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August 16, 1984

Mr. James G. Keppler
Regional Administrator
U.S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

Subject: Byron Generating Station Units 1 and 2
Integrated Design Inspection
Inspection Report No. 50-454/84-32

Reference (a): April 9, 1984 letter from J. Nelson Grace to Cordell Reed.

(b): May 2, 1984 letter from J. Nelson Grace to Cordell Reed.

Dear Mr. Keppler:

This letter supplies additional information regarding Commonwealth Edison's responses to the findings, unresolved items, observations and general concerns which were identified during the Byron integrated design inspection.

Attachment A to this letter contains responses to the NRC concerns identified in references (a) and (b) regarding the analyses of the consequences of pipe breaks. Several of these responses refer to work done recently to confirm the adequacy of the Byron 1 design with regard to jet impingement efforts. The report of that review is also enclosed. Similar documentation will be produced for Byron 2 and the Braidwood units.

Please address further questions regarding this matter to this office.

One signed original and fifteen copies of this letter and the attachment are provided for NRC review. Three copies of the report are also enclosed. Eight copies are being provided directly to Ron Parkhill and three copies are being sent to John Streeter.

Very truly yours,

D. L. Farrar
Director of Nuclear Licensing

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Enclosure : "Byron 1, Confirmation of Design Adequacy of Jet Impingement Effects," August 1984

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AUGUST 1984

ATTACHMENT A

RESPONSES TO NRC LETTERS DATED APRIL 9, 1984 AND MAY 2, 1984 REGARDING REINSPECTION OF HIGH AND MODERATE ENERGY PIPE BREAKS AND CRACKS

INTRODUCTION

The NRC letters dated April 9, 1984 and May 2, 1984 transmitted concerns regarding the reinspection of high and moderate energy pipe breaks and cracks conducted during the week of March 26, 1984. The following responses clarify the Byron design approach and design features and should resolve these concerns.

Central to many of the IDI Team's concerns are comments relating to two Sargent & Lundy documents, Report BB-JI-01 "Jet Impingement Summary Documentation Report" and Calculation 3C8-1083-001 "Verification of High Energy Line Break Design Approach for Jet Impingement on Safe Shutdown Equipment." These concerns identify areas of potential jet impingement effects which the IDI team felt were not addressed or inadequately addressed by these two documents.

The nature of these concerns indicate an incomplete communication regarding the design approach used to address high and moderate energy line breaks and cracks and the purpose and scope of these two documents. The effects of postulated high energy line breaks and cracks were an important factor in the basic layout and design of the plant and in the separation criteria used for plant design. Report BB-JI-01 and Calculation 3C8-1083-001 document specific but limited aspects of this design.

Report BB-JI-01 was written to document and explain an informal review performed at Sargent & Lundy during the SER review to confirm that the separation concept had been adequately maintained to insure a high level of protection from effluents of pipe failure. This review specifically examined separation of electrical cables and electrical and mechanical equipment required for safe shutdown on the basis that these components were more likely to be subject to jet impingement damage and/or to be relocated than safe shutdown piping and structure.

Calculation 3C8-1083-001 is a more rigorous review of the potential jet impingement effects on safe shutdown mechanical and electrical equipment. This calculation was completed after the IDI Team report of September 30, 1983, as a demonstration of the effectiveness of the Byron design approach. Again, certain types of components were not addressed because the purpose was to demonstrate that a representative group of components would not be adversely affected by jet impingement.

To address these concerns in a more global sense, in addition to the responses to individual concerns, an additional report has been completed and is included with these responses. This report, "Confirmation of Design Adequacy for Jet Impingement Effects," addresses all types of safe shutdown components and, again demonstrates the adequacy of the Byron Unit 1 design for postulated jet impingement effects. Similar documentation will be produced for Byron Unit 2 and Braidwood Units 1 and 2.

Response to NRC Letter
Dated April 9, 1984

CONCERN NO. 1

"An evaluation needs to be made of jet impingement effects on piping (including check valves), conduit, cables and cable trays, electrical penetrations, snubbers, and structures (including tanks and heat exchangers). Calculation 3C8-1083-001 states that these items were not addressed in the jet impingement analysis covered by this calculation. Sargent & Lundy stated that cables are addressed in the Fire Protection Report. However, the analysis of cables for fire protection is not adequate for purposes of evaluating jet impingement effects."

RESPONSE

Protection from jet impingement effects results from the design approach of:

1. Isolating high energy lines from s·fe shutdown systems;

2. Separating redundant safe shutdown systems; and

3. Providing diverse methods of shutdown.

The potential hazard associated with High Energy Line Breaks (HELB) and jet impingement can be evaluated by reviewing:

1. Location of high energy lines;

2. Location of safe shutdown systems; and

3. The redundant and diverse equipment used for safe shutdown.

This, in fact, was the method used by the Auxiliary Systems Branch of the NRC to review the plant design for protection against the effects of high energy line breaks. This review is documented in Section 3.6 of the Byron Safety Evaluation Report (NUREG-0876, Supplement No. 2, January 1983).

After the original IDI inspection, the IDI Team found that because individual jet properties were not calculated, the required jet impingement work could not readily be determined to be complete. In response to the IDI concerns, Sargent & Lundy prepared Calculation 3C8-1083-001 to demonstrate that the original design provides adequate protection against jet impingement effects. This calculation was a damage study (or functional failure analysis) which evaluates the loss of active safe shutdown electrical and mechanical equipment due to jet impingement. This study examined this subset of safe shutdown components because of the critical nature and potential vulnerability to jets of this equipment. Failure of equipment physically near the equipment in question, plus a limiting single active failure, was addressed in the study. The study demonstrated that the original design approach is effective.

The scope of Calculation 3C8-1083-001 was limited to safe shutdown equipment and, as indicated in the calculation, specifically did not address the items listed in Concern No. 1. The scope was intentionally limited because the examination of the critical components was considered adequate to establish that the approach taken in the design provides the required protection against the effects of jet impingement.

The items listed in Concern No. 1 will have a lesser potential for unacceptable damage as a result of jet impingement when compared to equipment and cables. This conclusion is reached as a result of the design of the plant system and the physical nature of jets and fluid discharge. To address this concern, an additional confirmatory report (including a revision of Calculation 3C8-1083-001) has been performed to confirm that the piping, tanks, heat exchangers, structures, cables, conduit, snubbers, and electrical penetrations are designed such that safe shutdown capability is not adversely affected by high energy line breaks and jet impingement. This report, "Confirmation of Design Adequacy for Jet Impingement Effects," has been included with these responses.

In the particular concern expressed about cables, the basic information cited in the Fire Protection Report pertaining to cable separation is applicable to jet impingement. The Fire Protection Report was used as a source of information which locates safe shutdown equipment and systems in the plant. The effects of single active failure and the potential for jet impingement damage to walls are unique aspects which can be evaluated by examining the specific system failures and by extending the jet area of influence.

In the Auxiliary Building, the majority of the fire barriers also serve as impingement barriers. The report, "Confirmation of Design Adequacy for Jet Impingement Effects," has been prepared utilizing, as boundaries, only those walls which can be demonstrated to withstand jet loads. The study demonstrates that separation plus the diversity of shutdown paths provide safe shutdown capability considering jet impingement and single active failure.

In the containment, a judgment is made that the 20-foot horizontal separation of the redundant electrical divisions provides protection against jet impingement. This judgment is made also when evaluating the separation of mechanical and electrical equipment. This separation in conjunction with the redundancy and diversity of the design provides protection against jet impingement effects. The separation of redundant electrical cables is documented in the Safe Shutdown Analysis of the Fire Protection Report. The only locations in the containment where a large number of cables of a division could be damaged by one jet are cable trays located high in the containment. The high energy lines are located low in the containment. With very few exceptions, the high energy lines (or postulated jets) in the containment are oriented vertically or horizontally and not skewed. Given that the jets must have a vertical component to reach the trays, the 20-foot horizontal separation is judged to be adequate. In addition, most high energy lines in the containment are high temperature lines. It is judged that these postulated two-phase jets are of limited influence because of jet dissipation as the fluid flashes. This judgment is verified by the jet impingement load calculation methodology (based on test results) in NUREG/CR-2913 (January 1983) currently under review by the Mechanical Engineering Branch of the NRC.

Most cold high energy lines (either inside or outside of containment) are limited in potential jet energy because the breaks are generally fed by closed lines or pumps (with limited flow) rather than high energy vessels.

As an additional review of jet impingement effects, Bechtel Power Corporation is reviewing the Byron design for high and moderate energy line breaks and cracks as it affects specific systems in the Independent Design Review process. This review will provide an independent confirmation of the adequacy of Byron jet impingement design approach.

CONCERN NO. 2

"An evaluation needs to be made of jet impingement effects on instrumentation lines. Sargent & Lundy initially stated to the team that instrumentation lines, both inside and outside of containment, are within Westinghouse scope of work for analyzing the effects of piping failures. When the team requested formal confirmation of Westinghouse work in this area, Sargent & Lundy stated that, based on its discussions with Westinghouse during the week of March 26, 1984, it was now unclear who had the responsibility for this work and whether it had been accomplished."

RESPONSE

Sargent & Lundy has the responsibility for design against the effects of jet impingement. This was accomplished in the original routing of the instrument lines. Sargent & Lundy meeting notes of a special project meeting on High Energy Rupture Studies (March 23, 1976) states that wherever 20 foot separation cannot be maintained between redundant essential instrumentation lines, the need for additional protec-tion will be investigated.

Westinghouse performed a review of the separation of instrument lines in 1983. The Sargent & Lundy responsible project engineer thought, based on discussion with Westinghouse, that this review had included an evaluation of potential jet impingement effects. Subsequently, the responsible engineer contacted Westinghouse and was informed that the Westinghouse review had not included jet impingement effects. This was reported by the IDI Team during the week of March 26, 1984, when the issue was first raised.

As-built drawings of safe shutdown instrument line routings have been reviewed against the original routing criteria to confirm that adequate separation is provided. These lines are included in the August, 1984 report, "Confirmation of Design Adequacy for Jet Impingement Effects," described in the response to Concern No. 1.

CONCERN NO. 3

"An evaluation needs to be made of jet impingement effects on block walls and other walls surrounding equipment cubicles to determine whether piping failures in one cubicle can affect equipment in other cubicles. The jet impingement analyses performed by Sargent & Lundy address line failures and equipment confined to areas which are defined by block walls or other walls. Analyses have not been made of the effects of jet impingement upon these walls. The inspection team was informed that the Structural Department has some preliminary data on loading of walls due to jet impingement forces, but that it is necessary to perform final load checks based on final postulated impingement forces. Sargent & Lundy stated that there are about ten cubicle areas involving block walls, and these would fail under jet impingement forces."

RESPONSE

Early in the design, certain concrete and block walls were designed considering jet impingement loads. A partial list of documentation discussing these considerations is listed at the conclusion of this response.

Block walls in these 10 cubicle areas had not been specifically determined to fail due to jet impingement forces, but rather that, if exposed to high jet impingement forces, the integrity of the block walls had not been established.

Using final HELB locations, wall loads have been postulated for use in the final load check of the structure. The results of this load check confirm that HELB will potentially cause failure only in walls where failure does not affect safe shutdown capability.

The previously mentioned report, "Confirmation of Design Adequacy for Jet Impingement Effects," has included the potential effects of block wall failure.

Documentation of Concrete and Block Wall Design

- Project Communication, "Schedule for Pipe Whip Restraint Information for Auxiliary Building, Auxiliary Feedwater Tunnel and Main Steam Tunnel," March 15, 1976. This memo states that impingement loads will be provided to structural engineers for design and lists location of high energy line breaks.

- Project Meeting Notes, "High Energy Line Rupture Studies - March 23, 1976 Interdepartmental Meeting." At this meeting:

(1) the schedule for transmitting impingement loads was reviewed, and;

(2) the structural engineers were informed that for much of the auxiliary building, the loads were very low and would be transmitted to verify that they could be neglected in the structural design.

- Project Communication, "Pipe Rupture Analysis at El. 346'-0" in Auxiliary Building," July 7, 1976. This memo confirmed a discussion held in a June 14, 1976 Inter-departmental Meeting where it was determined that block walls were acceptable around the blowdown condenser because potential failure due to high energy line break would not affect safety-related equipment.

- Project Communication, "Preliminary Pipe Rupture Analysis for A.S. lines inside Auxiliary Building El. 426.00-401.0 and Pipe Tunnel El. 394.0," November 17, 1976. This memo transmitted jet impingement loads due to auxiliary steam line ruptures.

- Project Communication, "Pipe Rupture Analysis Progress Inside the Main Steam Tunnel and Auxiliary Building," February 22, 1977. This memo documented that potential jet impingement loads in the main steam tunnel and auxiliary building were being addressed.

CONCERN NO. 4

"Additional information needs to be provided with respect to the feasibility of repairing equipment within 72 hours or cross-connecting to Byron Unit 2 in specific cases where the jet impingement or water spray analyses did not identify safe shutdown paths. The Sargent & Lundy analyses of jet impingement and water spray identified ten cases where equipment repairs are assumed to be made in a time frame such that the plant achieves cold shutdown in 72 hours. In another three cases, the analyses assume that safe shutdown is achieved by cross-connecting Byron Unit 2 equipment (e.g., pumps) into Unit 1 loads. The following needs to be provided in each case where safe shutdown is dependent upon repairs:

a. describe the postulated damage and the nature of the repair operation,

b. Verify that the equipment needed for repair or replacement will be stored onsite,

c. verify that procedures have been written for each repair/replacement case, to include necessary qualifications and training of personnel,

d. demonstrate that each repair/replacement can be accomplished in time to support cold shutdown within 72 hours (or sooner if required) giving consideration to the environmental conditions that could prevent or limit access to the area.

In cases where credit is taken for cross-connection between units, confirmation needs to be made as to the availability of the Unit 2 equipment (prior to operation of Unit 2) and that technical specifications are written to require operability of equipment in Unit 2 (and dedication to Unit 1) whenever Unit 1 is in operation."

RESPONSE

In many of the cases where mention of equipment repair or cross-connection was contained in the reports, this was done to demonstrate additional available shutdown methods. Subsequent evaluation has confirmed that equipment repair or cross-connection is not required as part of a design basis shutdown procedure. Calculation 3C8-1083-001 (now Appendix A to "Confirmation of Design Adequacy for Jet Impingement Effects") has been augmented to reflect this. No cross-connection or repair has been found to be required as a result of high or moderate energy line failure.

CONCERN NO. 5

> "Sargent & Lundy needs to evaluate Westinghouse design criteria SS 1.19, "Protection Criteria Against Dynamic Effects Resulting From Pipe Rupture" for applicability to Byron. Sargent & Lundy informed the team that this is a baseline design document and their normal practice would be to review it and identify any areas where compliance would be considered impractical. SS 1.19, Rev. 0 was transmitted by Westinghouse to Sargent & Lundy in 1978, but was never sent to the Project Management Division, which is responsible for reviews for protection against the effects of pipe failure. The team is concerned that this oversight may make it difficult for Sargent & Lundy to comply with all design provisions of SS 1.19 at the current stage of construction."

RESPONSE

This concern should be clarified in light of further investigation at Sargent & Lundy since the IDI visit the week of March 23, 1984. Westinghouse Design Criteria SS 1.19 (proprietary) contains design information applicable to Byron and was utilized in the design of the Byron Station.

When the IDI Team asked questions about information in a preliminary 1970 version of this document (SS 1.19) which the IDI Team had brought to the inspection, they were told that the information appeared familiar and consistent with the plant design basis but the responsible Mechanical Project Engineer (K. J. Green) could not recall having reviewed the specific document. Revision 0 of SS 1.19 was located in the Structural Project Engineer's file during the inspection.

The following has been determined since the IDI inspection:

- A copy of SS 1.19 (preliminary) was in the office of J. Lazowski, Mechanical Design and Drafting Project Leader on the Byron Project and a piping designer in the initial layout of the safety-related piping systems.

- A copy of SS 1.19 (preliminary) was in the Byron Project Files. This copy bears the name of R. B. Johnson, the responsible project engineer in the Project Management Division for high energy line break work in 1974 through 1980.

- A copy of SS 1.19 (preliminary) was in the files of K. J. Green, the current responsible engineer in the Project Management Division for High Energy Line Break. Retrieval of this document from the files was complicated at the time of the inspection because it is part of the

Westinghouse Reactor Fluid Systems Standard Design Package Four Loop Plant Nuclear Steam Supply Systems. The document is identified in this package as STD-DES-4L-RFS-4L7 rather than SS 1.19. The designation SS 1.19 appears only as a handwritten note on page 2 of this document.

- Revision 0 of SS 1.19 was transmitted to the Sargent & Lundy Project Team by Westinghouse Letter CAW-2725 (4-6-79). While it has not been clearly determined where this particular copy was subsequently filed, the copy was received by the Project Manager.

A documented review of Revision 0 of SS 1.19 has been completed and no inconsistency between this document and the Byron design has been found.

CONCERN NO. 6

"Criteria should be established for reviewing design changes for impact upon completed analyses of effects of postulated piping failures. Sargent & Lundy stated that its procedures require the responsible engineer for the design change to evaluate all aspects of the change, including impact upon the piping failure analyses. The team considers this is inadequate because the piping failure analyses are highly specialized and were performed by groups other than those responsible for the design, i.e., Project Management Division and Nuclear Safeguards and Licensing Division. Criteria need to be established defining circumstances under which design changes will have an impact upon completed analyses of piping failures, and in these cases the design changes should be reviewed by the groups responsible for the piping failure analyses."

RESPONSE

Design changes which would require a review for effects of piping failures are those which involve extensive relocation of high energy lines or safe shutdown equipment. The design approach used and the verification studies ensure that minor changes do not compromise the design. This approach conservatively assumes loss of equipment in a general area after a postulated piping failure rather than an evaluation of the exact geometrical relationship of the high energy break location and safe shutdown equipment.

Design changes are reviewed by the responsible engineer and referred to other members of the project team as required. Major changes are reviewed by all affected design disciplines. The design change procedures require the responsible engineer to identify the scope of review needed. The project experience in the confirmation work performed to date demonstrates that this approach has been successful since design problems have not been found, and plant changes are not required.

CONCERN NO. 7

"Sargent & Lundy needs to confirm Westinghouse agreement with the list of equipment required for safe shutdown. Calculation 3C8-1083-001 includes the "Safe Shutdown Equipment List (SSEL)" which is based upon active valve lists in the FSAR, the Byron/Braidwood Mechanical Equipment Qualification List and the Byron/Braidwood Fire Protection Report. There is no record of this SSEL having been concurred with by Westinghouse. Calculation 3C8-1083-001 indicates required instrumentation needed to support safe shutdown, e.g., 2 of 4 reactor coolant cold leg temperature sensors. In four cases, the postulated piping failures result in fewer than the required instruments for safe shutdown, and in two of these four cases the report states that core exit thermocouples would provide redundancy to the failed instruments (hot or cold leg resistance temperature detectors). These conclusions are inconsistent with the "required" instrumentation indicated in Calculation 3C8-1083-001, and need to be confirmed by Westinghouse."

RESPONSE

Westinghouse has reviewed the Safe Shutdown Equipment List (SSEL) in Calculation 3C8-1083-001 as included as Appendix A of the August 1984 Confirmatory Report. Westinghouse concurs with the SSEL and the Confirmatory Report.

The Safe Shutdown Equipment List (SSEL) includes equipment in both the NSSS (Westinghouse) and Balance-of-Plant (Sargent & Lundy) scope. The term "required" when used in conjunction with this list really means "required under at least one High Energy Line Break scenario." Therefore, allowing failure of a "required" system or component is not inconsistent. This list was assembled using equipment lists and equipment classifications developed in the design of the safe shutdown systems. Westinghouse has provided, as part of the NSSS design information, descriptions of the Westinghouse designed systems, classification of NSSS equipment, and emergency operating procedures. Jet impingement analysis is in the Sargent & Lundy scope of responsibility and, therefore, Sargent & Lundy has the responsibility for defining the SSEL in Calculation 3C8-1083-001.

As was discussed with the IDI Team the week of March 26, 1984, Westinghouse provided to Sargent & Lundy a list of all safety-related electrical equipment in conjunction with the environmental qualification of Class 1E electrical equipment in 1981. P&ID's showing the safe shutdown portions of systems were also developed by Sargent & Lundy and reviewed with Westinghosue in 1982. For the mechanical equipment qualification program, Sargent & Lundy developed a list of safe shutdown mechanical components.

This list was transmitted to Westinghouse and reviewed with Westinghouse in 1981. The information developed during these efforts was the basis of the list of safe shutdown equipment included in Calculation 3C8-1083-001. The final calculation was not reviewed by Westinghouse. However, the input information was.

The formulation of a calculation such as this draws on the information provided by sources such as Westinghouse and Commonwealth Edison. The Sargent & Lundy responsible engineers utilize their experience and expertise to interpret available information and to provide clarification to additional information as they determine necessary. The concern also gives an example in which temperature sensor requirements were modified based on evaluations performed by Sargent & Lundy. This is an example where further investigation was made by Sargent & Lundy responsible engineers in consultation with Commonwealth Edison.

In the course of the design of Byron Station, Sargent & Lundy has conferred with Westinghouse on questions which involve clarification in Westinghouse design information. Because of the questions being raised, Westinghouse has reviewed the SSEL in Calculation 3C8-1083-001 to confirm the adequacy of the NSSS portion of this list.

CONCERN NO. 8

"Additional information needs to be provided with respect to specific piping failure analyses as follows.

a. Report BB-J1-01 states for Zone 11.3-1 that failure of steam generator blowdown lines (3") do not pose a jet impingement hazard to a motor control center. Analysis needs to be made of the effects of jet impingement from these breaks upon essential service water lines in the area (6", 8", and 20").

b. Calculation No. 3C8-1083-001 states that Motor Control Center 1AP21E is postulated to fail due to jet impingement; failure would render all its dependent equipment inoperable. The calculation assumes a single active failure to one specific equipment item which is powered by the redundant Motor Control Center (MCC 1AP23E), but not failure of that entire motor control center. A failure analysis needs to be performed to substantiate this assumption.

c. Report BB-J1-01 indicates for Zone 11.6-0 that water spray could result in failure of 2 of 3 cooling fans in an electrical equipment cubicle in addition to single active failure resulting in loss of the redundant power division. Analysis needs to be made of the heatup of electrical equipment in this case and its effect upon ability to achieve safe shutdown.

d. Report BB-J1-01 indicates for Zone 11.3-0 there are two each unit 1 and unit 2 component cooling water pumps, a pump common to both units, and valves used to align the common pump to either unit. Based on review of the drawings and the fact that fire protection piping resulting from a recent design change was not on the drawings, the team is concerned that the right combination of water spray damage and assumed single active failure could result in loss of component cooling water to one unit. A detailed pipe break/crack review should be performed, including the new fire protection piping, to determine whether the design is adequate.

e. Report BB-J1-01 states that for Zone 11.2A-1, fire protection and containment spray lines are about 20' from the residual heat removal pump and are therefore, unlikely to damage the pump. The team determined, based on review of the drawings, that this separation is only about 15'. An analysis needs to be made as to whether this separation is adequate and, if not, whether necessary repairs can be made and cold shutdown can be achieved within the technical specification allotted time for shutting down when the containment spray system is unavailable.

f. Commonwealth Edison letter dated December 30, 1973, in response to Finding 2-17 of the subject report, states, "in the event spray disables one AF train and single failure disables the other, safe shutdown can be achieved per Figure 1 by feed and bleed of the primary system with or without RHR." The team considers that feed and bleed is not an acceptable alternate means of decay heat removal in the event of high and moderate energy pipe failures. Sargent & Lundy should identify specific piping breaks/cracks which could result in damage to essential decay heat removal equipment and for which feed and bleed cooling was assumed in order to achieve safe shutdown. For these cases, there should be sufficient protection to assure that at least one train of equipment would be available for an acceptable decay heat removal method."

RESPONSE

(a) Report BB-JI-01 describes the conclusions reached in informal reviews of jet impingement and water spray effects. These conclusions were reached prior to finalization of break locations in high energy systems. As a result, a conservative approach was taken to potential line break locations. Final break locations are now available. Break information for the steam generator blowdown (SD) lines in question are shown in the attachment to Westinghouse letter CAW-7145 (3-22-84) which has been provided to the IDI Team. This letter indicates that no blowdown system breaks are postulated in the same room as the essential service water lines in question.

If a break were postulated in the SD piping at the fitting closest to the Essential Service Water Lines, the resulting loads, calculated using NUREG/CR-2913, would be negligible.

(b) The only active component in a motor control center (MCC) is the contactor portion of each combination starter. The main power feed cable for Motor Control Center 1AP23E is connected directly to the bus. There is no active motor control center component whose failure can directly affect the power supply to the motor control center. The operation or failure of any active motor control center component will affect only the individual circuit connected to that component. Complete failure of the MCC would result only from loss of power to the MCC circuits.

Further review of the high energy line break location reveals that MCC 1AP21E will not be affected by jet impingement. Calculation 3C8-1083-001 is being augmented to reflect this change and to include an assumption of loss of an entire electrical division as the postulated single failure. Although this exceeds the apparent intent of SRP Section 3.6.1, this simplifying assumption can be made because of the conservatism of the Byron design.

(c) Failure of two of three fans in the miscellaneous electrical equipment and battery room was judged not to affect safe shutdown because of the conservatism used in the Electrical Enviornmental Qualification Program and the results of studies on fan loss in similar areas. A calculation has subsequently been completed and it has been determined that, with the two fans out of service, a maximum transient temperature of about 108° F will be experienced in the room. The steady state qualification temperature in this zone (Environmental Zone A3) is specified as 108° F (FSAR Table 3.11-2, Byron Environmental Qualification Report Table 3.1-1). Therefore, as noted in Report BB-JI-01, no adverse effect of the jet impingement will impair safe shutdown.

(d) This concern, as written, does not fully explain the potential water spray hazard review in the component cooling pump area. In the original design layout of this area, the only piping in the area was component cooling piping and an essential service water line to the component cooling heat exchangers. This piping is designed to meet ASME, Section III requirements. A review of the stress levels shows that only one moderate energy crack location need be postulated in this area. This location is in a 12-inch component cooling supply header. Based on the single failure exclusion for dual purpose moderate energy systems (Ref: SRP Section 3.6.1), this crack would be of concern if it disabled three component cooling pump motors. Spray from the postulated crack would not disable these three motors because of the separation and orientation of the three motors and the location of the postulated break with respect to the motors.

The additional fire protection piping is the result of comments by the NRC Fire Protection Reviewers and was being finalized during the IDI reinspection. The potential for water spray damage had already been reviewed in detail at the time of the inspection and a decision had been made to install spray shields on the component cooling pump motors and to install partial walls between the pumps. This information was communicated to the IDI Team during the inspection.

A detailed review of potential pipe breaks/cracks has been performed in this area and the design is confirmed to be adequate.

(e) The fire protection and containment spray lines in the residual heat removal pump cubicle are designed to meet ASME, Section III requirements. The stress level for these lines has been reviewed and it has been determined that no cracks must be postulated in these lines in accordance with the stress criteria given for moderate energy line failure exclusion in Standard Review Plan Subsection 3.6.2 (Branch Technical Position MEB 3-1). Therefore, no crack is required to be postulated in these lines and a spray hazard does not exist for the residual heat removal pumps from these lines.

(f) The auxiliary feedwater system consists of a motor-driven auxiliary feedwater pump, a diesel-driven auxiliary feedwater pump and associated piping and valves. There are no high energy line breaks which will adversely affect the Auxiliary Feedwater System, including power and control functions. Spray from moderate energy lines could, at most, damage one train. The moderate energy lines in question are lines such as service water and fire protection. None of these potential cracks would, in itself, cause loss of offsite power or reactor trip. In accordance with Standard Review Plan Subsection 3.6.1 (Branch Technical Position APCSB 3-1), loss of feedwater is not assumed and the auxiliary feedwater system is required only if the single active failure causes loss of offsite power. In that event, one train of auxiliary feedwater is available.

Therefore, there are no postulated high or moderate energy line breaks which would result in both loss of an auxiliary feedwater train and demand for auxiliary feedwater (loss of offsite power or main feedwater). The NRC has previously required that feed and bleed cooling be incorporated into the Byron Emergency Operating Procedures. The NRC has required that the pressurizer PORV's at Byron be upgraded to afford greater assurance of success for feed and bleed cooling operations. The NRC has accepted feed and bleed cooling for design basis events as specifically noted in the Byron SER, Section 5.4.3; Supplement 2 to the Byron SER, Section 5.4.3; and Supplement 4 to the Byron SER (Draft), Section 5.4.6. Feed and bleed cooling is clearly acceptable to the NRC staff for a variety of design basis events and has been technially accepted as viable by the NRC for a wide variety of postulated events which go beyond the plant design bases. Feed and bleed cooling constitutes a technically acceptable alternative cooling mode for high and moderate energy line break events and that feed and bleed events should also be an acceptable licensing alternative for such events.

As demonstrated by the August 1984 Confirmatory Report, jet impingement will not result in a need for feed and bleed cooling. The references (12-30-83 letter) to feed and bleed in the event of total loss of auxiliary feedwater are options required only in the event of failure beyond the design basis and are included to shown that the diversity and redundancy of the plant design exceeds requlatory requirements.

Response to NRC Letter
Dated May 2, 1984

SITE INSPECTION

CONCERN NO. 1

"Report BB-JI-01 states for Zone 11.6-0 that a fire protection line is routed between Motor Control Center (MCC) 131 x 5 and MCC 132 x 5, and that a line break could at the most disable functions in one MCC only. We determined that the fire protection line is directly above MCC 132 x 5 and 17' from MCC 131 x 5. Water spray could be deflected by nearby ductwork to MCC 132 x 5 and simultaneously travel 17' to MCC 131 x 5. An analysis should be made to the potential for pipe cracks and, if any, the path of water spray."

RESPONSE

The two motor control centers (MCC) 131 x 5 and 132 x 5, are located on plant Elevation 426 feet 0 inch, in a corridor. These two MCC's were placed on opposite walls to afford the maximum possible separation within the area. The fire protection line is the only liquid line in the area. Fire protection headers, which are located in many areas of the plant where fluid systems would not ordinarily be routed, are designed to the requirements of ASME Section III. The fire protection line in this area was not originally reviewed for postulated crack locations because it was believed that the routing of the line and the cables, cable trays, drain lines, and air lines in the area made it very unlikely that water spray from a single crack could damage both MCC's.

Existing piping stress analyses have now been reviewed to assess the potential for pipe cracks. The fire protection line in question is designed to the requirements of ASME Section III, with stress levels adequately low such that no postulated cracks are required by the guidelines in Standard Review Plan Section 3.6.2. There are no other liquid piping lines in this area.

SITE INSPECTION

CONCERN NO. 2

"Report BB-JI-01 states for Zone 11.4-0 that a wall separates MCC 131 x 3 from water lines in the area. We determined there are fire protection and other moderate energy lines within 5'-15' of MCC 131 x 3 which are not separated from the MCC by any wall and which would spray the MCC. A determination should be made why these were not identified in the Sargent & Lundy analysis, whether they are postulated to crack, and, if so, the impact on ability to reach safe shutdown."

RESPONSE

Report BB-JI-01 contained an error concerning Zone 11.4-0 apparently caused by a misinterpretation of the design drawings. In reality there are fire protection, essential service water, and nonessential service water lines in this area. All of these lines have been reviewed to determine required postulated crack locations based on stress level. One postulated crack location on nonessential service water line 1WS57A-18 was identified. This location is over 30 feet west of the MCC. There are two structural columns between the crack location and the MCC. As a result, there is no impact on safe shutdown capability.

SITE INSPECTION

CONCERN NO. 3

"Report BB-JI-01 states that CV lines are oriented away from MCC 131 x 1 and are separated by about 25'. We were unable to locate one high energy CV line (1 CV42E-2") shown on the composite drawing (M-228) used in Sargent & Lundy's analysis. Therefore, there is uncertainty as to the effect of breaks in this high energy CV line on equipment in this area. It is noted that item 8.a of our April 9, 1984 letter indicates concern as to jet impingement upon essential service water lines in this area. Analyses should be made of effects of failure to CV lines upon these essential service water lines and other equipment required for safe shutdown. This includes MCC 131 x 1 for which our April 9, 1984 letter raised a question on single active failure of a redundant MCC (item 8.b)."

RESPONSE

Line 1CV42E-2" is the Charging Pump Miniflow Line. This line had been recently rerouted as part of a design change in response to I. E. Bulletin 80-18. This change had not yet been made to the composite drawings at the time of the IDI inspection. This line is downstream of the charging pump miniflow orifice. Therefore, a break in this line would not produce significant jet impingement forces. The current routing of the line is farther from MCC 131 x 1 than the original routing. An additional review demonstrated that jets do not impact MCC 131 x 1.

SITE INSPECTION

CONCERN NO. 4

> "We inspected a 1-1/2" boron injection line (1RC30AA-1-1/2) in the cold leg of loop A. Based on a terminal end break postulated by Sargent & Lundy, we determined that there could be jet impingement upon a 3/4" sample line in the hot leg. This is contrary to Westinghouse requirements (SS 1.19) for limiting small line LOCA's to the affected leg. This relates to the concern expressed in our April 9, 1984 letter (item 5) where the Project Management Division of Sargent & Lundy has not reviewed the Westinghouse design criteria for protection against pipe rupture."

RESPONSE

It appears that this concern results from a misinterpretation of SS 1.19. Small line LOCA's are limited to the affected leg to ensure natural circulation in the unfaulted loops. As was explained to the IDI Team at the time of the inspection, the 3/4-inch sample line in question is isolated by a 3/8-inch orifice at the connection to the main loop. The limited flow area (approximately 0.1 square inches) clearly eliminates concern about this failure. Section 3-3-2 of SS1.19 discusses the limitation on break propagation in light of the 3/8-inch orifice.

SITE INSPECTION

CONCERN NO. 5

"We inspected a 12" RHR line (1RC04AB-12) connected to the hot leg of loop C at a location where the FSAR had postulated breaks B10A and B10B. Sargent & Lundy had not determined whether the breaks were circumferential or longitudinal, so we postulated longitudinal breaks and identified potential targets. The targets were loop B and C drain lines, loop B crossover leg flow instrumentation lines, loop B 1-1/2" boron injection line and incore instrumentation lines. It is noted that some of these targets, if impacted and damaged, would result in violation of Westinghouse criteria, e.g., for confining damage to the affected loop."

RESPONSE

For the purpose of Calculation 3C8-1083-001, Sargent & Lundy had not distinguished between longitudinal and circumferential breaks. This calculation evaluated safe shutdown equipment as a representative sample of safe shutdown components and assumed that all equipment in a conservative area of influence was damaged by jets from breaks, including breaks B10A and B10B. Sargent & Lundy and Westinghouse had established in the design of the piping that no longitudinal breaks need be postulated on the Byron high energy piping with the exception of one elbow on each main reactor coolant loop which is mitigated by a jet impingement shield. This was determined by comparing piping stresses with the guidelines of Branch Technical Position MEB 3-1.

Therefore, the postulated longitudinal breaks identified in this concern are not potential breaks. It should be noted, however, that most of the targets listed are normally isolated by manual valves or 3/8-inch orifices. The design of the plant provides adequate protection against the postulated circumferential break.

SITE INSPECTION

CONCERN NO. 6

"Due to the unavailability in the FSAR of intermediate break locations for the pressurizer spray line, we could not assess compliance with Westinghouse criteria for protection against the effects of such breaks. This area should be evaluated."

RESPONSE

The intermediate break locations are in the pressurizer enclosure and at the auxiliary spray line connection from the charging system. The requirements and guidelines of Westinghouse Design Criteria SS 1.19 are met. The breaks have been plotted on composite drawings and will be included in the next amendment to the FSAR.

SITE INSPECTION

CONCERN NO. 7

"Calculation 3C8-1083-001 makes statements as to separation of instruments required for safe shutdown. Based on our field walkdown, we were unable to confirm that this separation also existed for the cabling and instrumentation lines associated with these instruments. Specific cases reviewed were the source range neutron detectors and pressurizer pressure transmitters."

RESPONSE

Safe shutdown instrument cables inside containment have been routed to maintain adequate separation between redundant cables. This was demonstrated in the Fire Protection Report. Similar separation was maintained when instrument lines were routed.

A confirmatory review of the separation of and potential jet impingement effects on safe shutdown instrument lines and cables has been completed as part of a full verification study of jet impingement effects. The results establish that adequate separation exists.

As for the two instruments mentioned in the IDI concern, the neutron detectors have been deleted from the high energy line break safe shutdown list as a result of meetings between Sargent & Lundy, Commonwealth Edison, and Westinghouse; and the pressurizer pressure transmitters have been demonstrated to be adequately separated to perform required safe shutdown function.

INSPECTION AT SARGENT & LUNDY OFFICES

CONCERN NO. 1

"Calculation 3C8-1083-001 defines "single train" zones as zones containing safe shutdown components or cables from only one train of the respective systems contained in these zones. The report states, that following any initiating high energy line break event in a "single train" zone, the additional failure by fluid jets of a safe shutdown component within the zone of this line break would be no worse than the initiating line break, i.e., either would disable that train. For each "single train" zone, you should verify there is no other piping except for that associated with the specific train of the specific system in the zone. If there is other piping, you should evaluate the effects upon the equipment in the zone resulting from jet impingement and/or water spray due to failure of that piping. This evaluation should consider that jets from piping breaks in nearby zones may reach components in the specific "single train" zone being evaluated. (See item 3 of our April 9, 1984 letter with respect to integrity of walls surrounding equipment cubicles)."

RESPONSE

The "single train" zones are Auxiliary Building subcompartments. In these zones there are no piping, cables, or instrument lines associated with the redundant train. However, piping damage is not a concern because the postulated Auxiliary Building jets in these areas do not contain sufficient energy to damage piping. This is discussed in more detail in the confirmatory report, "Confirmation of Design Adequacy for Jet Impingement Effects."

INSPECTION AT SARGENT & LUNDY OFFICES

CONCERN NO. 2

"Item 1 in our April 9, 1984 letter states that there should be an evaluation of jet impingement effects on piping. This evaluation should consider that, in some cases, jet impingement may not cause breaks or cracks to piping within the target zone, but it will bend, crimp or otherwise deform the pipe. Analyses should be made as to the effects upon pipes due to jet impingement and whether such effects will cause loss of functionality such that credit cannot be taken for their use in establishing safe shutdown."

RESPONSE

The potential for jet impingement damage to piping has been addressed in the confirmatory report, "Confirmation of Design Adequacy for Jet Impingement Effects."

INSPECTION AT SARGENT & LUNDY OFFICES

CONCERN NO. 3

"Calculation 3C8-1083-001 states that, in the event the RHR system is incapacitated, cold shutdown could be achieved by using the secondary system to remove decay heat by dumping water to the condenser and feeding the steam generators with main or auxiliary feedwater. The steam generator functions as an RHR heat exchanger. The steam generator can be flooded and the overflow will flow down the steam pipes and bypass to the condenser. We consider that this method of attaining cold shutdown in the absence of RHR is only minimally acceptable. Accordingly, you should identify all areas where pipe breaks or cracks could incapacitate the RHR system. In these areas you should perform a more rigorous jet impingement or water spray analysis (e.g., based on specific break/crack locations as opposed to Sargent & Lundy's previous practice of postulating breaks/cracks throughout the general area) to determine if the RHR system would be damaged. For the cases where this more rigorous jet impingement or water spray analysis results in the RHR system being incapacitated, you should consider modifications to protect the RHR equipment from jet impingement or water spray."

RESPONSE

The Byron plant is designed to safely remain in a hot standby condition for an extended period of time and the licensing basis is hot shutdown. For postulated accidents within the design basis, the Byron design includes an established capability to reach cold shutdown. In accordance with the licensing basis, this capability may include use of alternate procedures or non-qualified equipment.

The procedure of using steam generators to reach a cold shutdown condition is within the accepted Byron shutdown procedures. It requires use only of equipment normally used for shutdown. However, this procedure will not be required after high energy line breaks for the following reasons:

- The only active component inside containment (RHR suction valves) is not in proximity to any non-LOCA breaks. Therefore, manual operation will be possible prior to initiating RHR after an in-containment, non-LOCA HELB.

- No active components inside containment are required after a LOCA because suction is taken from the RWST and later from the containment sump.

- The only active component outside containment is the RHR pump. There are no breaks or cracks in the same cubicle as the RHR pump.

Therefore, no modifications are necessary to protect RHR equipment.

INSPECTION AT SARGENT & LUNDY OFFICES

CONCERN NO. 4

"The Sargent & Lundy pipe break and crack analyses do not consider loss of offsite power concurrent with a break or crack in nonseismic Category I piping, such as the fire protection system piping. A seismic event could be expected to damage offsite power equipment as well as cause breaks and cracks in nonseismic Category I piping. Sargent & Lundy stated that all nonseismic Category I piping in safety-related areas has seismic Category I supports and is, therefore, not postulated to break or crack as the result of a seismic event. Based on our internal staff review, we consider that you have not provided sufficient information to verify that nonseismic Category I piping in safety-related areas would not fail in the event of a safe shutdown earthquake (SSE). The use of Category I supports, by itself, would not ensure that this piping would remain intact in an SSE. You should provide additional information to justify the position that nonseismic Category I piping with Category I supports would remain intact in an SSE. Alternatively, you should re-evaluate the consequences of breaks and cracks in nonseismic Category I piping, using the assumption that an SSE could result in piping failure concurrent with loss of offsite power."

RESPONSE

Piping in the safety-related areas of the Byron plant falls into two categories:

1. Piping designed to the requirements of ASME Section III and supported to withstand seismic loads; and

2. Piping designed to the requirements of B31.1 and supported to withstand seismic loads.

Piping in either category which was designed using a specific stress analysis and demonstrated to be below allowable stresses at all points, was not considered to crack or break as a result of seismic events since this would be a nonmechanistic load combination. Cracks were postulated as initiating events in locations where the stress exceeded 40% of allowable in accordance with the Standard Review Plan Section 3.6.2. A limited amount of non-safety-related piping in safety-related areas has been designed by simplified methods and no specific stress analysis is available. Cracks were postulated at all fittings for this piping.