	B.3.22
1FE-VA005	HVAC Flow Element	Not Numbered	B.3.22
1FE-VA006	HVAC Flow Element	Not Numbered	B.3.22
1FE-VA007	HVAC Flow Element	Not Numbered	B.3.22
1FE-VA008	HVAC Flow Element	Not Numbered	B.3.22
1FE-VA009	HVAC Flow Element	Not Numbered	B.3.22
1FE-VA010	HVAC Flow Element	Not Numbered	B.3.22

B.2.3 Scope of Analysis Explanation and Validation

The scope of this assessment is limited to cables inside containment and sensing lines inside and outside containment as indicated in Section 1.0 above.

The scope was divided in this manner for the cables due to the differences in analysis methods used inside containment versus outside. The structural compartmentalization outside containment lends itself to strict definition of high energy line break jet hazard zones (HELB zones). Alternate safe shutdown success criteria are defined after postulating complete failure of cables within a hazard zone plus single failure. Inside containment, where jet hazard zones cannot always be strictly defined by structures, analyses must be performed by examining the locations of various components within an area relative to high energy line breaks.

Jet impingement effects on cables located inside containment can legitimately be analyzed separately from those outside containment and vice versa, because the containment wall serves as a high energy line break jet barrier. No HELB jets which emanate from within the containment can impinge on cables located outside. Similarly, no HELB jets which emanate from outside the containment can impinge on cables located inside. Therefore, since only one initiating HELB event at a time must be postulated, independent jet impingement assessments inside and outside containment are valid.

The sensing lines inside containment are addressed in this assessment, since attention must be given to jet interaction between cables and sensing lines inside containment to make a valid assessment. The sensing line/cable interaction outside containment did not have to be considered, because none of the safe shutdown sensing lines outside containment are located in HELB zones. The analysis for sensing lines outside containment are included as part of this assessment to provide a complete reference for all sensing line analyses.

B.2.4 Jet Interaction With Other Components

Outside containment, safe shutdown instrument sensing lines are not located in HELB zones as indicated previously. Therefore, jet interaction between these sensing lines and other safe shutdown components need not be considered.

The Summary Report addresses HELB jet interaction between functional groups of cables and sensing lines and other safe shutdown components inside containment to demonstrate that safe shutdown can be achieved following any HELB scenarios.

B.2.5 Analysis Format

Section B.3.0 of this assessment contains the actual jet impingement analysis for the cabling inside containment and the instrument sensing lines inside and outside containment. Tables B.2.2.1 and B.2.2.2 list the components which cables and sensing lines are analyzed for. The Tables also reference the applicable subsections of Section B.3.0 which contain the analysis for each functional group of cables and/or sensing lines.

Each analysis subsection describes the safe shutdown function of the components which the cables and sensing lines support. The specific HELB accident scenarios for which the components are required to be functional are defined. The general methodology used to disposition the cables and sensing lines is outlined. This outline includes a description of the considerations which must be addressed relative to cable, sensing line and other component interactions. Finally, a detailed analysis is included in each subsection to verify that the functional groups of cables and/or sensing lines can achieve their safe shutdown functions after the specific HELB scenarios for which the functions are required. The Summary Report verifies that an adequate number of functions remain unaffected by jet impingement such that safe shutdown can be achieved.

B.2.6 Accident Scenarios

The components listed in Tables B.2.2.1 and B.2.2.2 are not required for all HELB scenarios. This discussion is to identify the specific HELB accident scenarios after which the components analyzed in this assessment are required to be functional.

Table B.2.6.1 summarizes the HELB scenarios which could occur inside containment. The HELB scenarios outside containment will not be tabulated in this assessment since no safe shutdown sensing lines outside containment are located in HELB hazard zones. These scenarios are, however, tabulated in the Summary Report.

Table B.2.6.1 lists the safe shutdown instruments from Tables B.2.2.1 and B.2.2.2 and indicates the HELB scenarios after which the instruments are required to be functional. The instrument functions required after each HELB scenario have been indicated and subdivided into ESF/reactor trip functions and monitoring functions. The jet impingement dispositions for safe shutdown component cables and sensing lines inside containment will utilize this information as necessary.

TABLE B.2.6.1

INSTRUMENTS EMPLOYED FOR SAFE
SHUTDOWN FOLLOWING HELB
SCENARIOS INSIDE CONTAINMENT

	Large LOCA		Small LOCA		Steam LOCA		Main FW Break		Main Steam Break		Bypass FW Break		Charging Line Break		SD Break		SI Break	
	ESF	Monitoring	ESF	Monitoring	ESF	Monitoring	ESF	Monitoring	ESF	Monitoring	ESF	Monitoring	ESF	Monitoring	ESF	Monitoring	ESF	Monitoring
Wide Range RCS Pressure (ECCS Pressure)		x		x		x		x		x		x		x		x		x
Pressurizer Pressure	x		x		x				x									
Containment Pressure	x	x	x	x	x	x	x	x	x	x	x	x		x				
Main Steam Pressure		x		x		x	x	x	x	x	x	x		x		x		x
RWST Level		x		x		x												
Pressurizer Level				x				x		x		x		x		x		x
Narrow Range SG Level				x		x	x	x		x		x		x	x	x		x
Core Exit Temperature (T Hot)				x		x		x		x		x		x		x		x
Containment Radiation		x		x		x		x		x		x		x				
Narrow Range RCS Temperature											x							

B.2.7 Sensing Line and Cable Supports

Sensing line supports, conduit supports and cable tray supports do not require individual jet impingement assessments. The jet impingement assessments for sensing lines and cabling conservatively envelope the associated supports.

Unlike major piping systems, the sensing lines and cables are conveniently routed along major containment structures to minimize support extensions. This design feature is evident when examining Instrument Location Drawings (Reference B.5.1) and Electrical Installation Drawings (Reference B.5.2). These drawings illustrate that sensing line and cable routings closely follow the perimeters of major containment structures such as the containment wall, the missile shield wall, the fuel pool enclosure, the steam generator enclosures, the pressurizer enclosure and structural steel. The Conduit Support Drawings (Reference B.5.12) and the Cable Tray Support Drawings (Reference B.5.13) illustrate that supports are local to these major structures.

Sensing lines and cables which are analyzed in Section B.3.0 and found to be outside conservatively determined jet zones of influence are separated from jets by structures or by significant distances. Based on the conservatively determined separation and the sensing line and cable support localization, these supports require no further assessment.

B.3.0 ANALYSIS

B.3.1 Fail Safe Valves

Safe shutdown valves listed in Table B.2.2.1 which reference this disposition section are active valves that are designed to fail in a safe position upon loss of air and/or electrical power. The safe position is the position required for these valves to perform their safe shutdown functions. Failure of cables to these valves due to jet impingement effects would result in the valves moving into or remaining in their safe shutdown positions.

B.3.2 Pressurizer Level Sensing Lines and Cables

B.3.2.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the sensing lines and electrical cables for pressurizer level transmitters lLT-459, lLT-460 and lLT-461.

B.3.2.2 Shutdown Basis

Pressurizer level transmitters are employed for safe shutdown monitoring under certain HELB scenarios. These scenarios do not include large LOCA's or pressurizer steam side LOCA's. The level transmitters are not required for large LOCA's since the pressurizer level would be depleted rapidly. The transmitters are not required for a pressurizer steam side LOCA since the LOCA would result in a "boil up" and an erroneous level indication. The transmitters are not required for ESF actuation. The pressurizer level transmitter safe shutdown function is to provide level indication. One functional transmitter is adequate to support this monitoring function.

B.3.2.3 Sensing Line and Cable Installation

The pressurizer is provided with three sensing line taps located circumferentially at Elevation 450'-8" and three more located similarly at Elevation 407'-4". One vertically aligned pair of taps provide input to reactor protection Channel RI Transmitter lLT-459. The second vertically aligned pair of taps provide input to Channel RII Transmitter lLT-460. The third pair of taps provide input to Channel RIII Transmitter lLT-461.

The transmitters are all located outside the missile shield wall. Transmitters lLT-459, 460 and 461 are located near columns R-12, R-16 and R-7 respectively above the Elevation 377' floor.

The cables for Transmitters lLT-459 and 461 are routed upward until they penetrate through the Elevation 412' floor. From this point, they are routed to the respective containment electrical penetrations. The cable for Transmitter lLT-460 is routed upward and toward the electrical penetration area above the Elevation 426' floor. The transmitter cables are always located outside the missile shield wall.

B.3.2.4 Analysis Method

Demonstrate that physical separation and barriers prevent any HELB jets other than those emanating from large LOCA's and steam side LOCA's from disabling sensing lines and/or cables that support more than one of the level transmitters. Failure of one transmitter due to jets emanating from breaks other than large LOCA's and steam side LOCA's inside containment plus a single reactor protection channel failure leaves at least one functional transmitter which is acceptable for safe shutdown as discussed in section B.3.2.2.

Jet impingement effects on the sensing lines and cables will be performed systematically in three parts as follows:

B.3.2.4.1 Sensing Lines

Demonstrate that physical separation and barriers prevent jets emanating from HELB's other than large LOCA's and steam side LOCA's from disabling sensing lines supporting more than one of the three transmitters.

B.3.2.4.2 Cables

Demonstrate that physical separation and barriers prevent jets emanating from HELB's other than large LOCA's and steam side LOCA's from disabling cables supporting more than one of the three transmitters.

B.3.2.4.3 Sensing Line/Cable Interaction

Demonstrate that physical separation and barriers prevent jets emanating from HELB's other than large LOCA's and steam side LOCA's from disabling cables and sensing lines supporting more than one of the three transmitters.

B.3.2.5 Analysis

Analysis Sections B.3.2.5.1, B.3.2.5.2 and B.3.2.5.3 below, correspond to Analysis Method Sections B.3.2.4.1, B.3.2.4.2 and B.3.2.4.3 above.

B.3.2.5.1 Sensing Lines

Based on the "as-built" Sensing Line Drawings (Reference B.5.4) and Instrument Location Drawings (Reference B.5.1), the upper tap sensing lines for the three level transmitters are routed down through the pressurizer enclosure. Based on the HELB Location Drawings (Reference B.5.3), HELB jets that could affect the inner enclosure area emanate from the pressurizer spray line (Line 1RY01B) and the pressurizer pressure relief lines (Lines 1RY02A/B, 1RY03AA/AB/AC and 1RY06A). Based on Section B.2.6, pressurizer level indication is not required following a pressurizer steam side LOCA. HELB's in any of the lines listed above is a steam side LOCA in which the level indication is not required. Once outside the bottom of the pressurizer enclosure, the upper tap sensing lines diverge and eventually penetrate the missile shield wall. HELB's closest to the diverging area inside the missile shield wall are located on the pressurizer surge line (Line 1RY11A), the pressurizer auxiliary spray line (Line 1RY18A) and the loop 4 main feedwater line (Line 1FW03DD). The pressurizer surge line break is considered a large LOCA after which, pressurizer level indication is not required. The auxiliary spray line break is considered a pressurizer steam side LOCA after which pressurizer level indication is not required. All upper tap sensing lines are located outside the jet zones of influence of the feedwater line breaks. The lower tap sensing lines are also located in the same diverging area at a lower elevation. Only one lower tap sensing line (Line 1RY34DB to Transmitter 1LT-459) could possibly be affected by the Loop 1 and Loop 4 main feedwater line breaks. Based on the divergence and separation of the sensing lines after they leave the pressurizer area, there are no HELB jets inside the missile shield wall which can disable the sensing lines to more than one transmitter in a HELB scenario that requires level indication. Based on the above, no HELB jets inside the missile shield wall could result in the loss of more than one level transmitter in a HELB scenario that requires level indication.

Outside the missile shield wall, all pressurizer level sensing lines are located below the Elevation 426' floor. Based on the "as-built" Sensing Line Drawings (Reference B.5.4) and the Instrument Location Drawings (Reference B.5.1), the sensing lines located outside the missile shield wall which support Transmitter ILT-460 are of minimal length. Based on the Break Location Drawings (Reference B.5.3), there are no HELB's in the area of these sensing lines. No HELB jet could disable sensing lines outside the missile shield wall to Transmitter ILT-460. Based on the "as-built" Sensing Line Drawings (Reference B.5.4) and the Instrument Location Drawings (Reference B.5.1), the sensing lines outside the missile shield wall which support Transmitter ILT-459 are within the zone of influence of a Loop 4 main feedwater HELB jet and a Loop 1 steam generator blowdown HELB jet near Column R-7 above the Elevation 377' floor. The remainder of the sensing line routing outside the missile shield wall for Transmitter ILT-459 is outside all other jet zones of influence. The sensing lines outside the missile shield wall for Transmitter ILT-461 are outside the main feedwater and steam generator blowdown HELB jet zones of influence which affect the sensing lines for Transmitter ILT-459. Based on the above, HELB jets outside the missile shield wall could not disable sensing lines to more than one of the three pressurizer level transmitters simultaneously.

No HELB jets inside containment other than those emanating from large LOCA's and pressurizer steam side LOCA's could disable the sensing lines to more than one of the three pressurizer level transmitters simultaneously.

B.3.2.5.2 Cables

Based on the Electrical Installation Drawings (Reference B.5.2), all pressurizer level transmitter cables are located outside the missile shield wall. The cable for Transmitter ILT-460 begins near Column R-16 above the Elevation 377' floor and is routed upward to Elevation 410'. There are no HELB jets in this upward routing area. The cable is then routed under the Elevation 412' floor counterclockwise around the containment from Column R-16 to Column R-12. The only HELB's in this area are main steam and feedwater breaks and a steam generator blowdown line break as shown on the HELB Location Drawings (Reference B.5.3). Based on application of NUREG/CR-2913 (Reference B.5.5), the cable for Transmitter 1LT-460 is located outside the jet zones of influence in these areas. The cable is then routed up to Elevation 439' to the electrical containment penetration. Main steam line Break CO22 has the highest probability of affecting the cable. Detailed examination of the drawings shows that the cable is located outside the main steam jet zone of influence. No HELB jets are capable of disabling the cable for Transmitter 1LT-460.

The cable for Transmitter 1LT-459 begins near Column R-12 above the Elevation 377' floor and is routed upward to Elevation 424'. The cable is then routed counterclockwise around the containment between Columns R-12 and R-8 to the containment electrical penetration at Elevation 422.' The only HELB jets near this cable routing emanate from a Loop 4 main feedwater break and a Loop 4 SI accumulator line break. The cable may be affected by the feedwater jet, and is outside the SI jet zone of influence. The cabling for transmitter 1LT-461 is outside the main feedwater jet zone of influence which could affect transmitter 1LT-459. Based on the above, no HELB jets could affect the cabling to both Transmitters 1LT-459 and 1LT-461.

Based on the paragraphs above, no HELB jets can affect the cable for Transmitter 1LT-460. No HELB jet can affect cable to both Transmitters 1LT-459 and 1LT-461. Therefore, at least two of the three level transmitters will not be affected by jet impingement effects on cabling.

B.3.2.5.3 Sensing Line/Cable Interaction

Pressurizer level transmitter cables are only routed outside the missile shield wall. Based on this arrangement, sensing line/cable interaction inside the wall need not be considered. Sections B.3.2.5.1 and B.3.2.5.2 above indicate that no HELB jets can affect the sensing lines or cables to Transmitter 1LT-460 which are located outside the missile shield wall. These sections also indicate that only Loop 4 main feedwater and Loop 1 steam generator blowdown HELB jets outside the missile shield wall could affect sensing lines or cabling to Transmitter 1LT-459. These HELB jets do not affect sensing lines or cables for Transmitter 1LT-461. Based on the above, no HELB jets could disable a combination of sensing lines and cables that would render more than one of the three level transmitters inoperable.

B.3.2.6 Analysis Conclusion

In conclusion, cable/sensing line interaction only needs to be considered outside the missile shield wall. No HELB jets outside the wall could damage the sensing lines or cables that support Transmitter 1LT-460. No HELB jets outside the missile shield wall could disable cables and/or sensing lines that render both Transmitters 1LT-459 and 1LT-461 inoperable simultaneously. No HELB jets inside the missile shield wall could disable sensing lines to more than one of the three transmitters. Therefore, at least two pressurizer level transmitters will not be damaged as a result of HELB jet effects on cabling and sensing lines inside containment.

B.3.3 Steam Generator Narrow Range Level Sensing Lines And Cables

B.3.3.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single reactor protection channel failure have on the steam generator narrow range level sensing lines and cables.

B.3.3.2 Shutdown Basis

The steam generator narrow range level transmitters serve a dual purpose for safe plant shutdown. First, in the event of a main feedwater line break or a steam generator blowdown line break inside containment, any two of the four narrow range level transmitters on the affected steam generator are required for ESF/reactor trip actuation. An affected steam generator is one which is no longer capable of heat removal due to the initiating HELB. Two transmitters on the affected steam generator would be required following a main feedwater line break. Two out of four transmitters may or may not be required for ESF/reactor trip actuation in the event of a steam generator blowdown line break depending on whether the main feedwater pumps can compensate for the blowdown break fluid discharge. Rather than calculate the blowdown rate and compare it to the pump margin, this assessment will conservatively assume that the steam generator is affected and two out of four transmitters are required. The second transmitter functional requirement is monitoring. Any one narrow range transmitter serving an unaffected steam generator is required following any HELB scenario except a large LOCA. None of these transmitters are required following a large LOCA since all four steam generators would be affected.

B.3.3.3 Sensing Line/Cable Installation

Each of the four steam generators is provided with four level sensing line taps at Elevation 449' and four lower taps at Elevation 429'. The four pairs of sensing lines for each steam generator provide input to four narrow range level transmitters located outside the missile shield wall. The four transmitters are supported by reactor protection Channels RI, RII, RIII, and RIV. A total of sixteen narrow range SG level transmitters exist for the four SG's and are relatively equally spaced around the outside perimeter of the missile shield wall.

Each transmitter has one cable which is routed completely outside the missile shield wall. The cables are routed either clockwise or counterclockwise around the outside perimeter of the missile shield wall to the appropriate containment electrical penetration areas.

B.3.3.4 Analysis Method

The analysis method will be explained in two parts (Sections B.3.3.4.1 and B.3.3.4.2) for the two unique narrow range transmitter safe shutdown functional requirements. The requirement for one functional transmitter serving an unaffected steam generator will be addressed in Section B.3.3.4.1. The requirement for two functional transmitters serving an affected steam generator will be addressed in Section B.3.4.4.2.

B.3.3.4.1 Function One Analysis Method (Monitoring)

B.3.3.4.1.1 Sensing Lines

Demonstrate that physical separation and barriers between SG narrow range sensing lines allow at least one level transmitter which serves an unaffected steam generator to remain functional after consideration of jet impingement from any HELB and single reactor protection channel failure.

B.3.3.4.1.2 Cables

Demonstrate that physical separation and barriers between SG narrow range level transmitter cables allow at least one level transmitter which serves an unaffected steam generator to remain functional after consideration of jet impingement from any HELB and single reactor protection channel failure.

B.3.3.4.1.3 Sensing Line/Cable Interaction

Demonstrate that physical separation and barriers between SG narrow range level transmitter cables and sensing lines allow at least one level transmitter which serves an unaffected steam generator to remain functional after considering jet impingement from any HELB and single reactor protection channel failure.

B.3.3.4.2 Function Two Analysis Method (ESF)

B.3.3.4.2.1 Steam Generator A

Demonstrate that no more than one Steam Generator A narrow range level transmitter can be rendered inoperable due to Loop 1 main feedwater line break or Loop 1 steam generator blowdown line break jet impingement on sensing lines and cables inside containment.

B.3.3.4.2.2 Steam Generator B

Demonstrate that no more than one Steam Generator B narrow range level transmitter can be rendered inoperable due to Loop 2 main feedwater line break or Loop 2 steam generator blowdown line break jet impingement on sensing lines and cables inside containment.

B.3.3.4.2.3 Steam Generator C

Demonstrate that no more than one Steam Generator C narrow range level transmitter can be rendered inoperable due to Loop 3 main feedwater line break or Loop 3 steam generator blowdown line break jet impingement on sensing lines and cables inside containment.

B.3.3.4.2.4 Steam Generator D

Demonstrate that no more than one Steam Generator D narrow range level transmitter can be rendered inoperable due to Loop 4 main feedwater line break or Loop 4 steam generator blowdown line break jet impingement on sensing lines and cables inside containment.

B.3.3.5 Analysis

B.3.3.5.1 Function One Analysis (Monitoring)

B.3.3.5.1.1 Sensing Lines

Based on examination of "as-built" Sensing Line Drawings (Reference B.5.4) and Instrument Location Drawings (Reference B.5.1), Steam Generator A and D sensing lines are separated from Steam Generator B and C sensing lines by major structural barriers such as the missile shield walls, fuel pool enclosure walls, reactor enclosure walls, steam generator enclosure walls, head laydown enclosure walls and pressurizer enclosure walls. These barriers prevent HELB jets emanating from the western half of the Byron Unit 1 containment from disabling SG narrow range level sensing lines located in the eastern half of the containment and vice versa. The only exception to this separation is between columns R-16 and R-17 at Elevation 412' outside the missile shield wall. However, jets emanating from the CV system HELB's in that area could not damage level sensing lines located across the east-west containment boundary since the sensing lines are located outside the CV jet zones of influence. The jet emanating from the SI system HELB in the area is directed in the opposite direction from the sensing lines located across the east-west containment boundary. Based on the above, no HELB jet could damage sensing lines to more than two steam generators. Single reactor protection channel failure would still leave at least three functional level transmitters on each of two unaffected steam generators.

B.3.3.5.1.2 Cables

Based on the Electrical Installation Drawings (Reference B.5.2), cables from the SG narrow range level transmitters located in the south half of the Byron Unit 1 containment are routed counterclockwise behind the missile shield wall to the containment electrical penetration area at the east side of the containment. Similarly, cables from the SG narrow range level transmitter located in the north half of the Byron Unit 1 containment are routed clockwise behind the missile shield wall to the containment electrical penetration area. This design results in a low cable density in the west half of the containment and a high cable density in the areas near the containment electrical penetrations. By examination of the Electrical Installation Drawings (Reference B.5.2), it is obvious that only HELB jets affecting the two high cable density areas near the penetrations would have any possibility of damaging a significant number of level transmitter cables. One of the two areas is located between columns R-11 and R-13 between the Elevation 412' and 426' floors. The second area is located between columns R-8 and R-11 above the Elevation 426' floor.

Based on examination of the HELB Location Drawings (Reference B.5.3), no HELB jets affect the first area. The closest HELB's are on the Loop 1 SI accumulator lines. However, the unidirectional jets emanating from these breaks are either directed away from the high density cable area, or are separated from the cable area by the main steam line enclosure walls.

Based on examination of the HELB Location Drawings (Reference B.5.3), only one HELB exists in the second high cable density area. The break is on the Loop 4 SI accumulator discharge line just above the Elevation 426' floor. The unidirectional jet emanating from this break is directed down and away from all the level transmitter cables.

Based on the above, at least one narrow range level transmitter will remain functional on an unaffected steam generator after consideration of HELB jet effects on cables plus single failure.

B.3.3.5.1.3 Sensing Line/Cable Interaction

Based on the Electrical Installation Drawings (Reference B.5.2), all SG narrow range transmitter cables are located outside the missile shield wall. Sensing line/cable interaction inside the missile shield wall need not be considered.

Based on Section B.3.3.5.1.1 above, all sensing lines and transmitters for SG's B and C are located in the west half of the Byron - Unit 1 Containment. The Electrical Installation Drawings (Reference B.5.2) show that the cables serving these transmitters are located in both halves of the containment. No cables or sensing lines serving SG's A and D are located in the west half of the containment. Even in the event that a HELB jet could disable all sensing lines and cables in the west half of the containment (which is impossible due to separation and barriers), at least three transmitters would remain functional on each of unaffected SG's A and D after consideration of single failure. Sensing line/cable interaction therefore requires no further consideration in the west half of the containment.

Based on examination of "as-built" Sensing Line Drawings (Reference B.5.4), Instrument Location Drawings (Reference B.5.1), and Electrical Installation Drawings (Reference B.5.2) for the east half of the containment outside the missile shield wall, only four of the 16 transmitters (Transmitters 1LT527/537/517/547) have cables and sensing lines routed below the Elevation 412' floor. Even in the unlikely event that a HELB jet could disable the cables and sensing lines of the four transmitters and a single reactor protection system channel failure occurred, at least two transmitters per steam generator would remain functional. Based on further examination of the above drawings for the east half of the containment outside the missile shield wall, 10 of the 16 transmitters have cables and/or sensing lines routed above the Elevation 426' floor. Even in the impossible event (due to separation and barriers) that a HELB jet could disable the cables and sensing lines for the 10 transmitters (Transmitters 1LT556/548/557/558/527/537/517/547/519/549) plus a single reactor protection channel failure occurred, at least one transmitter would remain functional on each of two unaffected SG's.

Further examination of the drawings for the east half of the containment outside the missile shield wall shows that all 16 of the transmitters have cables and/or sensing lines routed between the Elevation 412' and 426' floors. However, the cables and sensing lines are distributed throughout the area and relatively few HELB's exist. The breaks that could affect the area are those on Line 1CV10CA-3, and those on the Loop 1 and Loop 4 SI accumulator lines. Based on application of NUREG/CR-2913 (Reference B.5.5), the CV breaks have only a 30" zone of influence. The only SG narrow range level sensing lines or cables within the 30" of the CV breaks are the sensing lines for Transmitter 1LT-556. The Unidirectional Loop 1 SI jets could only damage sensing lines and/or cables to Transmitters 1LT-556 and 1LT-518. The jet emanating from the Loop 4 SI accumulator discharge line break is directed downward and could not damage any of the SG narrow range level sensing lines or cables.

B.3.3.5.1.4 Function One Conclusion

Based on the sensing line/cable interactions outside the missile shield wall and the jet effects on sensing lines inside the missile shield wall, a more than adequate number of SG narrow range level transmitters will remain functional for safe shutdown monitoring after considering HELB jet impingement effects and single failure.

B.3.3.5.2 Function Two Analysis (ESF)

B.3.3.5.2.1 Steam Generator A

Transmitters 1LT-517, 1LT-518, 1LT-519 and 1LT-556 are the four narrow range level transmitters which serve steam Generator A. Jets emanating from any one of Loop 1 main feedwater line Breaks C050 through C055 or Loop 1 steam generator blowdown line Breaks C800 through C807 must not damage cables or sensing lines to more than one SG-A narrow range level transmitter.

C050,C801,C802,C803,C807

The breaks listed above are those on the Loop 1 main feedwater line and the Loop 1 steam generator blowdown lines which could result in HELB jets outside the missile shield wall. These breaks are located at or below Elevation 394'. Outside the missile shield wall all cables and sensing lines for Transmitters 1LT-518 and 1LT-519 are located above the Elevation 412' floor and would not be affected by the jets emanating from the HELB's listed above. One of the sensing lines for Transmitter 1LT-556 is located below the Elevation 412' floor. This sensing line is always located at least six feet from breaks C801 and C802 which is outside the jet zones of influence. The sensing line is always located at least fifteen feet from Breaks C803 and C807 which is outside the jet zones of influence. The sensing line is always located at least twenty feet from break C050, which is outside the jet zone of influence. Portions of the sensing lines and cabling for Transmitter 1LT-517 located outside the missile shield wall are below the Elevation 412' floor. Breaks C801 and C802 are the only breaks of those listed above that are near the sensing lines and cables. However, the sensing lines and cables in this area are always located at least twelve feet from breaks C801 and C802 which is outside the jet zones of influence. None of the sensing lines and cables located outside the missile shield wall for the Steam Generator A narrow range level transmitters could be affected by jets emanating from Loop 1 main feedwater or steam generator blowdown HELB's.

C051,C052,C053,C054,C055,C800,C804,C805,C806

The breaks listed above are those on the Loop 1 main feedwater line and the Loop 1 steam generator blowdown lines which could result in HELB jets inside the missile shield wall. All narrow range level transmitter cabling is located outside the missile shield wall, therefore, only the sensing lines need to be evaluated for jet effects inside the missile shield wall.

Sensing lines inside the missile shield wall for Transmitters 1LT-518, 1LT519 and 1LT-556 are all located above Elevation 419'. The main feedwater line breaks listed above are all located at or below elevation 408' in horizontal pipe routings. The steam generator blowdown line breaks listed above are all located at or below Elevation 409'. Based on the above, the subject sensing lines are all located outside the jet zones of influence for the HELB's listed above. Sensing lines and cables inside the missile shield wall for at least three of the transmitters would not be affected by main feedwater and steam generator blowdown HELB's.

Sensing lines and cables inside containment for at least three of the Steam Generator A narrow range level transmitters would not be affected by Loop 1 main feedwater and steam generator blowdown HELB jets.

B.3.3.5.2.2 Steam Generator B

Transmitters 1LT-527, 1LT-528, 1LT-529, 1LT-557 are the four narrow range level transmitters which serve Steam Generator B. Jets emanating from any one of Loop 2 main feedwater line Breaks C056 through C061 or Loop 2 steam generator blowdown line breaks C808 through C815 must not damage cables or sensing lines to more than one SG-B narrow range level transmitter.

C056,C811,C813,C814,C815

The breaks listed above are those on the Loop 2 main feedwater line and the Loop 2 steam generator blowdown lines which could result in HELB jets outside the missile shield wall. These breaks are located below Elevation 407'. Outside the missile shield wall, all sensing lines and cables for Transmitters 1LT-528 and 1LT-529 are located above the Elevation 412' floor and would not be affected by jets emanating from the HELB's listed above. The sensing lines and cables outside the missile shield wall for Transmitter 1LT-527, which are located below the Elevation 412' floor, are separated from the HELB's listed above by the missile shield wall plus at least sixty feet. One of the sensing lines outside the missile shield wall for Transmitter 1LT-557 is located below the Elevation 412' floor. This sensing line is separated from the breaks listed above by the main steam barrier wall except for breaks C811 and C815. The sensing line is always at least twelve feet away from these HELB's which is outside the jet zones of influence. Based on the above, none of the sensing lines and cables located outside the missile shield wall for the Steam Generator B narrow range level transmitters could be affected by jets emanating from Loop 2 main feedwater or steam generator blowdown HELB's.

C057,C058,C059,C060,C061,C808,C809,C810,C812

The breaks listed above are those on the Loop 2 main feedwater line and the Loop 2 steam generator blowdown lines which could result in HELB jets inside the missile shield wall. All narrow range level transmitter cabling is located outside the missile shield wall. Only the transmitter sensing lines need to be evaluated for jet effects inside the missile shield wall.

Sensing lines inside the missile shield wall for Transmitter 1LT-529 are always located above Elevation 419'. The main feedwater line breaks listed above are all located at or below Elevation 407' in horizontal pipe routings. The steam generator blowdown line breaks listed above are all located at or below Elevaton 409'. Based on the above, the sensing lines for Transmitter 1LT-529 are all located outside the jet zones of influence for the HELB's listed above due to vertical separation.

Sensing lines inside the missile shield wall for Transmitter 1LT-528 are located above Elevation 420' except in one area. The portions above Elevation 420' are outside the jet zones of influence for the HELB's listed above due to vertical separation. The only portion of sensing line for Transmitter 1LT-528 which is located below Elevation 420' is located near Column R-19 at the missile shield wall at Elevation 414'. This portion of sensing line s always located at least twenty feet from the nearest steam generator blowdown HELB listed above which is outside the jet zones of influence. Four of the main feedwater breaks which are on horizontal piping are located below Elevation 404' and could not affect the sensing line due to vertical separation. Break C061 is located at Elevation 407'. Based on the vertical and horizontal separation between the break and the sensing line, the sensing line is outside the jet zone of influence. The sensing lines inside the missile shield wall for Transmitter 1LT-528 are located outside the jet zones of influence for the HELB's listed above.

Sensing lines inside the missile shield wall for Transmitter 1LT-557 are all located above Elevation 419' except in one area. The portions of sensing lines above Elevation 419' are outside the jet zones of influence for the HELB's listed above due to vertical separation. The only portion of sensing line inside the missile shield wall for Transmitter 1LT-557 which is located below elevation 419' is located near Coluumn R-5. This portion of sensing line is separated from the HELB's listed above by at least fifty feet. Based on the above, the sensing lines inside the missile shield wall for Transmitter 1LT-557 are all located outside the jet zones of influence for the HELB's listed above.

Sensing lines and cables inside containment for at least three of the Steam Generator B narrow range level transmitters would not be affected by Loop 2 main feedwater or steam generator blowdown HELB jets.

B.3.3.5.2.3 Steam Generator C

Transmitters 1LT-537, 1LT-538, 1LT-539 and 1LT-558 are the four narrow range level transmitters which serve Steam Generator C. Jets emanating from any one of Loop 3 main feedwater line Breaks C062 through C066 or Loop 3 steam generator blowdown line Breaks C816 through C823 must not damage cables or sensing lines to more than one SG-C narrow range level transmitter.

C062, C063, C064 C819, C823

The breaks listed above are those on the Loop 3 main feedwater line and the Loop 3 steam generator blowdown lines which could result in HELB jets outside the missile shield wall. These breaks are all located at or below Elevation 390'. Outside the missile shield wall, all sensing lines and cables for Transmitters 1LT-538 and 1LT-539 are located above the Elevation 412' floor and would not be affected by jets emanating from the HELB's listed above. Portions of the sensing lines and cables outside the missile shield wall for Transmitter 1LT-537 are located below the Elevation 412' floor. These sensing lines and cables are separated from the HELB's listed above by the missile shield wall and at least fifty feet. A portion of one Transmitter 1LT-558 sensing line outside the missile shield wall is located below the Elevation 412' floor. This portion of sensing line is separated from the HELB's listed above by the missile shield wall and at least forty feet. Based on the above, none of the sensing lines and cables located outside the missile shield wall for the Steam Generator C narrow range level transmitters could be affected by jets emanating from Loop 3 main feedwater or steam generator blowdown HELB's.

C065, C066, C816, C817, C818, C820, C821, C822

The breaks listed above are those on the Loop 3 main feedwater line and the Loop 3 steam generator blowdown lines which could result in HELB jets inside the missile shield wall. All narrow range level transmitter cabling is located outside the missile shield wall. Only the transmitter sensing lines need to be evaluated for jet effects inside the missile shield wall.

Sensing lines inside the missile shield wall for Transmitters ILT-538 and ILT-539 are always located above Elevation 417'. The main feedwater line breaks listed above are all located at or below Elevation 407' in horizontal pipe routings. The steam generator blowdown line breaks listed above are all located at or below Elevation 409'. Based on the above, the sensing lines for Transmitters ILT-538 and ILT-539 are all located outside the jet zones of influence for the HELB's listed above due to vertical separation.

Sensing lines inside the missile shield wall for Transmitter ILT-558 are all located above Elevation 420' except in one area. The portions of sensing lines above Elevation 420' are outside the jet zones of influence for the HELB's listed above due to vertical separation. The only portion of sensing line inside the missile shield wall for Transmitter ILT-558 which is located below Elevation 420' is located near Column R-5. This portion of sensing line is separated from the HELB's listed above by at least twenty-five feet. Based on the above, the sensing lines inside the missile shield wall, for Transmitter ILT-558 are all located outside the jet zones of influence for the HELB's listed above.

Sensing lines and cables inside containment for at least three of the Steam Generator C narrow range level transmitters would not be affected by Loop 3 main feedwater or steam generator blowdown HELB jets.

B.3.3.5.2.4 Steam Generator D

Transmitter ILT-547, ILT-548, ILT-549 and ILT-559 are the four narrow range level transmitters which serve Steam Generator D. Jets emanating from any one of Loop 4 main feedwater line Breaks C068 through C072 or Loop 4 steam generator blowdown line Breaks C824 through C831 must not damage cables or sensing lines to more than one SG-D narrow range level transmitter.

C068, C069, C070, C825, C826, C827, C829, C830, C831

The breaks listed above are those on the Loop 4 main feedwater line and the Loop 4 steam generator blowdown lines which could result in HELB jets outside the missile shield wall. These breaks are all located at or below Elevation 407'. Outside the missile shield wall, all sensing lines and cables for Transmitter ILT-549 and ILT-559 are located above the Elevation 412' floor and would not be affected by jets emanating from the HELB's listed above. A portion of one Transmitter ILT-548 sensing line outside the missile shield wall is located below the Elevation 412' floor. This sensing line is separated from the HELB's listed above by at least fifty feet. The cables and sensing lines located outside the missile shield wall for at least three of the Steam Generator D narrow range level transmitters would not be affected by jets emanating from the HELB's listed above.

C071, C072, C824, C828

The breaks listed above are those on the Loop 4 main feedwater line and the Loop 4 steam generator blowdown lines which could result in HELB jets inside the missile shield wall. All narrow range level transmitter cabling is located outside the missile shield wall. Only the transmitter sensing lines need to be evaluated for jet effects inside the missile shield wall.

Sensing lines inside the missile shield wall for Transmitter ILT-548, ILT-549 and ILT-559 are always located above Elevation 420'. The main feedwater line breaks listed above are all located at or below Elevation 408' in horizontal piping. The steam generator blowdown line breaks listed above are all located below Elevation 409'. Based on the above, the sensing lines for Transmitters ILT-548, ILT-549 and ILT-559 are all located outside the jet zones of influence for the HELB's listed above due to vertical separation.

Sensing lines and cables inside containment for at least three of the Steam Generator C narrow range level transmitters would not be affected by Loop 4 main feedwater or steam generator blowdown HELB jets.

B.3.3.5.2.5 Function Two Conclusion

At least two SG narrow range level transmitters remain functional on affected SG's for ESF actuation after considering jet impingement effects on the transmitter cables and sensing lines and single reactor protection channel failure.

B.3.4 Pressurizer Pressure Sensing Lines and Cables

B.3.4.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single reactor protection channel failure have on the sensing lines and cables for Pressurizer Pressure Transmitters IPT-455, IPT-456, IPT-457 and IPT-458.

B.3.4.2 Shutdown Basis

The pressurizer pressure transmitters are required to generate ESF signals for reactor trip in the event of a large LOCA, small LOCA, pressurizer steam space LOCA or a main steam line break (MSLB). Low pressure signals from any two of the four transmitters are required in the event of a LOCA. High pressure signals from any two of the four transmitters are required in the event of an MSLB. The transmitters are not required for safe shutdown monitoring, since the reactor coolant wide range pressure transmitters serve this purpose.

B.3.4.3 Sensing Line/Cable Installation

The pressurizer is provided with three sensing line taps located circumferentially at Elevation 450'-8". These taps and the associated sensing lines are shared by the pressurizer pressure and level transmitters. One tap provides input to reactor protection Channel RI pressure Transmitter IPT-455. The second tap provides input to reactor protection Channel RII Transmitter IPT-456. The third tap provides input to reactor protection Channel RIII and RIV Transmitters IPT-457 and IPT-458, respectively. The sensing lines are routed downward through the pressurizer enclosure. Once outside the bottom of the enclosure, the lines immediately diverge. The lines are then routed through different sections of the missile shield wall to the transmitters.

The cables for Transmitters IPT-455 and IPT-456 are routed upward from the transmitters and counterclockwise around the outside of the missile shield wall to the containment electrical penetration area. The cables for Transmitters IPT-457 and IPT-458 are routed upward from the transmitters and clockwise around the outside of the missile shield wall to the containment electrical penetration area.

B.3.4.4 Analysis Method

Two separate analysis methods will be discussed below to verify that the two unique transmitter safe shutdown functions required after LOCA's and MSLB's can be accomplished after consideration of jet impingement and single failure.

B.3.4.4.1 Function One Analysis Method (LOCA)

B.3.4.4.1.1 Sensing Lines - Demonstrate that jet impingement affects on the pressurizer pressure transmitter sensing lines need not be considered for LOCA's.

B.3.4.4.1.2 Cables - Demonstrate that no jets emanating from LOCA's could damage more than a cable to one pressurizer pressure transmitter. Failure of one cable due to a jet plus single reactor protection channel failure leaves two of the four transmitters functional as required.

B.3.4.4.1.3 Sensing Line/Cable Interaction - Demonstrate that jet impingement interaction between pressurizer pressure sensing lines and cables need not be considered for LOCA's.

B.3.4.4.2 Function Two Analysis Method (MSLB)

B.3.4.4.2.1 Sensing Lines - Demonstrate that any jets emanating from a main steam line break cannot damage sensing lines which support more than one pressurizer pressure transmitter.

B.3.4.4.2.2 Cables - Demonstrate that any jet emanating from a main steam line break cannot damage cables which support more than one pressurizer pressure transmitter.

B.3.4.4.2.3 Sensing Line/Cable Interaction - Demonstrate that any jet emanating from a main steam line break cannot damage cables and sensing lines which support more than one pressurizer pressure transmitter.

B.3.4.5 Analysis

Two separate analyses will be discussed below to verify that the two unique transmitter safe shutdown functions required after LOCA's and MSLB's can be accomplished after consideration of jet impingement and single failure.

B.3.4.5.1 Function One Analysis (LOCA)

B.3.4.5.1.1 Sensing Lines - Any two out of the four pressurizer pressure transmitters are required to generate an ESF signal upon low pressurizer pressure. Failure of the transmitter sensing line pressure boundary due to jet impingement will result in a low pressurizer pressure signal. Failure of any number of the sensing lines would not prevent the transmitters from accomplishing their intended safe shutdown functions. No further consideration is required for LOCA jet impingement effects on these sensing lines.

3.4.5.1.2 Cables - Failure of one pressurizer transmitter cable due to jet impingement plus single failure is acceptable for safe shutdown. The transmitter cables are all located outside the missile shield wall, therefore, only jets emanating from LOCA's outside the missile shield wall need to be considered. The only LOCA breaks outside the missile shield wall are Breaks C725, C726 and C727 on the CV system letdown line. Based on the HELB Location Drawings (Reference B.5.3), these breaks are located west of Column R-5. The closest pressurizer pressure transmitter cable is located on the east side of Column R-5. The cable is located farther than 30 inches from the breaks (which is the jet zone of influence) and the jets are not directed toward the cable. Even if the jet could damage this cable, the remaining three cables for the three redundant transmitters would still be available. Base on the above, none of the transmitter cables could be damaged by jets emanating from LOCA's inside containment.

B.3.4.5.1.3 Sensing Line/Cable Interaction

Interaction of LOCA jets between pressurizer pressure transmitter sensing lines and cables need not be considered for the same reason given in Section B.3.4.5.1.1 above. Failure of the sensing lines does not prevent the transmitters from achieving their safe shutdown functions.

B.3.4.5.1.4 Function One Conclusion - Jet impingement effects on pressurizer pressure transmitter sensing lines and cables plus single failure do not prevent the transmitters from performing their safe shutdown function following a LOCA.

B.3.4.5.2 Function Two Analysis (MSLB)

B.3.4.5.2.1 Sensing Lines - Inside the missile shield wall, the pressurizer sensing lines are routed downward through the pressurizer enclosure until they emerge from the enclosure below Elevation 426 ft. No MSLB's could possibly affect any of the sensing lines in the enclosure. The remaining sensing line routing inside the missile shield wall is below Elevation 426 ft. Since the only MSLB's that could affect the area inside the missile shield wall are located above Elevation 460 ft., no further consideration must be given to the sensing lines inside the missile shield wall. Outside the missile shield wall, the only MSLB's are at the containment penetrations and at the top of the missile shield wall. Based on the "as-built" Sensing Line Drawings (Reference B.5.4) and the HELB Location Drawings (Reference B.5.3), the only pressurizer pressure transmitter sensing lines close to any of the MSLB's are those for Transmitter 1PT-455. However, the sensing lines are protected from the MSLB jet by a main steam line enclosure wall. No jets emanating from any MSLB's could damage any pressurizer pressure transmitter sensing lines.

B.3.4.5.2.2 Cables - The pressurizer pressure transmitter cables are only routed outside the missile shield wall. The only cables near MSLB's are those for Transmitter 1PT-456 located at Elevation 439 ft. and for Transmitter 1PT-455 located at Elevation 390 ft. However, these two cables are located near two different MSLB's. Since only one initiating HELB must be postulated at a time, no more than one cable could be affected.

B.3.4.5.2.3 Sensing Line/Cable Interaction - Based on Section B.3.4.5.2.1 above, no pressurizer pressure transmitter sensing lines could be damaged by a MSLB jet. Based on Section B.3.4.5.2.2 above, no more than one pressurizer pressure transmitter cable could be damaged by a MSLB jet. Therefore a jet emanating from any MSLB jet could not damage cables and sensing lines to more than one transmitter.

B.3.4.5.2.4 Function Two Conclusion - No jets emanating from any one MSLB could damage cables and sensing lines inside containment to more than one pressurizer pressure transmitter. Considering single failure of a reactor protection Channel, two out of the four transmitters would always be available to perform their safe shutdown function following a MSLB.

B.3.5 RCS Wide Range Pressure Sensing Lines and Cables

B.3.5.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single reactor protection channel failure have on the sensing lines and cables to the RCS wide range pressure transmitters.

B.3.5.2 Shutdown Basis

The RCS wide range pressure transmitters are used after all HELB scenarios for monitoring RCS pressure during shutdown. One functional transmitter is acceptable for safe shutdown monitoring. The transmitters are not used to provide any input to ESF/reactor trip functions.

B.3.5.3 Sensing Line/Cable Installation

The sensing lines utilize two pressure taps located on the RHR suction piping off the reactor coolant Loop 1 and Loop 3 hot legs on opposite sides of the reactor enclosure. The Loop 1 sensing line provides input to reactor protection Channel IV Transmitter 1PT-403 which is located outside the missile shield wall. Similarly, the Loop 3 sensing line provides input to reactor protection Channel RI Transmitter 1PT-405 which is located outside the missile shield wall. Each transmitter has one cable which is routed upward and clockwise around the outside of the missile shield wall to the containment electrical penetration area.

B.3.5.4 Interim Justification

The existing Byron Station design utilizes only the two pressure transmitters discussed above. Based on the response to FSAR Question

10.57, CECo has agreed to install four additional transmitters (lPT-406/407/408/409) at the first Byron Unit 1 refueling outage. Jet impingement effects will be considered in the final sensing line and cable design arrangements at that time.

Examination of the HELB Location Drawings (Reference B.5.3) immediately indicates that a HELB jet could disable one of the sensing lines. The existing transmitter design, therefore, does not meet the single failure criteria. However, in the interim period prior to the first refueling outage, RCS pressure could be ascertained to the practical degree necessary by using ECCS discharge pressure in the unlikely event that the above scenario occurs.

B.3.5.5 Analysis Method

B.3.5.5.1 Sensing Lines - Demonstrate that physical separation and barriers exist which prevent jets emanating from a single HELB from disabling the two sensing lines which serve Transmitters lPT-403 and lPT-405.

B.3.5.5.2 Cables - Demonstrate that physical separation and barriers exist which prevent jets emanating from a single HELB from disabling the two cables which serve Transmitters lPT-403 and lPT-405.

B.3.5.5.3 Sensing Line/Cable Interaction - Demonstrate that physical separation and barriers exist which prevent jets emanating from a single HELB from disabling a sensing line and a cable which serve Transmitters lPT-403 and lPT-405.

B.3.5.6 Analysis

B.3.5.6.1 Sensing Lines - The sensing lines to Transmitter lPT-403 and lPT-405 are separated by at least thirty feet and one or more of the following structures: reactor structure, refueling structure and missile shield wall. Based on the above and examination of the HELB Location Drawings

(Reference B.5.3), there are no HELB jets which could damage both of these sensing lines.

B.3.5.6.2 Cables - The cables for the RCS wide range pressure transmitters are located behind the missile shield wall. The cable for Transmitter lPT-405 begins between Columns R-1 and R-2 and is routed upward to Elevation 425 ft. The routing then proceeds clockwise around the containment to the containment electrical penetration near Column R-8. The cable for Transmitter lPT-403 begins between Columns R-5 and R-6 and is routed clockwise around the containment to Column R-8 where it then rises to Elevation 435 ft. and the containment electrical penetration. The only area where the cables co-exist without significant separation is near Column R-8 between the Elevation 412 ft. and 426 ft. floors. Based on the HELB Location Drawings (Reference B.5.3), no HELB jets affect this area. Therefore, no jets emanating from any one HELB could damage cables that support both RCS wide range pressure transmitters.

B.3.5.6.3 Sensing Line/Cable Interaction - No RCS wide range pressure transmitter cables are present inside the missile shield wall. Sensing line/cable interaction only needs to be considered outside the missile shield wall.

The following discussion demonstrates that no HELB jets can disable the sensing line to Transmitter lPT-403 and the cable to lPT-405. Based on the "as-built" Sensing Line Drawings (Reference B.5.4) and Instrument Location Drawings (Reference B.5.1), outside the missile shield wall, the sensing line for Transmitter lPT-403 is located near Column R-6 below the Elevation 412 ft. floor. The cable for Transmitter lPT-405 is below the Elevation 412 ft. floor near Column R-2. Based on examination of the HELB Location Drawings (Reference B.5.3), there are no jets which could possibly affect both the sensing line and cable. The two are always separated by at least a floor in all other areas.

The following discussion demonstrates that no HELB jets can disable the cable to Transmitter 1PT-403 and the sensing line to Transmitter 1PT-405. Based on the "as-built" Sensing Line Drawings (Reference B.5.4) and the Instrument Location Drawings (Reference B.5.1), outside the missile shield wall, the sensing line from Transmitter 1PT-405 is located near Column R-2 below the Elevation 412 ft. floor. The cable for Transmitter 1PT-403 is below the Elevation 412 ft. floor near Column R-6. Based on examination of the HELB Location Drawings (Reference B.5.3), there are no jets which could possibly affect both the cable and sensing line. The two are always separated by at least a floor in all other areas.

Based on further examination, the only HELB jets inside containment that could affect either one of the RCS wide range pressure sensing lines or cables emanate from LOCA's and safety injection HELB's. The smallest LOCA jet that could disable one of the sensing lines or cables emanates from a six inch diameter RCS line.

B.3.5.7 Analysis Conclusion

Based on the analysis above, no jets emanating from any one HELB inside containment could disable the sensing line and cables to more than one of the two RCS wide range pressure transmitters. Only jets emanating from LOCA's and safety injection HELB's could affect any of these sensing lines and cables.

B.3.6 RCS Narrow Range RTD Cables

B.3.6.1 Purpose

The purpose of this section is to determine the affects that jet impingement and single reactor protection channel failure have on the cables to the RCS hot and cold leg narrow range RTD's.

B.3.6.2 Shutdown Basis

The RCS narrow range RTD's are required to initiate reactor trip in the event of a bypass feedwater line break. In the event of a bypass feedwater line break, the main feedwater flow may compensate for the excess steam blowdown without a significant main steam pressure reduction. The RCS narrow range RTD's would prevent reactor overpower by sensing a high temperature difference between the RCS hot and cold legs. Two out of the four pairs of hot and cold leg RTD's are required to initate a reactor trip signal. The RTD's are only required to generate a reactor trip signal on high differential temperature for safe shutdown. The RTD's are not required for any other HELB scenarios or any other safe shutdown functions.

B.3.6.3 Cable Installation

Each of the four RCS Loops are provided with one narrow range cold leg manifold RTD and one hot leg manifold RTD. Loop 1 RTD's 1TE-411A and 411B are supported by reactor protection Channel RI. Similarly the Loop 2, 3 and 4 RTD's 1TE421A/B, ITE431A/B and ITE441A/B are supported by Channels RII, RIII and RIV, respectively. The cables for the RTD's on each loop are routed to a common conduit such that four conduits exist for the four loops. The conduits are then routed through the missile shield wall to the containment electrical penetration areas.

B.3.6.4 Analysis Method

Demonstrate that no bypass feedwater line breaks inside containment could damage the cables to more than one pair of RCS narrow range RTD's.

B.3.6.5 Analysis

Inside the missile shield walls, all bypass feedwater line breaks are located at or above Elevation 436 ft. The RCS narrow range RTD cables are located below Elevation 426 ft. inside the missile shield wall. Based on the above, no bypass feedwater line breaks could possibly affect the RTD cabling inside the missile shield wall.

Outside the missile shield wall, the bypass feedwater line breaks are postulated only in the two areas near the bypass feedwater line containment penetration areas. Based on examination of the Electrical Installation Drawings (Reference B.5.2), only one of the RTD cables is routed near either of these areas. The cable in this area is located at Elevation 410'. The highest bypass feedwater line break in this area is at Elevation 395'. The cable is outside the jet zones of influence. All RCS narrow range RTD cables outside the missile shield wall are located outside the bypass feedwater HELB jet zones of influence.

B.3.6.6 Analysis Conclusion

None of the RCS narrow range temperature RTD's could possibly by affected by jets emanating from bypass feedwater HELB's. The RTD's will therefore be capable of performing safe shutdown functions for the HELB scenario which they are required for.

B.3.7 Reactor Core Exit Thermocouples

B.3.7.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables for the core exit thermocouples.

B.3.7.2 Shutdown Basis

The core exit thermocouples are used for safe shutdown temperature monitoring. The thermocouples are only required for temperature monitoring and are not used to generate any ESF or reactor trip signals. The thermocouples are used for shutdown following any HELB scenario. The thermocouples are supported by Electrical Division 11 and Division 12 power. Thermocouples supported by either one of these power divisions are adequate for safe shutdown temperature monitoring. In the event that a HELB jet disables all Division 11 or Division 12 cables to the thermocouples and an electrical division failure occurred, the RCS hot leg wide range RTD's could be used in lieu of the thermocouples. The wide range RTD numbers are 1TE-413A/B, 1TE-423A/B, 1TE433A/B, and 1TE-443A/B for RC Loops 1-4, respectively.

B.3.7.3 Cable Installation

The reactor vessel is provided with 65 core exit thermocouples. Thermocouples T1-T33 are supported by electrical Division 11 power and T34-T65 are supported by Division 12. The thermocouple cables all leave the reactor head and are routed upward to the connector plate between Elevations 428' and 435'. The cables are then routed eastward from the connector plate to the dividing wall between Steam Generators A and D. From this point they continue in the same direction, however they are embedded in the wall until they penetrate outside the missile shield wall at Elevation 430'. Once outside the wall, the Division 11 and 12 cables converge into two conduits which are routed to two containment electrical penetrations.

B.3.7.4 Analysis Method

B.3.7.4.1 Thermocouple Cables

Demonstrate that no HELB jet could damage any of the core exit thermocouple cabling inside containment.

B.3.7.4.2 RTD Cables

Demonstrate that adequate separation exists between the RCS hot leg wide range RTD cables and the core exit thermocouple cables.

B.3.7.5 Analysis

B.3.7.5.1 Thermocouple Cables

The core exit thermocouple cabling vertical routing from the reactor head to Elevation 430' is always separated from HELB's by either the primary shield wall, fuel handling enclosure or the reactor head laydown enclosure. The cable routing from the connector plate to the dividing wall between Steam Generators A and D is located outside all HELB jet zones of influence.

The HELB's closest to the core exit thermocouple cable routing outside the missile shield wall are those on Main Stream Line 1MS01AD-30.25 at Elevation 461' and SI Accumulator Discharge Line 1SI09AD-10 at Elevation 429'. Based on the HELB Location Drawings and the Electrical

Installation Drawings, the SI jet could not possibly damage the cabling for the thermocouples.

The thermocouple cabling outside the missile shield wall at one point is located horizontally within 12' of main stream line break C022. However, the HELB jet is directed parallel to the cable. Based on conservative application of NUREG/CR-2913, no jet effects would be experienced more than a five pipe diameter radial distance from the jet line of action. Five pipe diameters is approximately 12' for the main steam piping. This application conservatively envelopes both two phase and steam jets. Closer examination of the NUREG shows that steam jets have a significantly smaller zone of influence than two phase jets. Based on more precise application of NUREG/CR-2913, no significant jet effects would be experienced at more than a three pipe diameter radial distance from the main steam line jet line of action. This more accurate determination of the main steam jet zone of influence indicates that the core exit thermocouple cables are unaffected by the MSLB jets inside containment.

B.3.7.5.2 RTD Cables

Based on the Electrical Installation Drawings, the core exit thermocouple cables and RCS wide range hot leg RTD cables are always widely separated. Based on this separation, the RTD's provide a totally redundant means of monitoring RCS temperature. The separation will not be described in all locations since no HELB jets can affect the thermocouple cables. One area, however, will be addressed to eliminate any possible concern over the main steam line jet affecting the thermocouple cables. The hot leg wide range RTD cables are all separated from this main steam break by at least one wall or floor plus at least 50'. The break could not affect any RCS wide range RTD cables.

B.3.7.6 Analysis Conclusion

Based on the above, no HELB jets could affect any core exit thermocouple cabling. The RCS wide range RTD cables are widely separated from the thermocouple cables and provide a redundant means of temperature indication.

B.3.8 Main Steam Pressure Sensing Lines

B.3.8.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single reactor protection channel failure have on the main steam pressure sensing lines to Transmitters IPT514/524/534/544, IPT-515/525/535/545 and IPT-516/526/536/546.

B.3.8.2 Analysis and Conclusion

Each main steam line located in the valve rooms just outside the containment is provided with three pressure transmitters and their associated sensing lines. All main steam pressure sensing lines for the transmitters are located completely within the valve rooms. The valve rooms are HELB exclusion zones which cannot be affected by HELB jets. Jet effects on the cables for these transmitters are addressed in Appendix A. No jet interaction effects between the sensing lines and cables need be considered since jets do not affect the sensing lines.

B.3.9 RWST Level Sensing Lines

B.3.9.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single reactor protection channel failure have on the refueling water storage tank level sensing lines to Transmitters 1LT-930/931/932/933.

B.3.9.2 Analysis and Conclusion

Based on the Instrument Location Drawings (Reference B.5.1), each of the RWST level transmitters and their associated sensing lines are located in the refueling water pipe tunnel. These sensing lines are unaffected by HELB jets since there are no high energy lines in the tunnel.

B.3.10 Containment Pressure Sensing Lines

B.3.10.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single reactor protection channel failure have on sensing lines to Containment Pressure Transmitters 1PT-934/935/936/937.

B.3.10.2 Sensing Line Installation

The four containment pressure transmitters are located just outside the Byron Unit 1 northeast containment quadrant. The sensing lines are routed from the transmitters, through the containment penetrations to the bellows which are located on the containment wall. Transmitters 1PT-935 and 1PT-936 are located at Elevation 455' and are separated by 25'. Transmitters 1PT-937 and 1PT-934 are located directly below 1PT-935 and 1PT-936, respectively at Elevation 430'. Transmitters 1PT-934,935,936 and 937 are supported by reactor protection channels RIV, RIII, RII, and RI, respectively.

B.3.10.3 Analysis Method

Demonstrate that no HELB jets could damage any of the containment pressure transmitter sensing lines inside or outside containment.

B.3.10.4 Analysis and Conclusion

Based on the Instrument Location Drawings (Reference B.5.1) and HELB Location Drawings (Reference B.5.3), the sensing lines inside containment could not be damaged by HELB jet effects. The breaks inside containment which are closest to the sensing lines are those on Main Stream Line 1MS01A-30.25 and those on the pressurizer relief lines. The main steam break is not directed at the sensing lines and is located 10' above and 40' horizontally from the nearest sensing line. Based on conservative application of NUREG/CR-2913 (Reference B.5.5), no containment pressure sensing lines will be affected. The largest pressurizer relief line is 6" in diameter. Based on the application of NUREG/CR-2913 (Reference B.5.5), no containment pressure sensing lines will be affected. The relief lines are separated from the sensing lines by the pressurizer enclosure and at least 20'. Outside containment, there are no high energy lines in the area where the sensing lines are located. The sensing lines are unaffected by HELB jet impingement.

B.3.11 Reactor Containment Fan Cooler (RCFC) Electrical Cables

B.3.11.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single electrical division failure have on the RCFC cables.

B.3.11.2 Cable Installation

The RCFC cables originate at the RCFC motors at Elevation 385'. One fan is located in each of the four containment quadrants. The cables are routed from the motors into the missile shield walls, then up through embedded conduits until they reach Elevation 422'. The remaining cable runs are routed behind the missile shield wall, through cable pans above the Elevation 412' and 426' floors to the containment electrical penetrations.

B.3.11.3 Shutdown Basis

Two out of the four RCFC fans are required to be functional for safe shutdown following any HELB scenario.

B.3.11.4 Analysis Method

B.3.11.4.1 RCFC A

Demonstrate that no HELB jets can damage the safe shutdown electrical cables supporting RCFC A.

B.3.11.4.2 RCFC B

Demonstrate that no HELB jets can damage the safe shutdown electrical cables supporting RCFC B.

B.3.11.4.3 RCFC C

Demonstrate that no HELB jets can damage the safe shutdown electrical cables supporting RCFC C.

B.3.11.4.4 RCFC D

Demonstrate that no HELB jets can damage the safe shutdown electrical cables supporting RCFC D.

B.3.11.5 Analysis

B.3.11.5.1 RCFC A

The RCFC A cables located below Elevation 420' are either embedded in the missile shield wall or are in the RCFC area where no HELB's exist. No HELB jets can affect the cables in this area.

The cables for RCFC A emerge from the embedded conduit behind the missile shield wall at Elevation 422' and enter a cable pan. SI accumulator line breaks and CV line breaks are in this cable pan area, however, due to the unidirectional non-expanding cold water SI jets, the cable pan would not be impinged. The cable pan is outside the two phase CV jet zones of influence. No other HEL .re near the remainder of the RCFC A cable pan routing.

B.3.11.5.2 RCFC B

The RCFC B cables located below Elevation 420' are either embedded in the missile shield wall or are in the RCFC area where no HELB's exist. No HELB jets can affect the cables in this area. The cables for RCFC B emerge from the embedded conduit behind the missile shield wall at Elevation 422' and enter a cable pan. SI accumulator line breaks and CV line breaks are in this cable pan area, however, due to the unidirectional, non-expanding cold water SI jets, the cable pan would not be impinged. The cable pan is outside the two phase CV jet zones of influence. The cable pan continues upward through the Elevation 426' floor to Elevation 447', then is routed counterclockwise around the outside of the missile shield wall until it reaches the containment electrical penetration. The main steam line breaks are the only HELB's close to the remainder of cable pan routing described above. The closest main steam break is located at Elevation 461'. The cable pan is located at Elevation 447'. Twelve feet of horizontal separation exists between the cable pan and main steam line, in addition to the vertical separation. Based on conservative application of NUREG/CR-2913 (Reference B.5.5), the horizontal separation leaves the cable pan outside the jet zone of influence. Based on more precise application of NUREG/CR-2913 (Reference B.5.5) for steam jets, any target located more than a three pipe diameter radial distance from the break would see no significant jet effect. Three main steam pipe diameters is approximately 9'. The cable pan is located 12' horizontally and 14' vertically from the main steam break.

B.3.11.5.3 RCFC C

The RCFC C cables located below Elevation 420' are either embedded in the missile shield wall or are in the RCFC area where no HELB's exist. No HELB jets could affect the cables in this area. The cables emerge from the embedded conduit behind the missile shield wall at Elevation 422' and enter a cable pan. The pan is routed horizontally for approximately 12' along the outside of the missile shield wall. There are SI accumulator line breaks and CV line breaks postulated in the cable pan area. The cable pan is located outside all the CV jet zones of influence and the SI line break results in a unidirectional jet directed down and away from the cable pan. The cable routing continues through another pair of embedded conduits until emerging from the missile shield wall at Elevation 424' near Column R7. The cables enter a cable pan at this point which is routed directly to the containment electrical penetration. There are no HELB's in this cable pan area. No HELB jets could affect the cable pan.

B.3.11.5.4 RCFC D

The RCFC D cables located below Elevation 420' are either embedded in the missile shield wall or are in the RCFC area where no HELB's exist. No HELB jets could affect the cables in this area. The cables emerge from the embedded conduit behind the missile shield wall at Elevation 422' and enter a cable pan which is routed up through the Elevation 426' floor. The only HELB in the area is an accumulator line break from which a unidirectional jet emanates down and away from the cable pan. The cable pan continuation above the 426' elevation is routed to the containment electrical penetration. The only HELB in this area is the accumulator discharge line break. The accumulator discharge line break could not impinge the cable pan due to orientation.

B.3.11.6 Analysis Conclusion

Based on the above, no HELB jets could damage any of the reactor containment fan cooler safe shutdown electrical cables.

B.3.12 Containment Purge Valves

B.3.12.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables for containment purge Valves IVQ001A and IVQ002A.

B.3.12.2 Cable Installation

The purge valve cables originate at Elevation 462' between columns R-7 and R-9 and are routed downward to cable pans between the Elevation 412' and 426' floors and above the Elevation 426' floor. The cable pans are then routed to the containment electrical penetrations.

B.3.12.3 Analysis Method

Demonstrate that no jets emanating from any HELB's could damage any of the cables.

B.3.12.4 Analysis and Conclusion

All cabling is located above the Elevation 412' floor outside the missile shield wall. The only HELB's in the area of the cabling are SI accumulator line breaks. However, these lines are oriented such that jets emanate downward, away from the cables.

B.3.13 Chilled Water Containment Isolation Valve Cables

B.3.13.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables located inside containment for chilled water containment isolation valves 1WO056A and 1WO056B.

B.3.13.2 Shutdown Basis

The valves and electrical cabling are designed to isolate the chilled water lines in the event of a LOCA to ensure no contaminants cross the containment boundary. The chilled water system inside containment is a closed loop piping system. In the event of a LOCA, chilled water isolation would not be required since the piping system will maintain the containm nt pressure boundary.

B.3.13.3 Cable Installation

The valves and their associated cables are located outside the missile shield wall. The entire cable installation will not be described here since the valves are only designed to perform a safe shutdown function following a LOCA. The only line break behind the missile shield wall that would result in a LOCA is a CV letdown line break. Therefore, only the portions of cabling near these letdown line breaks will be considered.

B.3.13.4 Analysis Method

Demonstrate that no LOCA jets could damage the cabling for the chilled water containment isolation valves.

B.3.13.5 Analysis and Conclusion

The only LOCA jets that could affect the area outside the missile shield wall emanate from the letdown line. Based on the HELB Location Drawings (Reference B.5.3) the only CV letdown line breaks outside the missile shield wall in containment are Breaks C725, C726 and C727. The cables for valve 1WO056B are located more than two containment radial columns from the breaks and are outside the 30" jet zone of influence. The cables for Valve 1WO056A are located in the same area as the breaks. The lowest cable elevation is Elevation 403'; the highest break is at Elevation 395'. Based on the 30" zone of influence, the CV jets could not damage any of the cables to Valves 1WO056A and 1WO056B.

B.3.14 Component Cooling Water Containment Isolation Valve Cables

B.3.14.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables located inside containment for component cooling water containment isolation valves 1CC9416 and 1CC9438.

B.3.14.2 Shutdown Basis

The valves and electrical cabling are designed to isolate the component cooling lines in the event of a LOCA to ensure no contaminents cross the containment boundary. In the event of a LOCA, component cooling, isolation would not be required since the piping system would maintain the containment pressure boundary.

B.3.14.3 Cable Installation

The valves and their associated cables are located outside the missile shield wall. The entire cable installation will not be described here since the valves are only required to perform a safe shutdown function following a LOCA. The only line break behind the missile shield wall that would result in a LOCA is a CV letdown line break. Therefore, only portions of the cabling near these letdown line breaks will be considered.

B.3.14.4 Analysis Method

Demonstrate that no CV system letdown line break outside the missile shield wall could affect the cables for the component cooling water containment isolation valves.

B.3.14.5 Analysis and Conclusion

Based on the HELB Location Drawings (Reference B.5.3), the only CV letdown line breaks behind the missile shield wall in containment are Breaks C725, C726 and C727. The cables for Valves 1CC9416 and 1CC9438 closet to the letdown line breaks are located more than 25 feet away. This is much greater than the 30" CV jet zone of influence. Based on the above no HELB jets could damage cabling to the component cooling isolation valves during a scenario in which the valves are required to operate.

B.3.15 Hydrogen Recombiner Containment Isolation Valve Cables

B.3.15.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables for the containment isolation hydrogen recombiner Valves 1ØG057A, 1ØG079, 1ØG080 and 1ØG081.

B.3.15.2 Shutdown Basis

One of the supply line valves and one of the return line valves must be capable of opening after a LOCA to ensure that an acceptable hydrogen concentration is maintained within the containment atmosphere.

B.3.15.3 Cable Installation

The valves and their associated cables are located outside the missile shield wall. The entire cable installation will not be described here since the valves are only designed to perform a safe shutdown function following a LOCA. The only line break behind the missile shield wall that would result in a LOCA is a CV letdown line break. Therefore, only the portions of cabling near these letdown line breaks will be considered.

B.3.15.4 Analysis Method

Demonstrate that no CV system letdown line break could affect the cables for the hydrogen recombiner containment isolation valves.

B.3.15.5 Analysis and Conclusion

Based on the HELB Location Drawings (Reference B.5.3) and the Electrical Installation Drawings (Reference B.5.2), the cables for Valves 1ØG057A, and 1ØG081 and the letdown line breaks are separated by the refueling cavity enclosure and the Elevation 412' floor. No LOCA jets could affect the cables for these two valves. Valves 1ØG079 and 1ØG080 are located near Column R-5 at Elevation 403'. The cables serving the valves are always located above Elevation 403'. The highest letdown line break is at Elevation 395'. The cables are outside the 30" CV letdown line jet zones of influence. No LOCA jets could affect the cabling for any of the hydrogen recombiner containment isolation valves.

B.3.16 Reactor Head Vent Valve Cables

B.3.16.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables inside containment for reactor head vent valves 1RC014A, 1RC014B, 1RC014C and 1RC014D.

B.3.16.2 Shutdown Basis

Two vent valves are located in series on each of the two parallel reactor head vent lines. The valves should remain functional during all HELB scenarios in the unlikely event of non-condensible gas formation in the reactor head.

B.3.16.3 Cable Installation

The cables originate at the four reactor head vent solenoid valves and are routed upward from the reactor head to the connector plate between Elevations 428' and 435'. The cables are then routed east from the connector plate to the dividing wall between Steam Generators A and D. From this point they continue in the same direction, however, they are embedded in the wall until they penetrate outside the missile shield wall at Elevation 435'. Once outside the wall, the cables are routed to the containment electrical penetrations.

B.3.16.4 Analysis Method

Demonstrate that no HELB jet could damage any of the head vent valve cabling inside containment.

B.3.16.5 Analysis and Conclusions

The cable routing from the reactor head up to Elevation 435' is always separated from HELB's by either the primary shield wall, fuel handling enclosure or the head laydown area enclosure. The cable routing from the connector plate to the dividing wall between Steam Generators A and D is located outside all HELB jet zones of influence.

The HELB's closest to the vent valve cabling outside the missile shield wall are those on Main Steam Line 1MS01AD-30.25 at Elevation 461' and the SI Accumulator Discharge Line. Based on the HELB Location Drawings (Reference B.5.3), the SI jets could not damage the cables due to separation and orientation.

The cabling outside the missile shield wall at one point is located horizontally within 24' of the main steam jet. However, the jet is directed vertically downward. Based on conservative application of NUREG/CR-2913 (Reference B.5.5), the cables are located outside the jet zone of influence. The reactor head vent valve cables would not be damaged by any HEL jets.

B.3.17 RCP Seal Water Return Line Containment Isolation Valve Cables

B.3.17.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables for RC Pump seal water return line containment isolation Valve 1CV8112.

B.3.17.2 Shutdown Basis

The seal water return line isolation valve is designed to close following a LOCA. Outside containment this line feeds a closed system which is designed to handle water from the Reactor Coolant System. Isolation is therefore not required in the event of a LOCA, however, jet effects on the valve cables due to a LOCA will be investigated.

B.3.17.3 Cable Installation

Valve 1CV8112 is located outside the missile shield wall at Elevation 395' near Column R-5. The valve cables go up through a riser to Elevation 420' and are then routed counter-clockwise around the containment to Column R-18. The cables go up through another riser to Elevation 440' and continue in a counter-clockwise direction until they reach the electrical penetration area at Column R-8.

B.3.17.4 Analysis Method

Demonstrate that no HELB jets emanating from LOCA's could damage the cables for Valve 1CV8112.

B.3.17.5 Analysis and Conclusion

All cabling for Valve 1CV8112 is located outside the missile shield wall and is protected from LOCA jets emanating from within the wall. The only LOCA's that could occur outside the wall would be on the CV letdown line. The cables are within approximately 6' of the HELB's, however, the HELB's have only a 30" jet zone of influence. The letdown line is not oriented such that the jets would be directed at the cables. No LOCA jets could damage the cabling for Valve 1CV8112.

B.3.18 Pressurizer PORV and Block Valve Cables

B.3.18.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables to pressurizer PORV's and block valves 1RY455A, 1RY456, 1RY8000A and 1RY8000B.

B.3.18.2 Shutdown Basis

The PORV's are not required for normal shutdown or for shutdown following any HELB scenario. The PORV's are used when the primary system pressure must be reduced rapidly. This functional requirement would exist following a steam generator tube rupture. Tube rupture will not be considered a HELB scenario in this assessment since no jet impingement effects would be experienced outside the steam generator. PORV's can be employed for safe shutdown following a HELB when utilizing primary loop "feed and bleed", however, credit is not taken for this operational mode in this assessment

The block valves are required to close in the unlikely event that a PORV sticks in the open position. The block valves are not required to close following a LOCA since the valves could not isolate any HELB's.

Even though the PORV's and block valves are not required for safe shutdown following any HELB scenarios, jet impingement effects on the valve cables will be discussed below.

B.3.18.3 Cable Installation

Valves 1RY455A and 1RY8000A are powered by Electrical Division 11 and Valves 1RY456 and 1RY8000B are powered by Division 12. All the subject valve cables are in close proximity to one another inside the pressurizer enclosure. The cables are routed out through the missile shield wall to the appropriate containment electrical penetrations. These cable routings outside the missile shield wall all span less than 90 radial degrees of the containment.

B.3.18.4 Analysis Method

Demonstrate that the only HELB jets which could impact the PORV and block valve cables emanate from a LOCA which precludes the need for valve operability.

B.3.18.5 Analysis and Conclusion

Based on the Electrical Installation Drawings (Reference B.5.2), all cables inside the missile shield wall which are required to operate the PORV's and block valves are located in the pressurizer enclosure on just outside the enclosure. Based on the HELB Location Drawings (Reference B.5.3), the only HELB jets that could affect the valve cables inside the missile shield wall emanate from the pressurizer spray line and pressurizer relief lines. These breaks are considered LOCA's. Since LOCA's result in RCS depressurization, use of the PORV's for depressurization would not be required. Heat removal could still be achieved via the steam generators and RHR system which are separated from the initiating HELB by the pressurizer enclosure and missile shield wall.

Outside the missile shield wall, the subject cables are all located above the Elevation 412' and 426' floors in the containment electrical penetration areas. The only HELB's near these areas are on the SI accumulator lines. However, orientation of these unidirectional jets prevents PORV and block valve cable damage.

Based on the above, no non-LOCA HELB's could damage the cabling for Valves 1RY455A, 1RY456, 1RY8000A or 1RY8000B.

B.3.19 RHR Loop Suction Valve Cables

B.3.19.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables for RHR loop suction Valves 1RH8701A, 1RH8701B, 1RH8702A, and 1RH8702B.

B.3.19.2 Shutdown Basis

The RHR loop suction valves are used to achieve normal cold shutdown. The valves would be used under any HELB scenario except a LOCA. These suction valves are not required following a LOCA since RHR suction would be taken from the RWST and containment sump. In the event that RHR suction valves are not available for cold shutdown, primary or secondary "feed and bleed" operations could be used. Credit need not be taken for primary "feed and bleed" since secondary "feed and bleed" would be available.

B.3.19.3 Cable Installation

Valves 1RH8701B and 1RH8702B are located inside the missile shield wall near the RC Loop 1 and 3 hot legs. Valves 1RH8701A and 1RH8702A are located outside the missile shield wall near the containment penetrations for the two RHR suction lines.

The cables for Valve 1RH8701B originate at Elevation 391' and are routed upward to Elevation 398' then east to the missile shield wall. Both cables penetrate the wall between Columns R-11 and R-12 and are routed up to the containment electrical penetration area above the Elevation 426' Floor.

The cables for Valve 1RH8702B originate at Elevation 390' and are routed to the cable pan near Column R-1 at Elevation 400'. The pan is routed through the missile shield wall at Column R-19 then up through the Elevation 426' Floor. The cable pan continues counterclockwise around the outside of the missile shield wall to the containment electrical penetration.

The cables for Valve 1RH8701A originate behind the missile shield wall near Column R-7 at Elevation 380' and are routed up to Elevation 401'. The cables are then routed clockwise around the outside of the missile shield wall to the containment electrical penetration.

The cables for Valve 1RH8702A originate outside the missile shield wall near Column R-4 at Elevation 379' and are routed clockwise around the containment to Column R-7. The cables then rise to Elevation 424' and continue counterclockwise to the containment electrical penetration.

B.3.19.4 Analysis Method

B.3.19.4.1 Redundant RHR Trains

Demonstrate that no jet from a non-LOCA HELB can damage RHR loop suction valves. If none of the valves can be damaged by a non-LOCA jet, and a single failure is postulated in the redundant train, credit can be taken for manual actuation of the undamaged valves. This credit can be taken since the plant can be maintained in hot standby until conditions permit containment habitability. Once the valve is actuated manually, RHR suction can be taken from the RC system.

B.3.19.4.2 Alternate Cold Shutdown

Demonstrate that secondary "feed and bleed" is available for cold shutdown in the event that a HELB jet damages RHR suction valve cabling.

B.3.19.5 Analysis

Based on examination of HELB Location Drawings (Reference B.5.3) and Electrical Installation Drawings (Reference B.5.2), the cables for at least one of the RHR valves is within a main feedwater jet zone of influence. The following analysis sections will explain alternative valve actuation and cold shutdown methods.

B.3.19.5.1 Redundant RHR Trains

This discussion is to demonstrate that manual valve actuation could be performed in the event that a non-LOCA HELB damaged the cabling to one or more of the valves. The basis for this method is that the plant can be maintained in a hot standby condition indefinitely until the containment environment is suitable for access. Sargent & Lundy Calculation 3C10-1083-001 Revision 2 (Reference B.5.9) indicates that no non-LOCA HELB jets can impinge any of the four RHR loop suction valves. Credit is taken for manual operation of a valve which is rendered inoperable due to jet impingement effects on cabling. Credit is not taken for manual operation of a valve which experiences a single active failure. Based on the above, at least one RHR train can be used for cold shutdown following non-LOCA HELB jet impingement effects on cabling.

B.3.19.5.2 Alternate Cold Shutdown

In the event that the RHR system is not utilized for cold shutdown, primary or secondary "feed and bleed" operations could be used as alternatives.

The secondary "feed and bleed" operation requires that at least one steam generator is available to remove heat through RCS natural circulation transferring heat to either feedwater or auxiliary feedwater. One steam generator will be available after all non-LOCA HELB scenarios.

The primary "feed and bleed" operation requires that at least one of the letdown paths or one of the pressurizer PORV's be operable such that hot RCS inventory can be bled off. Feed can be accomplished via the CV, SI and/or RHR systems which take water from the RWST or the containment sump.

B.3.19.6 Analysis Conclusion

The analysis above indicates that jet impingement effects could damage cabling to at least one RHR loop suction valve. However, in the event of single failure, the valves can be manually actuated. Cold shutdown can be achieved by diverse means independently of the RHR loop suction valves.

B.3.20 Containment Radiation Monitor Cables

B.3.20.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the cables for containment radiation monitors 1RE-AR011 and 1RE-AR012.

B.3.20.2 Shutdown Basis

The containment radiation monitors are used for accident assessment and monitoring. The monitors are not required for any ESF/reactor trip functions. One functional monitor is acceptable for safe shutdown.

B.3.20.3 Cable Installation

Based on the Electrical Installation Drawings (Reference B.5.2), radiation monitors 1RE-AR011 and 1RE-AR012 are located on the outside of the enclosures for Steam Generator D and C respectively at Elevation 432'. The cable for monitor 1RE-AR011 originates at the monitor and is routed along the side of the Steam Generator D enclosure between Elevations 432' and 438' until it crosses the missile shield wall. The cable is then routed downward, outside the missile shield wall, between Columns R-8 and R-9 until it is below the Elevation 426' floor. The cable is then routed horizontally to the containment electrical penetration at Elevation 417'. The cable for monitor 1RE-AR012 originates at the monitor and is routed along the outside of the enclosures for Steam Generators B and C at approximately Elevation 428'. Just inside the missile shield wall, at Column R-18, the cable is routed downward to Elevation 418' and continues counterclockwise around the inside of the missile shield wall to Column R-15. At this point, the cable is routed upward to Elevation 431', then horizontally along the outside of the enclosures for Steam Generator A and D to Column R-9. The cable then crosses the missile shield wall and is routed to the containment electrical penetration near Column R-8 at Elevation 439'.

B.3.20.4 Analysis Method

Demonstrate that no jets emanating from HELB's could damage cabling for either of the two containment radiation monitors.

B.3.20.5 Analysis and Conclusion

Based on the Electrical Installation Drawings (Reference B.5.2) and the HELB Location Drawings (Reference B.5.3), there are no HELB jets that could possibly affect the cabling for monitor 1RE-AR011 above Elevation 426'. Below the Elevation 426' floor, outside the missile shield wall, an accumulator line break could affect a small area between Columns R-9 and R-10, however, between the Elevation 412' and 426' floors, cabling for Monitor 1RE-AR011 is located between Columns R-8 and R-9. No HELB jets could affect the cabling inside containment for Monitor 1RE-AR011.

Based on the Electrical Installation Drawings and the HELB Location Drawings, there are no HELB jets that could possible affect Monitor 1RE-AR012 cabling located inside the missile shield wall due to the high cable elevation. The HELB's nearest the cable are those on Lines 1CV10CA-3 and 1CV10CB-3, however, the cable is located outside the 30-inch jet zones of influence. Outside the missile shield wall, there are no HELB's in the area of the cable. No HELB jets could affect the cables for Monitor 1RE-AR012.

Based on the above, no HELB jets could affect the electrical cables inside containment which support radiation Monitors 1RE-AR011 and 1RE-AR012.

B.3.21 Diesel Oil Day Tank Level Sensing Lines

B.3.21.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the diesel oil day tank level sensing lines for level switches 1LS-DO033 and 1LS-DO036.

B.3.21.2 Analysis and Conclusion

Based on the Instrument Location Drawings (Reference B.5.1), the sensing lines for these level switches are located inside the diesel oil day tank room. No High Energy Lines are located in this area. The sensing lines will not be affected by any HELB jets.

B.3.22 HVAC Flow Sensing Lines

B.3.22.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the auxiliary building HVAC sensing lines for flow elements 0FE-VA003 through 0FE-VA010.

B.3.22.2 Analysis and Conclusion

Based on the Instrument Location Drawings (Reference B.5.1), the sensing lines for these flow elements are located high in the auxiliary building where no High Energy Lines are present. The sensing lines will not be affected by any HELB jets.

B.3.23 Auxiliary Feedwater Pressure Switch Sensing Lines

B.3.23.1 Purpose

The purpose of this section is to determine the effects that jet impingement and single failure have on the sensing lines for auxiliary feedwater pressure switches 1PSL-AF051 and 1PSL-AF055.

B.3.23.2 Analysis and Conclusion

Based on the Instrument Location Drawings (Reference B.5.1), the sensing lines for these pressure switches are located in the auxiliary building between Columns 15 and 18 and Rows L and N above Elevation 383'. There are no High Energy Lines present in this area, therefore, no HELB jets will affect the sensing lines.

B.4.0 CONCLUSIONS

Section B.3.0 of this assessment verified the existing plant design approach for HELB jet impingement effects on cables inside containment and instrument sensing lines inside and outside containment by demonstrating that:

1. functional groups of cables and/or sensing lines are outside the zone of influence of all HELB jets.

2. functional groups of cables and/or sensing lines are not required to be functional for safe shutdown after the specific HELB scenario which could disable them.

3. an adequate number of redundant cables and/or sensing lines within functional groups remain undamaged and can achieve their safe shutdown function after certain cables and/or sensing lines within the same functional groups are disabled by jet impingement.

4. diverse means outside the functional groups are available for achieving the safe shutdown functions of the cables and/or sensing lines damaged by jet impingement.

Logic statements 1, 2 and 3 above were used throughout the analysis except in two cases; RCS wide range pressure transmitters and RHR loop suction valves. In each of these cases, a diverse means of achieving the safe shutdown function for these components was identified.

Additional RCS wide range pressure transmitters will be installed at the first Byron Unit 1 refueling outage as indicated in Section B.3.5.4. The new transmitter installation will provide sufficient redundancy such that an adequate number of cables and/or sensing lines remain undamaged to achieve their shutdown function after sustaining jet impingement effects and single failure.

Alternate shutdown means to the RHR Loop suction valves would be required only after a highly unlikely HELB event and single failure. Nonetheless, Section B.3.19.5 identifies three unique alternatives which could be employed to achieve the safe shutdown function.

In conclusion, the Section B.3.0 analysis verifies that the HELB design approach for jet impingement effects on safe shutdown electrical cables inside containment and safe shutdown instrument sensing lines inside and outside containment is adequate.

B.5.0 **REFERENCES**

B.5.1 Instrument Location Drawings:

M-820-1	Rev. N	dated 6-21-84
M-820-2	Rev. M	dated 6-21-84
M-820-3	Rev. N	dated 6-21-84
M-820-4	Rev. T	dated 6-21-84
M-821-1	Rev. Z	dated 6-21-84
M-821-2	Rev. W	dated 6-21-84
M-821-3	Rev. AB	dated 6-21-84
M-821-4	Rev. Y	dated 6-21-84
M-822-1	Rev. M	dated 6-21-84
M-822-2	Rev. S	dated 6-21-84
M-822-3	Rev. R	dated 6-21-84
M-822-4	Rev. T	dated 6-21-84
M-823-1	Rev. H	dated 6-21-84
M-823-2	Rev. J	dated 6-21-84
M-823-3	Rev. K	dated 6-21-84
M-823-4	Rev. M	dated 6-21-84
M-824-1	Rev. M	dated 6-21-84
M-824-2	Rev. P	dated 6-21-84
M-824-3	Rev. K	dated 6-21-84
M-824-4	Rev. V	dated 6-21-84
M-825-1	Rev. F	dated 6-21-84
M-825-2	Rev. G	dated 6-21-84
M-825-3	Rev. G	dated 6-21-84
M-825-4	Rev. J	dated 6-21-84
M-829-12	Rev. U	dated 3-21-84
M-830-7	Rev. S	dated 3-14-84
M-832-25	Rev. H	dated 3-4-83
M-831-10	Rev. K	dated 6-8-83
M-831-11	Rev. D	dated 8-16-82
M-833-1	Rev. H	dated 9-21-83

M-833-2	Rev. H	dated 9-21-83
M-833-3	Rev. E	dated 10-7-83
M-833-4	Rev. J	dated 12-13-82
M-835-3	Rev. B	dated 5-5-80

B.5.2 Electrical Installation Drawings:

6E-1-3511	Rev. AY	dated 4-14-84
6E-1-3512	Rev. AT	dated 4-5-84
6E-1-3513	Rev. BD	dated 3-22-84
6E-1-3514	Rev. BS	dated 3-29-84
6E-1-3515	Rev. AF	dated 2-16-84
6E-1-3516	Rev. AS	dated 2-28-84
6E-1-3517	Rev. AU	dated 4-3-84
6E-1-3518	Rev. AL	dated 1-19-84
6E-1-3519	Rev. AF	dated 12-15-83
6E-1-3520	Rev. U	dated 7-14-83
6E-1-3521	Rev. AL	dated 4-17-84
6E-1-3522	Rev. AN	dated 4-12-84
6E-1-3523	Rev. AR	dated 10-18-83
6E-1-3524	Rev. BN	dated 4-5-84
6E-1-3527	Rev. AA	dated 4-24-84
6E-1-3531	Rev. AK	dated 4-12-84
6E-1-3532	Rev. AJ	dated 4-5-84
6E-1-3533	Rev. AT	dated 4-12-84
6E-1-3534	Rev. AZ	dated 2-14-84
6E-1-3541	Rev. AT	dated 2-14-84
6E-1-3542	Rev. AU	dated 4-5-84
6E-1-3543	Rev. AM	dated 3-15-84
6E-1-3544	Rev. BP	dated 4-3-84
6E-1-3545	Rev. AM	dated 12-15-83
6E-1-3551	Rev. AW	dated 3-28-84
6E-1-3552	Rev. AE	dated 8-18-83
6E-1-3553	Rev. AE	dated 3-6-84

6E-1-3554	Rev. BU	dated 4-17-84
6E-1-3558	Rev. AA	dated 2-28-84
6E-1-3575	Rev. N	dated 6-1-84
6E-1-3576	Rev. P	dated 5-15-84
6E-1-3577	Rev. L	dated 5-1-84
6E-1-3578	Rev. V	dated 5-22-84
6E-1-3581	Rev. AF	dated 12-15-83
6E-1-3582	Rev. AS	dated 3-22-84
6E-1-3583	Rev. AZ	dated 2-28-84
6E-1-3584	Rev. AC	dated 12-6-83
6E-1-3587	Rev. AC	dated 2-9-84
6E-1-3591-1	Rev. Y	dated 2-14-84
6E-1-3591-2	Rev. V	dated 11-22-83
6E-1-3592	Rev. AA	dated 1-19-84
6E-1-3593	Rev. AB	dated 2-22-84
6E-1-3595	Rev. P	dated 12-15-83
6E-1-3511CT1	Rev. L	dated 12-6-83
6E-1-3511CT2	Rev. H	dated 10-18-83
6E-1-3512CT1	Rev. M	dated 12-6-83
6E-1-3513CT1	Rev. V	dated 11-3-83
6E-1-3514CT1	Rev. S	dated 2-9-84
6E-1-3514CT2	Rev. Z	dated 11-10-83
6E-1-3521CT1	Rev. R	dated 12-22-83
6E-1-3522CT1	Rev. S	dated 4-5-84
6E-1-3523CT1	Rev. T	dated 1-12-84
6E-1-3524CT1	Rev. U	dated 1-19-84
6E-1-3524CT2	Rev. L	dated 8-25-83
6E-1-3531CT1	Rev. N	dated 1-6-84
6E-1-3532CT1	Rev. G	dated 5-17-83
6E-1-3533CT1	Rev. T	dated 11-22-83
6E-1-3534CT1	Rev. U	dated 6-23-83
6E-1-3541CT1	Rev. U	dated 2-22-84
6E-1-3542CT1	Rev. S	dated 2-16-84
6E-1-3543CT1	Rev. P	dated 3-15-84

6E-1-3544CT1	Rev. AA	dated 2-14-84
6E-1-3544CT2	Rev. Y	dated 4-3-84
6E-1-3551CT1	Rev. S	dated 3-28-84
6E-1-3552CT1	Rev. J	dated 1-18-83
6E-1-3553CT1	Rev. E	dated 1-20-83
6E-1-3554CT1	Rev. W	dated 2-14-84
6E-1-3554CT2	Rev. AC	dated 4-3-84
6E-1-3053	Rev. F	dated 12-22-81

B.5.3 HELB Location Drawings:

M-155-1	Rev. L	dated 3-30-83
M-155-2	Rev. J	dated 3-15-82
M-156-1	Rev. K	dated 6-30-82
M-156-2	Rev. J	dated 3-15-82
M-157-1	Rev. N	dated 10-18-83
M-157-2	Rev. L	dated 11-18-82
M-158-1	Rev. M	dated 9-22-83
M-158-2	Rev. K	dated 9-22-83
M-161-1	Rev. L	dated 9-22-83
M-162-1	Rev. L	dated 9-22-83
M-163-1	Rev. N	dated 10-17-83
M-164-1	Rev. L	dated 9-22-83
M-165-1	Rev. L	dated 9-22-83
M-165-2	Rev. K	dated 8-12-82
M-166-1	Rev. K	dated 12-22-82
M-166-2	Rev. K	dated 8-12-82
M-167-1	Rev. P	dated 11-28-83
M-167-2	Rev. L	dated 8-12-82
M-168-1	Rev. L	dated 6-9-82
M-168-2	Rev. H	dated 2-5-82
M-169-1	Rev. L	dated 10-26-83
M-170-1	Rev. M	dated 10-26-83
M-171-1	Rev. L	dated 10-26-83

M-172-1	Rev. M	dated 10-26-83
M-173-1	Rev. D	dated 11-27-79
M-174-1	Rev. D	dated 11-27-79
M-175-1	Rev. G	dated 3-9-82
M-176-1	Rev. J	dated 7-26-83
M-189-1	Rev. H	dated 10-17-83

B.5.4 "As-Built" Sensing Line Drawings

T111-IPT-0403	Sheet 1	Rev. 8	dated 1-17-84
T111-IPT-0403	Sheet 2	Rev. 5	dated 1-16-84
T111-IPT-0403	Sheet 3	Rev. 6	dated 1-17-84
T111-IPT-0403	Sheet 4	Rev. 6	dated 1-17-84
T6-IPT-0405	Sheet 1	Rev. 12	dated 2-24-84
T6-IPT-0405	Sheet 2	Rev. 11	dated 2-17-84
T82-ILT-0459	Sheet 1	Rev. 13	dated 1-13-84
T82-ILT-0459	Sheet 2	Rev. 12	dated 1-7-84
T82-ILT-0459	Sheet 3	Rev. 10	dated 1-7-84
T146-ILT-0460	Sheet 1	Rev. 13	dated 4-9-84
T146-ILT-0460	Sheet 2	Rev. 10	dated 11-15-83
T146-ILT-0460	Sheet 3	Rev. 11	dated 1-18-84
T146-ILT-0460	Sheet 4	Rev. 13	dated 1-6-84
T275-ILT-0461	Sheet 1	Rev. 17	dated 3-10-84
T275-ILT-0461	Sheet 2	Rev. 13	dated 1-18-84
T275-ILT-0461	Sheet 3	Rev. 8	dated 1-6-84
T166-ILT-0462	Sheet 1	Rev. 14	dated 3-5-84
T166-ILT-0462	Sheet 2	Rev. 14	dated 1-17-84
T166-ILT-0462	Sheet 3	Rev. 10	dated 1-17-84
T166-ILT-0462	Sheet 4	Rev. 8	dated 1-17-84
T166-ILT-0462	Sheet 5	Rev. 10	dated 1-17-84
T84-IPT-0455	Sheet 1	Rev. 11	dated 1-12-84
T84-IPT-0455	Sheet 2	Rev. 6	dated 6-20-83
T84-IPT-0455	Sheet 3	Rev. 9	dated 2-15-84
T84-IPT-0455	Sheet 4	Rev. 4	dated 7-13-83

T84-IPT-0455	Sheet 5	Rev. 4	dated 7-13-83
T136-IPT-0456	Sheet 1	Rev. 4	dated 1-10-84
T298-IPT-0457	Sheet 1	Rev. 9	dated 2-6-84
T112-IPT-0458	Sheet 1	Rev. 9	dated 3-2-84
T307-ILT-0517	Sheet 1	Rev. 10	dated 1-25-84
T307-ILT-0517	Sheet 2	Rev. 13	dated 2-9-84
T307-ILT-0517	Sheet 3	Rev. 19	dated 2-9-84
T321-ILT-0518	Sheet 1	Rev. 15	dated 1-7-84
T321-ILT-0518	Sheet 2	Rev. 14	dated 1-7-84
T321-ILT-0518	Sheet 3	Rev. 16	dated 3-9-84
T294-ILT-0519	Sheet 1	Rev. 15	dated 1-28-84
T294-ILT-0519	Sheet 2	Rev. 10	dated 11-21-83
T294-ILT-0519	Sheet 3	Rev. 18	dated 2-7-84
T297-ILT-0556	Sheet 1	Rev. 11	dated 2-4-84
T297-ILT-0556	Sheet 2	Rev. 10	dated 1-7-84
T109-ILT-0527	Sheet 1	Rev. 11	dated 2-24-84
T109-ILT-0527	Sheet 2	Rev. 11	dated 1-27-84
T109-ILT-0527	Sheet 3	Rev. 13	dated 2-24-84
T109-ILT-0527	Sheet 4	Rev. 6	dated 2-24-84
T320-ILT-0528	Sheet 1	Rev. 13	dated 3-10-84
T320-ILT-0528	Sheet 2	Rev. 13	dated 3-5-84
T320-ILT-0528	Sheet 3	Rev. 14	dated 2-14-84
T34-ILT-0529	Sheet 1	Rev. 10	dated 2-4-84
T34-ILT-0529	Sheet 2	Rev. 13	dated 1-16-84
T325-ILT-0557	Sheet 1	Rev. 11	dated 1-25-84
T325-ILT-0557	Sheet 2	Rev. 7	dated 10-26-83
T325-ILT-0557	Sheet 3	Rev. 11	dated 1-25-84
T325-ILT-0557	Sheet 4	Rev. 7	dated 3-1-83
T107-ILT-0537	Sheet 1	Rev. 12	dated 1-25-84
T107-ILT-0537	Sheet 2	Rev. 12	dated 1-7-84
T107-ILT-0537	Sheet 3	Rev. 17	dated 2-6-84
T348-ILT-0538	Sheet 1	Rev. 10	dated 1-25-84
T348-ILT-0538	Sheet 2	Rev. 7	dated 1-7-84
T37-ILT-0539	Sheet 1	Rev. 13	dated 2-4-84

T37-ILT-0539	Sheet 2	Rev. 9	dated 1-25-84
T37-ILT-0539	Sheet 3	Rev. 10	dated 1-25-84
T306-ILT-0558	Sheet 1	Rev. 12	dated 1-25-84
T306-ILT-0558	Sheet 2	Rev. 9	dated 11-15-83
T306-ILT-0558	Sheet 3	Rev. 9	dated 1-31-84
T308-ILT-0547	Sheet 1	Rev. 11	dated 1-17-84
T308-ILT-0547	Sheet 2	Rev. 9	dated 1-17-84
T308-ILT-0547	Sheet 3	Rev. 13	dated 2-4-84
T332-ILT-0548	Sheet 1	Rev. 11	dated 1-25-84
T332-ILT-0548	Sheet 2	Rev. 9	dated 3-9-84
T332-ILT-0548	Sheet 3	Rev. 10	dated 1-25-84
T332-ILT-0548	Sheet 4	Rev. 11	dated 3-10-84
T285-ILT-0549	Sheet 1	Rev. 15	dated 1-26-84
T285-ILT-0549	Sheet 2	Rev. 12	dated 11-1-83
T285-ILT-0549	Sheet 3	Rev. 17	dated 2-4-84
T312-ILT-0559	Sheet 1	Rev. 15	dated 1-4-84
T312-ILT-0559	Sheet 2	Rev. 13	dated 1-26-84
T81-ILT-0501	Sheet 1	Rev. 9	dated 1-24-84
T81-ILT-0501	Sheet 2	Rev. 7	dated 10-21-83
T81-ILT-0501	Sheet 3	Rev. 15	dated 3-7-84
T81-ILT-0501	Sheet 4	Rev. 14	dated 3-14-84
T22-ILT-0502	Sheet 1	Rev. 10	dated 2-27-84
T22-ILT-0502	Sheet 2	Rev. 8	dated 10-28-83
T22-ILT-0502	Sheet 3	Rev. 9	dated 1-6-84
T22-ILT-0502	Sheet 4	Rev. 14	dated 2-27-84
T106-ILT-0503	Sheet 1	Rev. 9	dated 2-20-84
T106-ILT-0503	Sheet 2	Rev. 12	dated 2-20-84
T106-ILT-0503	Sheet 3	Rev. 15	dated 3-15-84
T106-ILT-0503	Sheet 4	Rev. 10	dated 2-20-84
T266-ILT-0504	Sheet 1	Rev. 11	dated 1-27-84
T266-ILT-0504	Sheet 2	Rev. 12	dated 1-27-84
T266-ILT-0504	Sheet 3	Rev. 8	dated 6-24-83
T266-ILT-0504	Sheet 4	Rev. 7	dated 1-27-84
T266-ILT-0504	Sheet 5	Rev. 2	dated 2-11-84

T295-IFT-0512	Sheet 1	Rev. 10	dated 12-19-83
T295-IFT-0512	Sheet 2	Rev. 6	dated 12-20-83
T299-IFT-0513	Sheet 1	Rev. 9	dated 12-20-83
T299-IFT-0513	Sheet 2	Rev. 9	dated 10-28-83
T299-IFT-0513	Sheet 3	Rev. 15	dated 12-20-83
T38-IFT-0522	Sheet 1	Rev. 6	dated 12-19-83
T38-IFT-0522	Sheet 2	Rev. 7	dated 3-9-84
T310-IFT-0523	Sheet 1	Rev. 9	dated 7-29-83
T310-IFT-0523	Sheet 2	Rev. 7	dated 12-21-83
T39-IFT-0532	Sheet 1	Rev. 7	dated 12-19-83
T39-IFT-0532	Sheet 2	Rev. 7	dated 12-19-83
T319-IFT-0533	Sheet 1	Rev. 7	dated 10-21-83
T319-IFT-0533	Sheet 2	Rev. 8	dated 1-12-84
T317-IFT-0542	Sheet 1	Rev. 11	dated 12-19-83
T317-IFT-0542	Sheet 2	Rev. 8	dated 10-28-83
T317-IFT-0542	Sheet 3	Rev. 11	dated 12-7-83
T286-IFT-0543	Sheet 1	Rev. 10	dated 2-23-84
T286-IFT-0543	Sheet 2	Rev. 9	dated 1-16-84
T286-IFT-0543	Sheet 3	Rev. 8	dated 1-16-84
M-2540C-11	Rev. B	dated 1-23-84	
M-2540C-12	Rev. B	dated 1-12-84	
M-2540C-13	Rev. B	dated 1-23-84	
M-2540C-14	Rev. B	dated 1-23-84	
M-2540C-15	Rev. B	dated 2-08-84	
M-2540C-16	Rev. B	dated 2-08-84	
M-2540C-17	Rev. B	dated 2-08-84	
M-2540C-18	Rev. B	dated 2-08-84	
M-2540C-19	Rev. B	dated 1-03-84	
M-2540C-20	Rev. C	dated 1-03-84	
M-2540C-22	Rev. B	dated 1-03-84	
M-2540C-23	Rev. B	dated 1-5-84	
M-2540C-24	Rev. B	dated 1-5-84	
M-2540C-25	Rev. B	dated 1-23-84	
M-2540C-26	Rev. C	dated 1-23-84	

M-2540C-27	Rev. C	dated 1-5-84
M-2540C-28	Rev. P	dated 1-23-84
M-2540C-29	Rev. B	dated 1-23-84
M-2540C-30	Rev. B	dated 2-24-84
M-2540C-31	Rev. B	dated 2-24-84
M-2540C-32	Rev. B	dated 3-23-84
M-2540C-33	Rev. B	dated 2-27-84
M-2540C-34	Rev. B	dated 2-24-84
M-2540C-35	Rev. B	dated 2-24-84
M-2540C-36	Rev. B	dated 2-27-84
M-2540C-37	Rev. B	dated 2-27-84
M-2540C-38	Rev. B	dated 2-27-84
M-2540C-39	Rev. C	dated 1-23-84
M-2540C-40	Rev. C	dated 12-27-83
M-2540C-41	Rev. B	dated 1-23-84
M-2540C-42	Rev. B	dated 12-27-83
M-2540C-43	Rev. B	dated 1-9-84
M-2540C-44	Rev. B	dated 2-8-84
M-2540C-45	Rev. B	dated 1-9-84
M-2540C-46	Rev. B	dated 2-10-84
M-2540C-47	Rev. B	dated 1-9-84
M-2540C-48	Rev. B	dated 1-5-84
M-2540C-51	Rev. B	dated 1-9-84
M-2542C-128	Rev. B	dated 5-20-83
M-2542C-129	Rev. B	dated 6-2-83
M-2542C-130	Rev. B	dated 6-2-83
M-2542C-131	Rev. B	dated 6-2-83
M-2542C-132	Rev. B	dated 6-2-83
M-2542C-133	Rev. B	dated 1-3-84
M-2542C-134	Rev. B	dated 12-27-83
M-2542C-135	Rev. B	dated 12-14-83
M-2542C-136	Rev. B	dated 12-14-83
M-2542C-137	Rev. B	dated 12-14-83

B.5.5 NUREG/CR-2913 "Two-Phase Jet Loads," January 1983

B.5.6 NUREG-75/087 "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," September, 1975.

B.5.7 Byron/Braidwood Stations, Final Safety Analysis Report, Amendment 44, December 1983

B.5.8 Westinghouse letter CAW-7434 to Sargent & Lundy dated June 8, 1984.

B.5.9 Sargent & Lundy Calculation Number 3C8-1083-001 Revision 2 entitled "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Equipment, Instrumentation and Cables."

B.5.10 Sargent & Lundy Calculation Number HELB-1, Revision 0 entitled "Postulated High Energy Line Breaks Inside Containment."

B.5.11 Sargent & Lundy Calculation Number HELB-2, Revision 0 entitled "Verification of High Energy Line Break Design Approach for Jet Impingement Effects on Safe Shutdown Cables Inside Containment and Safe Shutdown Instrument Sensing Lines Inside and Outside Containment."

B.5.12 Conduit Support Drawings

6E-1-3511A	Rev. AK	dated 5-10-84
6E-1-3512A	Rev. AF	dated 6-19-84
6E-1-3513A	Rev. AW	dated 6-7-84
6E-1-3514A	Rev. BJ	dated 6-7-84
6E-1-3521A	Rev. AN	dated 6-1-84
6E-1-3522A	Rev. AN	dated 5-10-84
6E-1-3523A	Rev. AH	dated 6-7-84
6E-1-3524A	Rev. BG	dated 5-1-84
6E-1-3527A	Rev. S	dated 5-15-84
6E-1-3531A	Rev. AL	dated 6-7-84
6E-1-3532A	Rev. AM	dated 5-17-84

6E-1-3533A	Rev. AN	dated 6-5-84
6E-1-3534A	Rev. AZ	dated 6-12-84
6E-1-3541A	Rev. AW	dated 6-1-84
6E-1-3542A	Rev. AU	dated 6-7-84
6E-1-3543A	Rev. AN	dated 6-26-84
6E-1-3544A	Rev. BL	dated 6-7-84
6E-1-3551A	Rev. AN	dated 6-1-84
6E-1-3552A	Rev. Z	dated 5-22-84
6E-1-3553A	Rev. T	dated 4-5-84
6E-1-3554A	Rev. BP	dated 5-30-84
6E-1-3556A	Rev. K	dated 7-23-82
6E-1-3558A	Rev. AA	dated 5-3-84
6E-1-3575A	Rev. H	dated 5-1-84
6E-1-3576A	Rev. R	dated 5-15-84
6E-1-3577A	Rev. H	dated 5-1-84
6E-1-3578A	Rev. M	dated 5-10-84

B.5.13 Cable Tray Support Drawings

6/20E-1-3221H	Rev. G	dated 1-27-84
6/20E-1-3222H	Rev. T	dated 6-20-83
6/20E-1-3223H	Rev. H	dated 1-27-84
6/20E-1-3224H	Rev. J	dated 6-24-83
6/20E-1-3241H	Rev. K	dated 3-30-84
6/20E-1-3242H	Rev. R	dated 6-5-84
6/20E-1-3243H	Rev. L	dated 6-30-83
6/20E-1-3244H	Rev. V	dated 4-12-84
6/20E-1-3251H	Rev. M	dated 3-30-84
6/20E-1-3252H	Rev. C	dated 4-25-79
6/20E-1-3254H	Rev. S	dated 3-30-84

B.5.14 Structural Drawings

S-914	Rev. AG	dated 2-24-84
S-915	Rev. AE	dated 3-23-84
S-918	Rev. AW	dated 10-27-83

S-919	Rev. BH	dated 3-2-84
S-1072	Rev. P	dated 8-20-82
S-1073	Rev. K	dated 6-10-82
S-1074	Rev. N	dated 5-19-83

Appendix C

Jet Impingement Effects On Safe Shutdown Piping

C.1 Scope

This Appendix summarizes the reviews which have been completed to confirm that jet impingement will not result in damage to piping and piping supports such that the plant's capability to be safely shut down is impaired.

C.2 Jet Impingement Effects on Piping Outside Containment

Outside the Containment, high energy lines have been separated from safe shutdown components to the extent practicable. A limited number of locations in the Auxiliary Building and Main Steam Tunnel do contain high energy lines and safe shutdown piping. Piping in these areas is addressed in this section.

The safety related (Category I) components in the main steam tunnel are located in the valve rooms adjacent to containment. The valve rooms in the main steam tunnel are break exclusion zones and HELB's are not postulated in these areas in accordance with the requirements of Standard Review Plan Sections 3.6.1 and 3.6.2.

In the Auxiliary Building, HELBs are postulated in the Auxiliary Steam (AS) System, the Chemical and Volume Control (CV) System, and the Steam Generator Blowdown (SD) System. Damage to safe shutdown piping due to jet impingement is precluded because of the relative location of the breaks and safe shutdown piping (separation) or because of limitations on the magnitude of the loading due to the high energy line characteristics. Effects of jet impingement on Auxiliary Building piping have been reviewed and documented in Reference C.4.1.

C.2.1 Auxiliary Steam (AS) Line Breaks in the Auxiliary Building

The Auxiliary Steam lines are found in the AS System, and small portions of the Radwaste and Boric Acid Systems. The AS lines are not used for safety related functions and, as a result, most AS break locations are in areas which do not contain safe shutdown piping. A full review of the AS line routing has been completed (Reference C.4.1). No safe shutdown piping or supports were found to be adversely affected by postulated jet impingement from AS line breaks.

IMAGE EVALUATION
TEST TARGET (MT-3)

150mm

6″

C.2.2 Chemical and Volume Control (CV) System Breaks in the Auxiliary Building

The postulated CV system breaks in the Auxiliary Building result in jets which are driven by the Charging Pumps or by the Reactor Coolant System (Letdown line breaks). The limitations of charging pump discharge flow and the piping friction losses insure that jet loads from CV breaks in the charging portion of the CV system are small. Similarly, the flow restricting letdown orifices limit the mass flow and potential jet loads from a postulated letdown line failure. A review of potential CV system break jet impingement loads on Auxiliary Building piping has been completed (Reference C.4.2). This review verified that Auxiliary Building piping and supports will not be damaged by jet impingement loads from postulated CV system failures.

C.2.3 Steam Generator Blowdown (SD) System Breaks in the Auxiliary Building

The SD system postulated HELB locations in the Auxiliary Building are confined to two areas. These are the Blowdown Condenser Room and a corridor adjacent to the Main Steam Tunnel where the SD lines enter the Auxiliary Building. These break locations are sufficiently separated from safe shutdown piping to preclude the possibility of damage to the piping or supports as a result of jet impingement. This was confirmed by a review of the postulated break locations (Reference C.4.1)

C.2.4 Effects on Piping - Jet Impingement on Structure

Block and concrete partition walls in the Auxiliary Building HELB areas may experience a jet impingement load from the postulated breaks. As discussed in Appendix D, the majority of these walls are not predicted to be loaded by jet impingement or have been evaluated to show adequacy for the loads. A limited number of walls have been reviewed for failure effects rather than load capability due to the location with respect to safe shutdown systems. Failure of these walls has been shown to not damage safe shutdown piping systems or supports (Reference C.4.3).

C.3 Jet Impingement Effects on Piping Inside Containment

Inside Containment the jet impingement loads caused by postulated jets are generally larger than those in the Auxiliary Building and the number of postulated HELBs is much larger. Because of the greater potential for jet impingement on piping, each safe shutdown piping system inside containment has been reviewed to confirm that, if potentially damaged by jet impingement, the specific line in question is not required for safe shutdown.

C.3.1 Piping Inside Containment

To insure that all effects including flooding were considered, the review initially considered all piping inside Containment. The Station Air (SA) and Instrument Air (IA) systems were eliminated from consideration because they contain only air and have no safe shutdown function. The VP and VQ systems consist only of short piping sections near the containment penetrations and are not affected by HELBs. The remaining eighteen systems were reviewed in detail. These systems are:

Component Cooling (CC)
Containment Spray (CS)
Chemical and Volume Control (CV)
Fire Protection (FP)
Feedwater (FW)
Main Steam (MS)
Off Gas (OG)
Process Sampling (PS)
Reactor Coolant (RC)
Radioactive Equipment Drains (RE)
Waste Processing Drains (RF)
Residual Heat Removal (RH)
Reactor Coolant (Pressurizer) (RY)
Steam Generator Blowdown (SD)
Station Heating (SH)
Safety Injection (SI)

Essential Service Water (SX)
Chilled Water (WØ)

The review of these systems was performed in two stages. In the first stage, the systems were reviewed to determine if the piping inside containment was required for safe shutdown, and if any other potential effects (such as flooding) would potentially result from piping failure. If failure could not be judged acceptable in the first stage, a further review of the potential for jet impingement damage and the consequences of the damage, if any, was completed.

In addition to direct failure of a system required for safe shutdown, the postulated pipe failures (due to jet impingement) were reviewed for the additional effects of break propagation and flooding. Break propagation was reviewed with respect to the guidelines of Westinghouse Design Criteria SS 1.19 (Reference C.4.4). Potential flooding effects were reviewed for non-primary system breaks. All potential primary system spillage is included in the design basis containment flooding (Reference C.4.5). Of breaks other than primary system breaks, charging system breaks have the highest operating pressure and, therefore, the highest blowdown rate per unit break area when conservative assumptions are used. Reference C.4.6 determined a maximum rate from a 4" charging line break of 2.9 cfs or about 175 cfm. From Reference C.4.5, the Containment floor free area is over 12,000 ft^2 at elevation 377'. As a result, a 4" line break in any system will not significantly affect flooding. This 4" guideline was used to determine if flooding effects should be evaluated.

The results of each system review is summarized in the following sections and documented in detail in Reference C.4.7.

C.3.1.1 Component Cooling (CC) System

CC system flow inside Containment is required only if Reactor Coolant Pump (RCP) seal water injection (CV system) is lost in a non-LOCA event. In this event CC flow to the RCP thermal barrier prevents degradation of

RCP seals. Therefore, the CC system piping was reviewed to determine if the thermal barrier flow would be degraded by non-LOCA jet impingement effects in conjunction with a loss of seal water injection.

In the event of a HELB inside Containment the seal water injection would be lost only if the piping was damaged because the other components (other than check valves) are outside Containment. As a result, CC damage will affect safe shutdown only if seal water injection piping was also damaged.

The CC piping was reviewed and only one instance was found where CC and CV seal water injection piping were located in close proximity to each other and a postulated HELB. This was a location just outside the secondary shield wall where the Loop 2 seal injection and thermal barrier supply lines are near a postulated feedwater line break. Both ends of postulated break are restrained, one by a pipe whip restraint and one by the secondary shield wall. The calculated pipe movements have been reviewed with as-built dimensions from field walkdown measurements. The pipe and restraint were found to act as jet impingement shields which adequately protect the CC and CV lines in question.

C.3.1.2 Containment Spray (CS) System

The CS system routing is such that no HELBs are near the CS piping. The CS system is used only after LOCA. The CS piping is outside the secondary shield wall and therefore protected from LOCAs. As a result no further evaluation is required.

C.3.1.3 Chemical and Volume Control (CV) System

The CV system has different criteria for different portions of the system. The basic requirements for the CV system piping are:

1) Seal Injection lines between the check valve and pump cannot be broken by a non-LOCA HELB.

2) Seal Injection lines cannot fail in conjunction with loss of component cooling flow to the RCP thermal barrier.
3) The seal bypass line must be broken upstream of the seal bypass flow limiter by a non-LOCA HELB.
4) Letdown and excess letdown lines (upstream of normally closed isolation lines) must be broken by a non-LOCA HELB.
5) Seal water return and leak off lines must not fail in conjunction with loss of seal injection as a result of a non-LOCA HELB.

These requirements prevent a CV break from resulting in the potential for Reactor Coolant System Leakage. The CV piping was reviewed to insure that, due to the routing and separation of the piping, the above requirements are satisfied and that postulated jet impingement on CV piping does not affect safe shutdown capability. The only area found which required further evaluation was the location discussed in Section C.3.1.1.

C.3.1.4 Fire Protection (FP) System

The FP system piping is not required after a HELB and is 4" diameter or less inside containment. Therefore, no further evaluation is required.

C.3.1.5 Feedwater (FW) System

FW piping is routed such that jet impingement from postulated break locations on other systems will not impact the FW piping. In a review of the FW system, two cases were found where a postulated FW break on one loop could potentially cause large jet impingement loads on a FW line in another loop. These two cases involve a break in Loop 2 and a pipe in Loop 3, and a break in Loop 1 and a pipe in Loop 4. These two cases were evaluated in detail (References C.4.8) as discussed in Section C.3.2.

C.3.1.6 Main Steam (MS) System

Postulated HELBs would not result in jet impingement which affects the MS piping. The MS piping is routed from the Steam Generators outside the secondary shield wall to the containment penetration area. Breaks in these areas will not cause loads on MS piping due to either separation or orientation of the lines.

C.3.1.7 Off Gas (OG) System

The OG lines are potentially used only after a LOCA. No LOCA breaks are near the OG lines since the OG lines are located only outside the secondary shield wall. Therefore, jet impingement on these lines will not affect safe shutdown capability.

C.3.1.8 Process Sampling (PS) System

The PS lines do not perform a safe shutdown function. The lines are isolated by normally closed containment isolation valves. LOCAs do not affect the containment isolation piping. Other PS system piping failures will not affect safe shutdown capability.

C.3.1.9 Reactor Coolant (RC) System

Included in the RC system review were all lines connected to the RC system but not isolated by check valves or normally closed valves. As a result, the RC system review addressed the lines which, if damaged, might result in a LOCA. The following criteria (Reference C.4.4) were used to complete this review:

1. LOCA will not be caused by a non-LOCA HELB.
2. LOCA will not cause a subsequent break which increases break area by more than 20%.
3. LOCA will not cause LOCA in another loop.
4. A small LOCA will not cause a LOCA in the other leg of the same loop.

These criteria are explained in detail and allowable exceptions are noted in Reference C.4.4. The routing of the RC lines and the location and orientation of the breaks in the containment was examined in detail and, with the exception of two RC bypass lines, the criteria were found to be met.

Two locations on the RC bypass piping could not be judged acceptable based only on a review of the locations and additional calculations were required. On Loops 3 and 4, a safety injection line break (from the accumulator) is in the vicinity of the normally closed bypass isolation valve. These two locations were evaluated in detail (References C.4.8) and the results are discussed in Section C.3.2.

C.3.1.10 Radioactive Equipment (RE) Drains

The RE lines are non-safety and normally isolated from the RC System. The lines are isolated by normally closed containment isolation valves. RE lines near the containment penetrations are not subject to loading from LOCA jets. Jet impingement on RE lines will not affect safe shutdown because the RE lines would contain only a small amount of fluid and are not required for safe shutdown.

C.3.1.11 The RE lines are non-safety and normally isolated from the RC System. The lines are isolated by normally closed containment isolation valves. RF lines near the containment penetrations are not subject to loading from LOCAs. Jet impingement on RF lines will not affect safe shutdown capability.

C.3.1.12 Residual Heat Removal (RH) System

The only lines inside Containment which are specifically identified as RH lines are the RHR suction lines from the RC system. The RHR supply lines to the RC system are designated SI lines and were reviewed with the SI system. The suction lines are not used after a LOCA and are not located near non-LOCA breaks. On the RC side of the suction line isolation valves, all RC system criteria (Section C.3.1.9) are met. As a result, jet impingement loads on the RH piping will not affect safe shutdown.

C.3.1.13 Reactor Coolant (Pressurizer) (RY) System

The safe shutdown RY piping is associated with the pressurizer. Included are the spare lines, relief and safety valve lines, and the surge line. These lines were reviewed with respect to postulated break locations and, with one exception, found by inspection to be separated by distance or barriers such that the piping would not be damaged by jet impingement.

The single exception is in the congested area at the top of the pressurizer enclosure. A postulated pressurizer spray line break is near a Power Operated Relief Valve (PORV) line. The spray line does not affect the spray valves and, therefore, the liquid portion of the break can be isolated. As noted in Reference C.4.4, propagation of pressurizer steam space breaks is not limited to the 20% criteria because of the lower mass release rate associated with steam breaks.

C.3.1.14 Steam Generator Blowdown (SD) System

The SD system is a non-safety system. The piping inside Containment is 2" diameter or smaller. LOCAs do not affect these lines. Non-LOCAs will not result in SD system damage such that more than two steam generators will blow down. Therefore, safe shutdown is not adversely affected.

C.3.1.15 Station Heating (SH) System

The SH system is a non-safety system and does not contain lines larger than 4" inside containment. The SH system piping is located outside the secondary shield wall. The portion of the system used for containment isolation is not located near postulated LOCA breaks. Jet impingement on the SH piping will not affect shutdown capability.

C.3.1.16 Safety Injection (SI) System

The Safety Injection System is used after LOCAs to supply fluid to the primary system. The safety injection lines are fitted with runout protection orifices to ensure that flow is delivered to all loops. These orifices are located near the secondary shield wall. Therefore, breaks in the SI line to a faulted loop will not affect safe shutdown capability as long as the break is downstream of the runout orifice.

Review of the SI line locations and routings verified that the SI design prevented jet impingement from a LOCA in one loop from affecting SI lines to the other three loops and from affecting any SI lines upstream of the flow limiters. As a result, jet impingement of SI piping will not affect the SI safety function. Potential jet impingement with the loop was reviewed to check for relatively small breaks (4" or less) which might impair high head safety injection. This was checked because, in certain instances, damage to a high head SI line by one of these smaller breaks might require use of Safety Injection pumps after a break which could be otherwise mitigated by use of charging pumps. This is discussed in Section 2-3-4 of Westinghouse Design Criteria SS 1.19 (Reference C.4.4). The review verified that this criteria has been met.

For non-LOCA breaks, the SI piping required to provide normal RHR supply to the RC system was reviewed and verified to be designed such that damage is precluded.

C.3.1.17 Essential Service Water (SX) System

The SX system supplies cooling water to the Reactor Containment Fan Coolers (RCFCs). The SX routing is outside the secondary shield wall. Postulated jet impingement does not affect the SX piping due to separation from the postulated HELBs.

C.3.1.18 Chilled Water (WO) System

The WO system is a non-safety system and is not required for safe shutdown. However, because the system includes piping inside Containment as large as 10", potential flooding effects were reviewed. An in-depth review confirmed that postulated jets do not impinge on the WO piping.

C.3.2 Additional Evaluations of Safe Shutdown Piping

In the review described in Section C.3.1 of the piping systems in the Containment only four instances were found where the potential for adverse jet impingement effects on safe shutdown capability could not be dismissed based on an examination of piping and break locations and, if needed, very conservative estimates of the potential loading on piping. These few cases required a more detailed evaluation of the actual predicted loading and the capability of the piping to withstand this load.

The four cases can be summarized as follows:

Case	Break I.D. (Line)	Target
1	C515 (1SI05DC-6")	1RC21AC-8"
2	C521 (1SI05DD-6")	1RC21AD-8"
3	C060 (1FW03DG-16")	1FW03DC-16"
4	C054 (1FW03DA-16")	1FW03DD-16"

Loads were calculated (Reference C.4.8) on these piping lines by using Reference C.4.10 (steam and two phase jets) and Reference C.4.11 (liquid jets). The piping was then evaluated to confirm that the required safe shutdown functions would not be affected by jet impingement damage to the piping.

C.3.3 Jet Impingement Effects on Piping Supports

Piping supports (hangers, struts, auxiliary steel and snubbers) have been reviewed in conjunction with the above described piping review to confirm that jet impingement damage to supports will not impair safe shutdown capability. The safe shutdown piping addressed in C3.2 was categorized into two groups. The first was piping which had no breaks near or was not used to achieve a safe shutdown condition after breaks in the vicinity of the piping. These situations require no further review because damage to supports was shown either not to occur or to be acceptable. The second category was pipes which may be used for shutdown following a break in the vicinity of the pipe. These were evaluated by a walkdown of the area to determine which supports, if any, could be loaded by jet impingement. The effect of these support loads on the pipe capability was reviewed to confirm that safe shutdown capability was not adversely affected. The walkdown and review is documented in Reference C.4.9. Significant loads were calculated on one safety injection system support. A detailed review established that the piping would not be adversely affected by the jet impingement loads.

C.4 References

C.4.1 Sargent & Lundy Calculation HELB-5, "Jet Impingement Effects on Auxiliary Building Piping."

C.4.2 Sargent & Lundy Calculation EMD-047455, "Jet Impingement Loads for High Energy CU Lines in the Auxiliary Building," Rev. 0, May 1984.

C.4.3 Sargent & Lundy Calculation 3C8-0784-002.

C.4.4 Westinghouse Design Criteria SS1.19, "Criteria for Protection Against Dynamic Effects Resulting from Pipe Rupture," Rev. 0, March 1978.

C.4.5 Sargent & Lundy Calculation RAS-FL-1, "Flood Level Inside Containment," Revision 1, July 1982.

C.4.6 Sargent & Lundy Calculation 3C8-1281-001, "Auxiliary Building Flood Level Calculations," Rev. 2, March 1984.

C.4.7 Sargent & Lundy Calculation HELB-3, "Jet Impingement Effects on Piping Inside Containment," Rev. 0, July 1984.

C.4.8 Sargent & Lundy Calculation EMD-048575, "Jet Impingement Loads on Essential Piping Inside Containment," Rev. 0, July 1984.

C.4.9 Sargent & Lundy Calculation HELB-7, "Evaluation of Jet Impingement on Piping Supports," Rev. 0, August 1984.

C.4.10 NUREG CR-2913, "Two Phase Jet Loads," January 1983.

C.4.11 Sargent & Lundy Engineering Mechanics Division Technical Procedure No. 24, "Analysis of Postulated Pipe Rupture," Rev. 4, Nov. 1979.

Appendix D

Jet Impingement Effects On Structure

D.1 Purpose and Scope

The purpose of this appendix is to summarize the structural design approach for jet impingement loading. The scope includes structural elements such as walls, slabs, and structural steel, inside and outside of the containment.

D.1.1 Introduction

The initial structural assessment for jet impingement loading, which was part of the original structural design, was based upon relative line size and line energy in conjunction with line location. Using this information, a review was made to determine which lines in various areas of the plant could have a significant impact on the structural design. For example, the chemical and volume control system letdown line in the Letdown Heat Exchanger room was judged to have a significant jet impingement loading and was therefore addressed in the original plant design.

In other areas of the Auxiliary Building, jet impingement effects on structural elements were considered to be of no concern since either the potential loading was small relative to the structural capacity in the area or the structural element involved was considered nonessential since failure would not affect safe shutdown. In other words, potential damage to the structure would not affect safe shutdown systems due to the location of the structure. For example, in reference D1.0 a project decision was made to provide block walls rather than concrete partition walls around a high energy line area since there was no safety-related components affected by the potential wall overstress.

In the original Containment design, jet impingement loads from a postulated longitudinal break in the vicinity of certain NSSS supports were judged to be significant. Jet deflectors were therefore designed and installed to redirect the jet away from these supports.

D.1.2 Verification Through Final Load Check

Most loadings used in the original plant design, including jet impingement loading, are based on various assumptions and judgments. The original structural design is performed early in the plant design process before many internal system designs are completed. To account for this, a structural final load check is performed in order to verify the original assumptions and judgments, and to account for the actual loadings caused by the plant internal systems, such as piping, which may have been incomplete at the time of the original structural plant design. The following is a summary of how jet impingement loads are included in the final load check and how the original assumptions and judgments made about jet impingement loading are verified.

D.1.3 Method of Analysis in Final Load Check

Jet impingement loads are considered by one of two methods. The first method is to assume that a break can occur anywhere in the high energy line and can hit any structure in a given compartment. This method is conservative and is only used to minimize redundant calculations of small loads from many small line breaks in a given subcompartment. An assessment is made to determine the most sensitive structure in the subcompartment and its structural capability is determined. This assessment is based on assuming the load on various locations of each structural element in order to determine the maximum of each structural effect such as shear and bending moment. High energy lines which could produce jet loads which exceed a cutoff load, based on the most sensitive structure, are addressed by the second method. For these lines, specific breaks are postulated and their corresponding jet impingement loads and structural targets are determined. The jet impingement load is applied to the target structure as an equivalent static load, including an appropriate dynamic load factor to take into account the dynamic nature of the load and the time dependency of the load. An appropriate form factor is used as required to take into account the characteristic of the target surface.

D.2 STRUCTURES OUTSIDE OF CONTAINMENT

D.2.1 Shear Walls and Concrete Slabs

Shear walls and reinforced concrete slabs are the most common structural target due to jet impingement loading and provide the separation for the various safety related systems in the plant. The sizing of shear walls and slabs is based upon resisting seismic forces and to provide radiation shielding. Therefore, jet impingement forces on these members are usually not design controlling. The jet impingement loads are summarized as shown in References D1.1.1 through D1.1.7 The structural final load check calculations which verify the structural adequacy for areas with jet impingement loading on shear walls and slabs are filed in structural calculations listed in References D2.1.1 through D2.1.24.

D.2.2 Structural Steel

There are only a few zones outside of Containment where structural steel is loaded by jet impingement. The loadings on these areas are contained in Reference D1.1.1. The structural final load check calculations which verify the structural adequacy for areas where structural steel is subjected to jet impingement loading are contained in References D2.2.1 through D2.2.7.

D.2.3 Concrete and Block Partition Walls

Partition walls do not support the floors above them and are not part of the lateral load resisting system. They are therefore treated differently for jet impingement loading than shear walls which are primary structural elements. As outlined in the original design, partition walls in areas with no safety related systems are not required to resist jet impingement loading since a potential overstress and the possible wall damage due to jet impingement loading is of no consequence to safe shutdown systems.

The potential effects of partition wall failures with respect to equipment, cables, piping, and instrumentation was reviewed in detail (Reference

D.2.3.6) and shown to not adversely affect safe shutdown.

Calculations for the partition walls which are designed to withstand the jet impingement loading are filed in structural calculations listed in References D2.3.1 through D2.3.5.

D.3 STRUCTURES INSIDE OF CONTAINMENT

D.3.1 Concrete Walls

Similar to shear walls outside of the Containment, internal Containment concrete structures are sized for seismic loadings, shielding, and missile protection. Therefore, jet impingement loads are usually not design controlling. The jet impingement loads are provided as shown in References D1.1.7 through D1.1.8 and the structural final load check calculations which verify the structural adequacy of the Containment internal walls with jet impingement loading are filed in structural calculations listed in Reference D3.1.1.

D.3.2 Structural Steel Inside Containment

Structural steel inside Containment was reviewed to confirm that jet impingement loading will not damage the steel to the extent that components used for safe shutdown will not function.

D.3.2.1 Structural Steel Outside Secondary Shield

Outside of the secondary shield wall, the amount of structural steel and the number of HELBs is limited because of the plant design. A review was made of the relative locations of the steel and postulated breaks (Reference D1.1.9). As a result of the high energy line location and orientation and the restraints provided at the break locations, no significant loads on structural steel outside the secondary shield wall will result from postulated HELBs.

D.3.2.2 Structural Steel Inside Secondary Shield

A large proportion of the HELBs are located inside the secondary shield wall. Structural steel is located at elevations 390 and 400. The piping which contains HELBs is routed, for the most part, horizontally at elevations some distance above or below the structural steel. The relative locations of the steel and the HELBs was reviewed and only 20 structural steel components were found to be loaded by jet impingement (Reference D1.1.9). The steel was evaluated with these loads and it was confirmed that structural steel failure will not result from jet impingement. These calculations are listed in Reference D3.2.1.

D.3.3 Reactions From Piping Loaded by Jet Impingement

Appendix C discusses the effect of jet impingement on piping and pipe supports. For those piping systems which are utilized for safe shutdown and potentially impacted by jet impingement, the reactions from pipe and support loading were determined and reviewed to confirm the structural adequacy of the supporting member. The support reactions resulting from jet impingement were bounded by the seismic design loads.

References

Project Transmittal

D.1.0 Sargent and Lundy Interoffice Memorandum, "Pipe Rupture Analysis at El. 364'-0" in Auxiliary Building", R. J. Netzel to J. C. LaVallee, 7-7-76.

Project Calculations

D.1.1.1	HELB-WL-2 Rev. 1
D.1.1.2	EMD-048305
D.1.1.3	EMD-048306
D.1.1.4	EMD-048309
D.1.1.5	EMD-047947
D.1.1.6	DIT-BB-EMD-0004-0
D.1.1.7	EMD-047938
D.1.1.8	EMD-048133
D.1.1.9	HELB-6, Rev.0
D.2.1.1	SED-6.6.16.3
D.2.1.2	SED-18.2.1.4
D.2.1.3	SED-18.2.2.1
D.2.1.4	SED-18.2.2.2
D.2.1.5	SED-18.2.2.3
D.2.1.6	SED-18.2.3.1
D.2.1.7	SED-18.2.3.2
D.2.1.8	SED-18.2.3.7
D.2.1.9	SED-18.2.4.1
D.2.1.10	SED-18.2.4.4
D.2.1.11	SED-18.2.4.5
D.2.1.12	SED-18.2.4.6

D.2.1.13	SED-18.2.4.9
D.2.1.14	SED-18.2.5.9
D.2.1.15	SED-18.2.5.10
D.2.1.16	SED-18.2.5.11
D.2.1.17	SED-18.2.5.14
D.2.1.18	SED-18.2.11.2
D.2.1.19	SED-18.2.11.3
D.2.1.20	SED-18.2.11.4
D.2.1.21	SED-18.7.1.1
D.2.1.22	SED-18.7.1.2
D.2.1.23	SED-18.7.1.5
D.2.1.24	SED-18.7.1.6
D.2.2.1	SED-18.2.1.2
D.2.2.2	SED-18.2.5.4
D.2.2.3	SED-18.2.5.14
D.2.2.4	SED-18.2.6.2
D.2.2.5	SED-18.2.7.3
D.2.2.6	SED-18.2.9.5
D.2.2.7	SED-18.2.1.4
D.2.3.1	SED-16.1.1
D.2.3.2	SED-16.1.2
D.2.3.3	SED-16.1.3
D.2.3.4	SED-16.1.4
D.2.3.5	SED-18.8.1.1
D.2.3.6	3C8-0784-002
D.3.1.1	SED 6.6.16.2
D.3.2.1	SED 6.6.16.1