UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	Docket Nos. 50-454 OL
COMMONWEALTH EDISON COMPANY	)	50-455 OL
	)	
(Byron Nuclear Power Station,	)	
Units 1 and 2)	)	

MOTION TO REOPEN THE RECORD IN THE BYRON LICENSING PROCEEDING TO INCLUDE THE BYRON STATION DESIGN AS AN ISSUE

Intervenors move the Atomic Safety and Licensing Board to reopen the record in the Byron operating license proceeding to include the Byron station design as an issue. In support of their motion, intervenors submit a memorandum herewith.

DATED: September 12, 1984

Respectfully submitted,

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DOCKETED USNRC

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COMMONWEALTH EDISON COMPANY	)	50-455 OL
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(Byron Nuclear Power Station, Units 1 and 2)	)	

INTERVENORS' MEMORANDUM IN SUPPORT OF MOTION
TO REOPEN THE RECORD IN THE BYRON LICENSING PROCEEDING
TO INCLUDE THE BYRON STATION DESIGN AS AN ISSUE

Intervenors' motion to reopen the record to include the Byron design as an issue is based on new evidence made available to intervenors on August 20, 1984 during the hearing which concluded on August 24, 1984. The new evidence focuses on a recently completed Independent Design Review ("IDR") conducted by the Bechtel Power Corporation. Even though that design review examined only a limited portion of the Byron station design, it found numerous design deficiencies. As a result of these findings, there is a likelihood that design deficiencies of safety significance exist throughout the Byron station.

Intervenors have explicitly reserved the Byron station design as an issue in the reopened hearings. Intervenors have now completely reviewed the four volumes of the Bechtel IDR and are greatly concerned with the number of potentially safety-significant design problems found in the very limited review. The IDR, particularly when read in light of the NRC's earlier Independent Design Investigation ("IDI"), shows enough serious design defects at Byron that a complete and comprehensive idependent design review is warranted. Intervenors now request the Board to reopen the record to determine whether such a review should be conducted prior to issuance of an operating license for Byron.

A. <u>Bechtel's Independent Design Review</u>

The recently completed Independent Design Review, conducted by the Bechtel Power Corporation, reviewed the design relative to only three systems at the Byron station. The systems were: (1) the component cooling water ("CCW") system; (2) the essential service water ("ESW") system; and (3) the Class 1E 125 V dc distribution system. The review covered the identification/implementation of commitments and criteria; design adequacy; adequacy of the Sargent & Lundy design process, including evaluation of engineering judgments and assumptions, use of standard design methods and the adequacy of the documentation of design calculations; Sargent & Lundy's interfaces with Westinghouse and Nuclear Power Services; design change control; and Sargent & Lundy's design reviews.

Overall, Bechtel found the segments of the Byron station design it examined to be "adequate" and found none of its 49 potential observations or 35 valid observations to be "safety significant" -- based on an unduly restrictive definition of that term. However, Bechtel did find negative trends in the analysis of the observations. The Bechtel report summarizes:

> There were some negative trends identified by the IDR team analysis of the apparent root causes of the observations requiring design or documentation changes for acceptable resolution. The trends observed were categorized into the following four areas:

. The use of undocumented judgments;

. Insufficient control of the FSAR;

. Insufficient review of changes;

. Noncompliance with Code requirements.

> These trends indicate that certain aspects of the design activities appear to have been controlled less systematically and rigorously than currently appropriate ...
>
> (Vol. I, pp. 3-4.)

Nonetheless, Bechtel concludes that "review of the specifics of the relevant Observations resulted in a judgement (sic) that these aspects are not sufficiently significant to justify further investigation." (Id. at 4.)

Bechtel's "judgment" on this point must be viewed in light of two factors which justify concern. First, Bechtel defined "safety significance" so restrictively that many discrepancies normally considered safety significant for NRC regulatory purposes are not categorized as such by Bechtel. Second, Bechtel reached its "judgment" despite the fact that its review substantiated certain highly critical observations made in the earlier NRC IDI report.

Bechtel's definition of "safety significant condition" -- on the basis of which it judged each deficiency to lack safety significance -- is as follows:

> A condition confirmed to exist which results in a loss of safety function <u>to the extent that there is a major reduction in the degree of protection provided to public health and safety</u>.
>
> (Vol. I, p. 8, emphasis added.)

This definition raises obvious questions -- not clearly answered by the Bechtel report -- about what constitutes a "major" reduction. How safety significant does a reduction have to be before it qualifies as "major"? By what criteria is this determined?

The definition also raises questions about the cumulative impact of numerous conditions, no single one of which, by itself, is adjudged to be sufficiently "major" to qualify as "safety significant" within Bechtel's definition. Bechtel found 35 valid observations -- 2 requiring design changes, 8 requiring FSAR revisions, and 13 requiring revision or development of other documents -- in its review of only three systems at Byron. (Vol. 1, p. viii.) How many valid observations, requiring how many design changes and other revisions, would be detected in a comprehensive design review of all major systems at Byron? What would be the cumulative safety significance of all such discrepancies? Is this Board satisfied that the cumulative impact of design deficiencies throughout the plant -- even assuming no single one to be "major" (whatever that undefined term means) -- would not collectively be "major"?

In contrast, no such restrictive definition of "safety significance" is, to intervenors' knowledge, normally used for NRC regulatory purposes. For example, NRC definitions of severity categories for both reactor operations and facility construction set forth five categories of severity. Unlike Bechtel's definition, the NRC categories do not exclude violations of minor safety significance (included as Severity Level V). (10 CFR, Part 2, App. C, Supplements I and II.)

The risk that design deficiencies of genuine safety significance would not qualify as such under Bechtel's restrictive definition is perhaps best illustrated by the IDR treatment of pressure problems in Byron's component cooling water ("CCW") system. (Observation Report 8.38, Vol. 1, pp. 25-26.)

Bechtel found that whereas the system's design pressure was only 150 psig, an S&L calculation showed peak pressure of 268.5 psig, and preoperational test results for a limited flow case showed a peak pressure of 158 psig. (Id. at 25.)

S&L's initial response was that the conditions resulting in these pressures in excess of design capacity were "not normal operating conditions." (Id.) This was hardly a comforting response. Safety problems are most likely to arise at nuclear power plants precisely when conditions are not "normal."

However, when S&L conferred with Westinghouse (the CCW system designer) about the pressure problem, Westinghouse identified two inleakage events (a letdown heat exchanger tube leak or a reactor coolant pump thermal barrier leak) either of which would generate "resultant system pressure well in excess of the 150 psig system design pressure." (Id. at 26.)

As a result, Westinghouse reported the problem to the NRC, "and design modifications have been initiated which will satisfactorily maintain system pressure below the 150 psig design pressure during the postulated inleakage conditions." (Id.)

Bechtel itself notes, "Although initially not judged as potentially safety-significant by the IDR team, this Observation was later determined by Westinghouse to be reportable based on the Westinghouse design intent of continued operation after primary leakage into the CCW system." (Id.)

Despite all this, Bechtel's IDR nonetheless reports, "None of the Observations is regarded as safety-significant by the IDR team, although some observations did require further design activity or commitments to future action by S&L for IDR resolution." (Vol. I, p. 3, emphasis added.)

The logic by which Bechtel concludes that excess CCW pressure has no "safety significance" is not readily apparent. Perhaps Bechtel means simply that the forthcoming design changes will obviate the problem. But under that logic, no design review would ever detect a "safety significant" problem, so long as the applicant agreed to remedy the particular deficiency.

In fact, Bechtel's procedure for determining safety significance seems to encourage precisely such logic (or illogic). The IDR states:

> Where deficiencies were determined to exist, Sargent & Lundy's proposed corrective action was reviewed for appropriateness for both specific and general corrective actions. A determination was then made as to whether a safety significant condition existed.
>
> (Vol. 1, p. 6, emphasis added.)

In other words, a potential deficiency was found, corrective action was reviewed, and only then was a determination of safety significance made. This has the effect of masking deficiencies which are safety significant (even under Bechtel's restrictive definition), because the determination is not made until after any necessary design changes are initiated. For this additional reason, one cannot extrapolate from Bechtel's failure to find deficiencies of safety significance that there are none at Byron. */

Bechtel's "judgment" that none of its observations are safety significant is also questionable in light of Bechtel's substantiation of certain earlier NRC findings in the IDI. With respect to high energy line breaks/moderate energy line breaks ("HELB/MELB"), Bechtel's final report states:

> The NRC's IDI had already identified a concern regarding the inadequacy of the documentation to demonstrate full compliance to FSAR commitments for HELB/MELB protection. The initial discussions with S&L confirmed the documentation status situation identified by the IDI.
>
> (Vol. I, p. 52.)

The actual "concern" raised by the IDI had been stated somewhat more forcefully by the NRC. The NRC's IDI had concluded:

> In the mechanical systems area there were deficiencies in the analyses related to postulated cracks and breaks in high and moderate energy lines and internal flooding. The effects of postulated cracks in moderate energy lines had not been examined (Finding 2-17) and the effects of jets from postulated breaks in high energy lines had not been examined (Finding 2-16). In both cases, there are specific licensing commitments to provide appropriate protection. The design cannot be adequate until the effects have been systematically examined and protection has been provided where the examination indicates that it is necessary. For the moderate

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*/ At page vii of the executive summary of the IDR, Bechtel contends that there is a sound basis for some extrapolation of the results of the system reviews to other areas outside the scope of their limited review.

> energy crack effects, it did not appear that the work was programmed to be done. For the high energy break jets, Sargent & Lundy personnel indicated that they had intended to do the work later; however, the team was concerned because it was late in the project and this work was not addressed in formal Sargent & Lundy instructions for the Byron and Braidwood project.
>
> (IDI, p. 1-4.)

Other IDI findings critical of S&L are discussed below. Together they place the Bechtel findings in a perspective that suggests the design problems at Byron are <u>at least</u> as significant as Bechtel's understated characterizations make them appear to be.

Even accepting Bechtel's restrictive definition of "safety significance" for the sake of argument, the IDR nonetheless raises questions about the adequacy of S&L design documentation practices. Bechtel's IDR identified:

> several underlying, or root, causes, the absence of any one of which would most likely have averted the Observations. They are as follows:
>
> 1. When the work was performed there was insufficient recognition of documenting activities and conforming changes.
>
> 2. Cognizant personnel were permitted to make interpretations of requirements and commitments, so that meeting the intent rather than complying with the strict interpretation of codes and standards was acceptable.
>
> From documents seen and discussions held during the review, it appears these conditions are being changed by S&L for ongoing and future work. Further, it is important that the threshold of acceptability in these matters is significantly higher now, than when much of the work was performed.
>
> (Vol. I, p. 66.)

One essential problem identified by Bechtel is that S&L's inadequate documentation makes it difficult to review S&L's engineering judgments. Thus, the Bechtel IDR continues,

> The S&L use of engineering judgements is also complicated by the fact that when these judgements have been employed in the past, they are sometimes not adequately documented such that even an "independent," knowledgeable reviewer can determine when a judgement was made or the basis for that judgement. In several instances this required the IDR reviewer to request extensive analysis and documentation to establish the design adequacy. In response to recent documentation concerns, S&L has committed in the future to document, in general, the engineering judgment and its basis.

(Id.)

While the IDR goes on to note that those S&L engineering judgments questioned by Bechtel proved adequate, at least following re-analysis or revised calculations (id. at 67), this judgment must be viewed in light of Bechtel's overly restrictive definition of "safety significance."

S&L's documentation deficiencies are especially significant for NRC regulatory purposes -- including any authorization of a Byron operating license. As Bechtel recognizes, "The FSAR is the principal document by which the applicant provides information to the NRC regarding plant safety." (IDR, Vol. 1, p. 67.) Yet, although Bechtel found no intentional neglect or purposeful misconstruction of the FSAR, Bechtel's observations "indicated that the FSAR did not accurately reflect the actual design or that certain FSAR design statements were not fully incorporated into the design ..." (Id. at 68.)

Again, Bechtel perceived no safety significance in these FSAR discrepancies (id.); again, its judgment on this point is questionable in light of its restrictive definition of safety significance. So, too, for Bechtel's conclusions that design change control "imperfections" (id.) at 69) and code noncompliances (id. at 70) were not safety significant. And even Bechtel acknowledges that this judgment about code noncompliances "should not be construed as meaning that code noncompliances are an acceptable means of design ...." (Id. at 70.)

In short, the 35 valid observations found by Bechtel in only three systems at Byron suggest that many more design deficiencies exist throughout the plant -- awaiting detection and remedy.

B. Nuclear Regulatory Commission's Byron Integrated Design Inspection

The NRC Office of Inspection and Enforcement conducted an inspection of a sample portion of the Byron station design on May 23-June 10, 1983 and June 20-June 30, 1983 (IDI). The Bechtel IDR was apparently part of Edison's response to the IDI. The IDI focused on the auxiliary feedwater system as a selected sample. The IDI activities included examination of procedures, records, training and inspection of the system as installed at the plant. The auxilliary feedwater system examination was broken down into the mechanical systems; mechanical components; civil and structural; electric power and instrumentation and control.

Overall, the IDI team found many significant problems in its limited investigation of the feedwater system design at the Byron station. There were trends of the use of undocumented judgments; insufficient control of the FSAR; insufficient review of changes; and instances of noncompliances with code requirements. While the IDI did conclude that its concerns relate "primarily to the documented bases and calculations supporting the design rather than the design itself" (IDI, pp. 1-5, 1-6), it also found significant problems with the design analyses for HELB/MELB (id. at 1-4, 1-6) which led in part to the Bechtel IDR.

A review of the feedwater system revealed deficiencies in the analysis related to postulated cracks and breaks in high and moderate energy lines and internal flooding, as discussed earlier in this memorandum (pp. 7-8 above). Problems were also noted in design calculations within the mechanical design system such as the calculations concerning net positive suction head available for the auxiliary feedwater pumps which contained numerous deficiencies and did not support the adequacy of the design. (IDI, p. 2-6.) The IDI team also found a calculation concerning flow measuring orifices in the auxiliary feedwater recirculation line, that had been signed as reviewed and approved although the calculation had not been completed (IDI, p. 2-6).

The investigation also revealed many instances of failure to meet licensing commitments in addition to defects found within calculations. In work performed by Westinghouse Electric Corporation, in which a sample package was analyzed by the IDI team, several deficiencies were found. (IDI, p. 1-6.) "In one instance a change in support locations led to a substantial increase in the piping's seismic response. In effect, this increase was estimated by using a sample ratio of span lengths, which was not accurate or conservative." (IDI, p. 1-6.) Overall, the IDI team concluded, the Westinghouse sample was too small to permit conclusions although it did raise significant questions. The IDI team recommended that further examination of the Westinghouse work be undertaken to determine whether systematic weaknesses are indicated. (IDI, p. 1-6.)

The following is merely a sample of some of the design-related deficiencies found by the IDI team in the feedwater system (broken down by component areas):

<u>Mechanical System</u>

(Findings 2-16, 2-17, p. 2-15)

[Quoted above at pp. 7-8.]

(Findings 2-8, 2-9, p. 2-8):

> FSAR Section 6.5.2 provides a detailed discussion of the NPSH required and available for the B train containment spray pump. This discussion was extensively revised in January 1979. No calculation was available to support the revision. PMD personnel stated that, for this revision, an updating of CS-5 had been performed; however, it could not be located during this inspection. A calculation should have been performed to support the FSAR description changes. The lack of an available calculation was contrary to Procedure GQ 3.08 (Reference 1.36), which states that revisions to design calculations shall be prepared, reviewed and approved in accordance with the requirements in GQ 3.08 for the original design calculations. (Finding 2-8)
>
> In addition, the following discrepancies were noted in relation to the FSAR discussion: (1) the length of 24-in. piping is indicated to be 69 ft., whereas it is 85 ft. in the current design; (2) a 16-in. gate valve in the current design was omitted; and (3) there is no consideration of partial

blockage of the screen, in accordance with Regulatory Guide 1.82. Although these specific items did not constitute deficiencies of technical significance, the FSAR description and the design should be consistent. (Finding 2-9)

(Finding 2-11, p. 2-9):

We found several different values used for the auxiliary feed pump discharge piping maximum pressure, as follows:

(1) Design criteria 2080psig

(2) Mechanical Department piping line list (an uncontrolled document) .... 2080 psig

(3) Piping contractor wall thickness calculation (Reference 2.65) ..... 1830 psig

(4) S&L wall thickness calculation (Reference 2.8) .... 1750 psig

The wall thickness calculations were based on non-conservative values. In addition, Sargent & Lundy had not performed a calculation to determine the maximum anticipated pressure of the system and assure that it does not exceed piping capability. The latter is contrary to the ASME Code, Section III, Subsection ND-3612.4, which states that pump discharge piping shall be designed for the maximum pressure exerted by the pump.

<u>Mechanical Equipment</u> (Finding 3-9, p. 3-15):

The qualification report (Reference 3.61) showed that the vendor used the forces and moments that were given in paragraph 115.10 of the specification for the suction and discharge nozzles incorrectly. This happened because the specification failed to properly define the coordinate system for the forces and moments. The X direction was intended to be along the axis of the pipe/nozzle interface, but the vendor assumed it was parallel to the pump shaft. <u>The vendor's static analysis (Report K-479) which showed the incorrect usage of these forces was reviewed and approved by Sargent & Lundy in Reference 3.61</u>. (Finding 3-9) (Emphasis added)

Civil and Structural (Findings 4-1, 4-2, pp. 4-5, 4-6):

In Section 11.0, page 11-4 contains a listing of transverse loads to be considered in the design of walls. This list omits horizontal seismic inertial loads, wind loads, and tornado differential pressures. This is not appropriate. It is considered to be a failure to follow Procedure GQ-4.04 of the Sargent & Lundy Quality Assurance Manual (Reference 1.36). The preparer of the design criteria did not include all "applicable design inputs" in that numerous horizontal loading sources were not listed within the list of transverse loads to be considered for wall design. (Finding 4-1)

In view of the inappropriate criteria, in our judgment, a systematic check of all walls to see that all loads were considered should be made in resolving this item.

On page 11-5 it is stated that the shear friction concept shall be used to calculate the reinforcement required for transverse shear. This would allow the use of only horizontal and vertical reinforcing steel near the face of the wall. Such an approach is contrary to Section 11.15.1 of ACI 318-71 (Reference 4.72) which the licensee committed to meet in FSAR Table 3.8-2. This Code states that shear friction ... "provisions apply where it is inappropriate to consider shear as a measure of diagonal tension." Since it is not inappropriate to consider shear as a measure of diagonal tension in these walls, the code requires consideration of diagonal tension with transverse steel provided as needed. This conflicting information between the FSAR and the design criteria is contrary to the provisions of GQ-3.04, Design Criteria, of the Sargent & Lundy Quality Assurance Manual (Reference 1.36). The preparer failed to incorporate the design criteria cited by the licensee in the FSAR within the project structural design criteria. This was a failure to reference "applicable design inputs in the design criteria." (Finding 4-2)

We noted one wall calculation where transverse steel had been added, indicating that the designer had not taken advantage of the criteria. However, in view of the lack of written guidance, we can not preclude the possibility that elsewhere designers might have omitted the transverse steel required by ACI 318-71. If this did happen, it could represent a significant technical deficiency.

Accordingly, in our judgment, a systematic check of all walls should be made in resolving the above finding.

The importance of the above findings for purposes of this motion is not any particular issue raised by these individual deficiencies, but rather the overall context they depict, in which the Bechtel IDR must be viewed. Based on the IDI review of the auxiliary feedwater system and the IDR review of the CCW, ESW, and Class 1E 125 V dc distribution systems, a consistent picture emerges which, if extended plantwide, suggests the need for a comprehensive design review prior to issuance of an operating license. That picture is one in which S&L's engineering judgments are, at best, often poorly documented. While most of the judgments, upon examination, appear nonetheless to be sound, some do not. And some of those, such as S&L's initial response to the CCW pressure problem discussed at pp. 5-6 above, fail to recognize problems of genuine safety significance -- regardless of whether they might be so characterized by Bechtel.

In sum, in their design review of a very limited portion of the plant, the IDR and IDI have revealed enough questionable design-related practices that a comprehensive design review is needed before there can be reasonable assurance that Byron can be operated safely.

C. Standards for Reopening the Record

As summarized in numerous cases, the standards for reopening the record are that: (1) the motion is timely; (2) significant new evidence on a safety question exists; and (3) the new evidence might materially affect the outcome. */

The significance of the deficiencies found in the IDR and the effect these findings might have on the outcome are apparent. If a sampling as small as that covered in the IDR reveals as many potentially safety-significant design deficiencies as did the IDR, then surely plantwide design information may affect the outcome of this proceeding. The question of timeliness is judgmental. As stated earlier, Intervenors were served with Bechtel's IDR on August 20, 1984, a mere four days before the hearing ended. The IDR consisted of four hefty volumes, requiring careful examination and evaluation prior to preparation of this motion. Fifteen working days is not an excessive amount of time for these purposes. Intervenors respectfully request that, based on the standards to reopen the record and Intervenors' showing, the Board reopen the record in this proceeding to receive evidence on the design of Byron.

CONCLUSION

For the foregoing reasons, Intervenors move this Board to reopen the record to include the Byron design as an issue in this proceeding, and specifically to address the question whether, in light of the IDR and the IDI, a comprehensive review of the Byron

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*/ E.g., Pacific Gas & Electric Co. (Diablo Nuclear Power Plant, Units 1 and 2) ALAB-598, 11 NRC 876, 879 (1980).

design is warranted prior to issuance of an operating license for Byron.

September 12, 1984

Respectfully submitted,

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BYRON STATION

INDEPENDENT DESIGN REVIEW
FOR
COMMONWEALTH EDISON COMPANY

FINAL REPORT

VOLUME 1

AUGUST 1984

BECHTEL POWER CORPORATION

EXECUTIVE SUMMARY

Background

This Final Report, dated August 1984, covers the work performed under the Independent Design Review (IDR) for the Byron Generating Station, Units 1 and 2, of Commonwealth Edison Company. The purpose of this review was to provide an additional level of confidence in the adequacy of the design of the Byron Station by Sargent & Lundy Engineers (S&L).

Under the IDR, Bechtel Power Corporation was engaged to review the S&L design of three selected safety systems for adherence to design requirements, for technical adequacy, for adequacy of the design process, and to draw broader conclusions as appropriate.

The systems selected for review were the essential service water (ESW) system, the component cooling water (CCW) system, and the 125 Volt dc distribution system. Included in the review are facilities for supporting and enclosing the systems (e.g., structures) and for serving the systems (e.g., electric power supply and control systems), and requirements for protecting the systems against external effects (e.g., high energy line breaks/fire protection). The review did not include other systems, verification of physical installations, or reviews of the designs of other contractors.

The IDR was performed by a dedicated team of qualified personnel in accordance with the Bechtel Program Plan dated April 1984. The Plan includes an approved Quality Assurance program.

Activities

The IDR effectively began on April 17, 1984. The completed work is documented in this Final Report.

A strategy was chosen whereby the selected systems would initially be reviewed on an overall basis for familiarization and to determine which areas should receive greatest attention. These areas were reviewed in greater depth in the latter stages of the IDR. Appendices A through D identify the areas reviewed and document the depth of review. Also, particular attention was given to the areas of design for high energy line breaks (HELB), moderate energy line breaks (MELB), and fire protection.

Work completed and reflected in this Final Report covered almost a 4-month period of detailed review and investigations. The IDR team expended approximately 15,000 total manhours and reviewed more than 1165 documents. In the process of identifying Observations, approximately 2120 points of evaluation were assessed.

All Observations have been closed out by the IDR team based on establishing, to the satisfaction of the team, that adequacy exists in the present design, or that committed resolution actions will provide assurance of design adequacy.

Results

A total of 49 potential Observations were identified. Of these, 35 Potential Observation Reports were ruled valid and forwarded as Observation Reports to S&L for response. Also, 14 Potential Observation Reports were determined not to be valid by the Level-1 Internal Review Committee, based on careful consideration of the scope of the IDR and interpretation of the Byron commitments and design. Of the 35 valid Observations, all are considered resolved on the basis of responses or corrective action committed to by S&L. Two invalid Observations were judged to have potentially broader implications for non-IDR scope systems, but were considered resolved based on additional information provided by S&L.

There were very few Observations made in comparison to the large number of design details, documents, and criteria reviewed. None of the Observations is regarded as safety-significant by the IDR team, although some Observations did require further design activity or commitments to future action by S&L for IDR resolution. In one case, the adequacy of the CCW system design pressure was questioned; this resulted in Westinghouse conservatively reporting the situation to the NRC and in a design change being initiated.

A summary of these results is shown in Table 1.

There were some negative trends identified by the IDR team in an analysis of the apparent causes of the Observations requiring design or documentation changes for acceptable resolution. The trends observed were categorized into the following four areas:

- The use of undocumented judgements;
- Insufficient control of the FSAR;
- Insufficient review of changes;
- Non-compliance with Code requirements.

These trends indicate that certain aspects of the design activities appear to have been controlled less systematically or rigorously than currently appropriate. However, review of the specifics of the relevant Observations resulted in a judgement that these aspects are not sufficiently significant to justify further investigation.

An intensive HELB review was made, but did not uncover significant, specific deficiencies in design adequacy. It is expected that the S&L review program will provide assurance of adequate HELB protection for jet effects elsewhere and will alleviate some identified concerns regarding design process.

The changes to procedures, documents, or components which were made as the result of an Observation were generally minor in nature and, if the change had not been made, the IDR team believes that there would not have been a significant reduction in the degree of protection provided to the public.

Generally, the IDR team found that the design work reflected acceptable standards of technical adequacy and design process, and that the apparent intent of key licensing commitments was consistently met.

The IDR additionally found that S&L has an established design process on the Byron Project by which design activities are generally performed in an adequately controlled manner. Since the review also encompassed S&L design work across a broad spectrum, there is a basis for critically extrapolating the conclusions from the review areas within the IDR scope to a broader conclusion. This provides further confidence in the overall design of the Byron Station.

Conclusions

Based upon the results of this review, it is the opinion of the IDR team that the design of the systems reviewed is adequate. Also, the team has been able to conclude that S&L has an established design process on the Byron Project by which design activities are performed in a sufficiently controlled manner, and there is a sound basis for some extrapolation of results of these system reviews to other areas outside the scope of this independent design review. Accordingly, the IDR team also believes that the results of this review provide support for a conclusion that there is reasonable assurance that the overall design of the Byron Station is technically adequate.

TABLE 1

RESULTS SUMMARY

POTENTIAL OBSERVATION REPORT ACTIONS

Item	Number
1. Total PORs	49
Invalid PORs	14 (1)
Valid PORs (ORs)	35
2. Resolutions of ORs	
Design Changed (2)	2
FSAR Revised (3)	8
Other Documents Revised or Developed (4)	13
No Further Action Needed (5)	12

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(1) Includes one POR which was combined.
(2) ORs 8.9, 8.38
(3) ORs 8.1, 8.3, 8.4, 8.6, 8.14, 8.23, 8.27, 8.47
(4) ORs 8.2, 8.5. 8.10, 8.16, 8.24, 8.31, 8.34, 8.35, 8.36, 8.41, 8.42, 8.44, 8.49
(5) ORs 8.17, 8.19, 8.21, 8.22, 8.25, 8.28, 8.29, 8.32, 8.37, 8.39, 8.40, 8.45

Section 1

INTRODUCTION

1.1 PURPOSE

Commonwealth Edison Company (CECo) requested Bechtel Power Corporation (BPC) to conduct an independent design review (IDR) of the Byron Station, Units 1 and 2. The purpose of this IDR was to provide an additional level of confidence in the design of the Byron Station through a review of selected systems and the design process employed by the architect/engineer, Sargent & Lundy Engineers (S&L).

This Final Report documents the results of the IDR.

1.2 SCOPE

The scope of the IDR was to review the design of the component cooling water (CCW) system, the essential service water (ESW) system, and the Class 1E 125 V dc distribution system. The system boundaries are as generally described in the FSAR. The review covers the design work done by S&L and their interfaces with others performing design work, such as Westinghouse (W) and Nuclear Power Services (NPS). The review of the three systems included mechanical process design; piping design, including stress analysis; electrical design; instrumentation and control systems design; civil/structural design; heating, ventilating and air conditioning (HVAC) design; support design for piping, electrical conduits and trays, and HVAC ducts; equipment and valve qualification; relevant nuclear engineering; and other design considerations, such as fire protection and high and moderate energy line breaks (HELB and MELB). The design of Unit 2 was reviewed to the extent necessary to determine that common systems are adequate and the quality of design is consistent with that of Unit 1.

The review of the three systems included the following:

1. Identification/implementation of commitments and criteria;
2. Design adequacy;
3. Adequacy of the S&L design process, including evaluations of engineering judgements and assumptions, use of standard design methods and the adequacy of the documentation of design calculations;
4. S&L design interfaces with W and NPS;
5. Design change control; and
6. S&L design reviews.

The review by scope did not include reviews of non-scope systems, verification of physical installations, or reviews of the designs of other contractors. However, several site visits were made by reviewers to examine the design change process in the field. Any viewing of implemented design was incidental and not a part of the review process.

The IDR was limited to S&L design work completed by April 1, 1984, although some S&L work in progress after this date was considered. Where such work was considered, this report identifies it in the Appendices.

1.3 RESULTS

The IDR completed its review of systems in the scope for engineering discipline activities of functional areas of design, and of design interfaces. These efforts were directed not only toward making a thorough assessment of the systems reviewed, but also toward drawing broader conclusions to the extent warranted.

More than 1165 documents have been reviewed. Approximately 15,000 manhours have been expended and 2120 points of evaluation assessed by the IDR team (see Appendices A through D).

From all of the material reviewed, a total of 49 Potential Observation Reports (PORs) were prepared. Of these, 14 were determined to be invalid and 35 were valid. Each of the valid Observation Reports (ORs) has been resolved to the satisfaction of the IDR team. A listing of potential Observations is given in Table 2, along with their respective status.

The resolutions of the ORs required minimal changes in design and other documents, including licensing documents. These resolutions covered not only each specific OR, but had broader implications as well. The nature of the ORs and their resolutions are given in Section 2.

An interpretation of the results is also provided in Section 2, as well as in Section 4. These interpretations indicate that the Observatons relate to a minor portion of the overall design, and there has been none which is safety-significant.

None of the Observations is regarded as safety-significant by the IDR team, although some Observations did require further design activity or commitments to future action by S&L for IDR resolution. In one case, the adequacy of the design pressure of the CCW system was questioned and resulted in Westinghouse conservatively reporting the situation to the NRC and in a design change being initiated. Also, particular attention was given to the areas of design for high energy line breaks (HELB), moderate energy line breaks (MELB), and fire protection.

There were some negative trends identified by the IDR team analysis of the apparent root causes of the Observations requiring design or documentation changes for acceptable resolution. The trends observed were categorized into the following four areas:

- o The use of undocumented judgements;
- o Insufficient control of the FSAR;
- o Insufficient review of changes;
- o Noncompliance with Code requirements.

These trends indicate that certain aspects of the design activities appear to have been controlled less systematically and rigorously than currently appropriate; however, review of the specifics of the relevant Observations resulted in a judgement that these aspects are not sufficiently significant to justify further investigation.

Generally, the IDR team found that the design reflected acceptable standards of technical adequacy and design process, and that the apparent intent of key licensing requirements was consistently met. The basis for this is described more fully in the body of this report, particularly in the assessments of system reviews and of extensions to unreviewed areas.

1.4 DESCRIPTION OF THE REVIEW

This IDR was performed in accordance with the Bechtel Program Plan dated April 1984, which included an approved quality assurance program.

The program was structured to review design requirements, design adequacy and the design process, and then to make overall assessments based on these reviews. Major emphasis was placed on the adequacy of the final product. The strategy was to perform an initial overview to an appropriate depth so as to identify those areas requiring further review. This determination was made based on the acceptability of overview results plus reviewer experience. If acceptability was not immediately apparent, the area was reviewed in greater detail until acceptability was resolved. Appendices A through D denote the areas selected for review within each engineering discipline, and indicate the depth of review in the various areas.

When document reviews and/or discussions with S&L personnel did not provide results acceptable to the reviewer, a Potential Observation Report was prepared and processed in accordance with the corresponding project procedure. Where an Observation Report was processed, the nature of the situation was noted. This information was collected and reviewed as it developed to provide guidance for additional investigations.

The basic results of the reviews are described, in detail, in Appendices A through D. The scope and methodology of program tasks are provided in the Program Plan as are the team organization, strategies employed and the Quality Assurance Program. The detailed summary of all evaluation points is also provided in Appendices A through D. Some of these evaluations eventually resulted in the generation of Observation Reports.

A cross-reference is provided in Table 3 between activities in the Program Plan and this Final Report.

As a key function of the IDR, individual reviewers, in consultation with the responsible team leaders, generated Potential Observation Reports, when they were unable to accept existing design. These PORs were then submitted to the Level-1 Internal Review Committee for review and initial disposition. This initial disposition was a determination of whether the condition identified by the reviewer constituted a valid, new and meaningful Observation for the scope of the IDR. For valid Observations, the Level-1 Internal Review Committee judged whether the identified condition was potentially safety significant, in which case it would require referral to the Level-2 Internal Review Committee. Invalid Observations were also considered as to whether the noted condition, were it likely to occur in a safety-related system, would constitute a safety-significant deficiency.

Valid Observations were forwarded to S&L with the objective of gathering additional, clarifying information to confirm or deny the existence of apparent deficiencies. Where S&L determined that the Observation was correct, the S&L response included proposed corrective action, both for the specific IDR-scope system deficiency and for other potentially affected systems. In many cases, S&L provided calculations for the purpose of demonstrating design adequacy. It was usually considered more practical to have S&L perform such calculations for review by the IDR team, since S&L was the original designer and could generally perform such calculations more expeditiously. In some cases, the IDR team performed calculations where considered necessary.

S&L responses were reviewed by the IDR team and, where the information supplied was sufficient to reach a conclusion as to whether the cited condition corrected a deficiency, that evaluation was made. In other cases, more information was obtained from S&L. Where deficiencies were determined to exist, S&L-proposed corrective action was reviewed for appropriateness for both specific and general corrective actions. A determination was then made as to whether a safety-significant condition existed. Also, as indicated in Section 4, General Assessment, trends were evaluated for Observations where changes were required to satisfactorily resolve those Observations, and broader conclusions were developed as appropriate, including possible generic implications.

The QA Program was employed to provide assurance that the IDR was performed in accordance with the approved procedures, that review results were documented appropriately and that these results were traceable to the observations and conclusions provided in this Final Report. The QA Program contained provisions for:

- A documented Quality Assurance Program, including training and indoctrination;
- Formal organization;
- Appropriate procedural coverage of review activities;
- Document control;
- Document turnover; and
- Auditing and monitoring of compliance with the QA Program Plan.

To implement the QA Program, the IDR Team Procedures Manual was prepared and issued containing all program documents and procedures. Only two audit findings resulted from several monitoring activities and the two audits conducted by the Project Quality Assurance Engineer. No findings were made during one CECo audit of Bechtel's efforts; and no findings were made by the NRC during two inspections of the Byron IDR. The CECo audit did produce a recommendation that, prior to Final Report issuance, it be confirmed that all relevant commitments have been addressed, and acceptable resolution was documented.

1.5 ORGANIZATION AND STAFFING

The personnel comprising the IDR team were primarily from BPC's San Francisco Power Division; a listing of these team members is included in the Program Plan. Additional short-term assistance was provided by specialists from the San Francisco Power Division and Corporate management. The IDR team met the CECo requirements for independence as specified in the letter dated April 12, 1984, from Messrs. B.R. Shelton and R.E. VanDerway to Mr. P. Karpa.

1.6 ACTIVITIES

Activities of the IDR team were formally initiated on April 17, 1984, by a joint meeting with CECo and S&L. Meetings were held in the S&L offices in Chicago to familiarize the IDR team with S&L's organization, as well as with the S&L personnel responsible for designing the systems being reviewed; to provide an overview of the systems being reviewed; to clarify the scope of the IDR and how it was to be conducted; and to obtain further orientation regarding available design information.

The FSAR and specific design documents were first selected by the IDR team and reviewed. Then discussions were held with S&L. In addition, some members of the IDR team visited the Byron jobsite to meet with S&L site personnel to review their design process, their interface with the S&L office in Chicago, and their interface with NPS.

An Interim Report was issued in May 1984 containing results to that date. A second Interim Report was released in June 1984, providing results to date on the high energy line break/moderate energy line break reviews.

Document reviews and discussions with S&L personnel were conducted, on an essentially continuous basis, until the Final Report was issued in early August 1984. A list of significant meetings with S&L is provided in Appendix F. Formal correspondence and relevant correspondence are available in the files of the IDR team.

1.7 DEFINITIONS

Observation - A condition wherein the IDR Level-1 Internal Review Committee believes there may be a failure to meet licensing commitments or other safety-related design requirements, or a deficiency in the design process may exist

Potential Observation Report (POR) - A preliminary internal report for the documentation of an Observation

Observation Report (OR) - Level-1 Internal Review Committee documentation of its evaluation of an Observation

Resolution Report - Documentation of the resolution of an Observation

Completion Report - Documentation of action taken (disposition) to complete the review effort associated with an Observation

Level-1 Internal Review Committee - A committee made up of key IDR team members

Level-2 Internal Review Committee - A committee made up of senior members of Bechtel Power Corporation who are not part of the IDR team

Safety Significant Condition - A condition confirmed to exist which results in a loss of safety function to the extent that there is a major reduction in the degree of protection provided to public health and safety

Root Cause - The predominant cause of those causes resulting in a deficiency.

Resolution:

All reviewed standard components are set within manufacturer's recommended range and, therefore, have significant margin for piping movement. Reviewed piping stress reports indicate relatively small seismic movement. Thermal movement has been taken into consideration in determining the acceptability of the limit on swing angle. As noted in S&L responses to OR 8.37 and OR 8.44, system walkdown during hot functional test indicates insignificant thermal effect on system operability.

The resolution is acceptable to the IDR team and the Observation is closed out.

The Observation is not safety-significant, since the S&L design and walkdowns during hot functional testing will adequately address operability.

Observation Report 8.38

Observation:

The CCW system design pressure is 150 psig, but an S&L calculation showed a peak pressure of 268.5 psig, and preoperational test results for a limited flow (3,000 gpm) case resulted in a peak pressure of 158 psig.

Resolution:

S&L responded that the conditions resulting in calculated peak pressures in excess of 150 psig were not normal operating conditions. Rather, they were the result of efforts to evaluate system capability for very abnormal conditions which could result in potential overpressure on the system. The preoperational test condition which produced the low flow situation was an abnormal condition established to check the pump curve. S&L also noted the 150 psig design pressure was established by Westinghouse, the CCW system designer. S&L used the Westinghouse design values.

However, S&L noted that, in the process of resolving the Observation by conferring with Westinghouse, Westinghouse determined that a design objective of the CCW system was to continue to operate after a letdown heat exchanger tube leak or reactor coolant pump thermal barrier leak (i.e., both cases resulting in high pressure reactor coolant leakage into the CCW system). The inleakage could result in automatic isolation of the surge tank vent due to high radioactivity, causing an increase in system pressure. The surge tank is protected by a relief valve (100 psig set pressure) but the increased pressure condition would produce a substantially increased pump suction pressure and a resultant system pressure well in excess of the 150 psig system design pressure.

The IDR team was advised that Westinghouse reported this to the NRC, and design modifications have been initiated which will satisfactorily maintain system pressure below the 150 psig design pressure during the postulated inleakage conditions.

The IDR team finds the response technically acceptable, and the Observation is closed out.

Although initially not judged as potentially safety-significant by the IDR team, this Observation was later determined by Westinghouse to be reportable based on the Westinghouse design intent of continued operation after primary leakage into the CCW system. The resolution process has resulted in submittal by Westinghouse of a report to the NRC, and subsequent design change. There is no reason to expect this situation is cause for a significant concern elsewhere.

Observation Report 8.41

Observation:
The S&L design process does not require calculation of the starting voltages at the terminals of MOV operators on simultaneous start of all

Section 3

PROGRAM

3.1 REVIEW FOR IDENTIFICATION/IMPLEMENTATION OF COMMITMENTS AND CRITERIA

One of the first tasks of the IDR program was to review the Byron FSAR and other pertinent documents to determine and identify licensing commitments and safety-related design requirements applicable to the systems selected for review. In addition to the FSAR, a review was made of the Byron SER (NUREG-0867, Feb. 1982), the Fire Protection Report, and the Environmental Report. As a result of these initial reviews, a set of commitment lists was developed. These lists were used and expanded as necessary by the various IDR team members to form the basis for determining if the Byron system designs meet the specified licensing commitments and design requirements. The commitments addressed as applicable to the reviewed systems are reflected in Appendices A-1 (CCW), B-1 (ESW), and C-1 (Class 1E 125 V dc). Commitment reviews for selected safety requirements common to the three selected systems (i.e., high energy line break (HELB), fire protection, and non-seismic/seismic systems interaction) were also made and used by the IDR team and are reflected in Appendix D-1. From the commitment lists plus the reviewers' experience with and knowledge of likely problem areas, along with an awareness of potentially weak areas identified by the NRC's Integrated Design Inspection (IDI), selected design requirements were evaluated for proper implementation. Requirements considered significant by the reviewers or for which a specific concern had been expressed were verified. In addition, when an individual reviewer determined that there were appropriate commitments in addition to those listed, the implementation of those commitments was pursued as appropriate.

Various design documents were reviewed to verify the implementation of design requirements. These documents included but were not limited to design criteria, drawings, calculations, specifications, project correspondence, and vendor documents. The methodology used to identify design requirements is given in Task-1 in the Program Plan.

3.2 REVIEW OF DESIGN ADEQUACY

Selected design documents for the three systems were reviewed for adequacy in meeting licensing commitments and safety-related design requirements. The total system design was reviewed including mechanical, nuclear, control and instrumentation, electrical and civil/structural aspects. Portions of other systems that service the three selected systems and other systems or accident effects that can affect the selected systems were also included in the IDR. Accordingly, the scope included auxiliary steel for support structures, electrical power and controls that uniquely serve a selected system, HVAC that must maintain a required environment for a selected system component, fire protection, and high energy line breaks/moderate energy line breaks (HELB/MELB).

Documents reviewed include design criteria, calculations, drawings, procurement specifications, ASME Section III Design Specifications, and CECo and vendor-furnished information.

The HELB/MELB review was unique. The NRC's IDI had already identified a concern regarding the inadequacy of the documentation to demonstrate full compliance to FSAR commitments for HELB/MELB protection. The initial discussions with S&L confirmed the documentation status situation identified by the IDI. Therefore, the IDR team tested the effectiveness of S&L's implementation (i.e., the design adequacy and compliance with commitments) by reviewing a significant number of FSAR-identified potential HELB locations which appeared to the reviewers to expose the CCW, ESW, or 125 V dc systems to pipe whip or jet effects. This review solely considered the effects on the systems based on the clearly established IDR scope. The IDR did not consider HELB/MELB effects on all components, equipment, or structures for all systems potentially affected by HELB/MELB situations. However, a review of potential break effects inside containment and in the auxiliary building, based on S&L break location information, was conducted for adverse effects on the systems within the IDR scope.

In the evaluation, it was conservatively assumed for the evaluated potential jet effects inside containment that the jet force from a circumferentially ruptured pipe would not cause loss of physical integrity of the "target" pipe where that target pipe was equal to or greater in diameter than the source pipe. Generic Bechtel calculations of equivalence to the Standard Review Plan 3.6.2 rationale for pipe whip supported this decision. Functionality after such an event was not evaluated. Because the reviewed systems are not high energy systems, pressure/temperature effects resulting from the postulated breaks were not evaluated consistent with the IDR scope. Also, it was readily established that, for the breaks postulated inside containment, no CCW or ESW related instrumentation tubing, instrument and electrical components, or cabling need remain functional after a HELB, and that none of the 125 V dc system was located inside containment. Therefore, adequacy of HELB design protection was not evaluated for these design features.

Jet effects were attributed to circumferential breaks only. Longitudinal breaks were not postulated in the high energy lines based on the S&L or Westinghouse stress analysis results, which permitted application of the regulatory exclusion of longitudinal breaks on a stress basis.

Validity of input data for instrument tubing span calculations is addressed in the Appendices. Compliance with applicable FSAR Chapter 7 commitment was reviewed, except that compliance with commitments in FSAR Section 7.5, "Safety Related Display Instrumentation" was not evaluated because, for Byron, the safety-related display system is a separate system and was not considered within the IDR scope. Also, the only portion of the IDR scope system to which Regulatory Guide 1.97, Rev. 2 is applicable is the Type D (information only) instrumentation for CCW flow and temperature. As such, these two variables constituted an insufficient sample basis from which to draw broader conclusions in the area of Reg. Guide 1.97 compliance. Further, SER Supplement 2 had already established substantial conformance to the regulatory guide. Therefore, compliance with Reg. Guide 1.97, Rev. 2 was not reviewed.

The specific areas identified for design adequacy review are indicated in Appendices A-2, B-2, C-2, and D-2 as are the conclusions of the individual points of evaluation. The areas identified also give clear indication of the depth of review judged pertinent by the appropriate reviewers. The methodology used to review for design adequacy is detailed under Task-2 in the Program Plan.

3.3 REVIEW OF THE DESIGN PROCESS

The IDR team reviewed the same three systems for design process as for adequacy and requirements process. Some conclusions drawn from these reviews may be applied to other S&L designs because these designs were developed using the same design process.

To assess the design process, the design activities considered included:

- o Adequacy of documentation of design calculations
- o Interface design control with Westinghouse and Nuclear Power Services
- o Design change controls
- o Design reviews for technical adequacy
- o Other elements of design control embodied in the FSAR and its referenced documents, such as:
    - Selection and documentation of design inputs
    - Documentation of design criteria
    - Preparation of drawings
    - Preparation of specifications
    - Control of design documents
    - Vendor document review
    - Coordination between disciplines
    - Equipment qualification.

At the outset, the fundamental concepts of a design process were established. Specifically, a design process is regarded as a sequence of design activities performed by an engineering group to document a design in a sufficiently correct, complete, and clear manner to permit the fabrication and/or construction of that design. There is a logic to the sequence of activities so that the output of certain activities serves as the input to other activities.

Also, it was recognized that various design processes contain elements unique to a particular organization, as well as many elements that are common to all organizations designing a product or facility. The process, for a given organization, develops over time into the "normal way of doing business." It is much more than the procedures providing compliance with an organization's QA program. Features of it are understood by senior members of the organization who know it intimately but may not have reduced it to writing. Consequently, it was necessary for the IDR team members to completely understand S&L's design process for nuclear power plants.

The procedures controlling the generation of design documents and which describe the performance of design activities, such as design reviews, were examined and related to the design process. In addition, these procedures were evaluated for compliance with the QA Program commitments for design control. Finally, selected design documents were reviewed for compliance with the requirements of the controlling procedures. The extent and specific results of these reviews are documented in Appendices A-3, B-3, C-3, and D-3.

The overall S&L design process is illustrated on Figure 3-1. It is particularly important to note that the Preliminary Design Group (PDG) is made up of senior-level personnel who have the benefit of many years of S&L experience in the design of power plants. Starting with unique client requirements, plus regulatory requirements, S&L design standards, and substantial relevant experiences, this PDG staff group established major parameters, produced the site layout, general arrangement drawings for all major equipment, piping, and loading diagrams using estimated equipment weights. The group received advice from the Structural Department staff on fundamental structural design, (e.g., concrete versus steel) and major pipe routing for pipe whip restraint design considerations. Typically, the PDG selects a previously designed plant which has been completed to use as a basis for the new design. For Byron, Zion was used as the baseline plant.

While the PDG developed these basic design documents, the project structure was formed by assigning senior-level Mechanical, Electrical and Structural engineers and a Project Manager. These groups developed design criteria, system-level documents, and structural designs. The end products of the design process are those documents required for procurement and construction, as well as supporting analyses and calculations. With the above as background, the design processes used for the three systems under review can be described.

The design process for the ESW system is typical for mechanical systems, but is somewhat unique in that it requires a significant civil/structural contribution. Consequently, ESW system review also illustrated the structural design process. The CCW system was conceptually designed by Westinghouse; the CCW piping and pipe supports were designed by S&L. Therefore, the CCW system design process reviewed by the IDR team was the S&L design process for piping systems and also provided insight into the S&L interface with Westinghouse.

The design process for the 125 V dc distribution system is a useful example of electrical system design. The design processes for the ESW, CCW piping and 125 V dc systems are illustrated in Figures 3-2, 3-3 and 3-4, respectively. Figure 3-5 provides similar information for the design process for the ESW system structural elements.

The process for the performance of high and moderate energy line break analyses (HELB/MELB) by S&L is described in an S&L internal memorandum dated 9/26/75, "Analytical Procedures for Meeting Separation and High/Moderate Energy Line Rupture Criteria," and by Project Instruction

PI-BB-38, "Pipe Whip Restraint Analysis, Design and Review." This latter document and "Interface Control Agreement, Westinghouse Piping and Structural Evaluation Program for the Byron Station, Unit 1 and Unit 2," Rev. 5, dated 10/25/83, also established W responsibilities in this area.

Each of the above processes contains basically the same design activities, i.e., preparation of design criteria, selection of input, performance of analyses or calculations, preparation of drawings and specifications, performance of design reviews, etc.

Also, valid Observation Reports have been examined for any indications of deficiency trends either in a particular design discipline (e.g., Mechanical), or in a particular design function (e.g., equipment qualification). Any such indications would have to be reviewed to determine if the design of those systems and structures not subject to IDR team review could be adversely affected by the deficiency trend noted. No such trends were detected.

As a result of this review, the IDR team concluded that the S&L design process is adequately documented in controlled procedures, complies with FSAR commitments, and its requirements are met.

.4 REVIEW OF DESIGN INTERFACES WITH WESTINGHOUSE (W) AND NUCLEAR POWER SERVICES (NPS)

The design interfaces between S&L and Westinghouse and between S&L and NPS, as applicable to the three systems, were reviewed to determine the adequacy of control by S&L of the flow of design information that passes between them and the other two organizations. Included in this review were the implementation of Westinghouse requirements with the S&L design and evidence that S&L requirements were incorporated in the NPS design. The adequacy of the Westinghouse and NPS designs was excluded from this review by IDR scope definition. In general, the methodology used for this review was similar to that used for the review of the adequacy of the design process.

The results of the review of design interfaces with Westinghouse and NPS are shown in Appendices A-4, B-4, C-4, and D-4.

3.5 REVIEW OF DESIGN CHANGE CONTROL

The control of design changes by S&L was evaluated first by interviewing selected S&L personnel to obtain a sense of the overall process. This evaluation included visits to the Byron jobsite to review, with S&L engineers, their activities as they related to design change control. With this understanding as a background, the procedures which control design changes, including revisions to existing documents, were reviewed for compliance with FSAR QA program requirements. Finally, selected documents involving design changes were reviewed for compliance with the above procedures. The extent and specific results of these reviews regarding design change control are documented in Appendices A-5, B-5, C-5, and D-5.

The specific results collectively indicate a change control process which meets appropriate QA requirements and is complied with.

3.6 REVIEW OF SARGENT & LUNDY DESIGN REVIEWS

S&L internal review reports were examined to assess the effectiveness of the S&L design review for the three systems and the review process in general. The methodology used for this review was similar to that used for the review of the adequacy of the design process.

The results of the review of S&L design reviews are shown in Appendices A-6, B-6, C-6, and D-6.

Section 4

GENERAL ASSESSMENTS

4.1 GENERAL

The results of the review work on the three systems may be extended to other areas outside this scope by recognizing common conditions. Then a critical extrapolation of the technical adequacy of the overall design may be made based an evaluation of the results of the IDR, on the nature of the design review conducted, and on the manner in which Sargent & Lundy performs engineering activities.

Specifically, this is permitted by circumstances of the review and of the way S&L performed its work. First, The IDR reviewed the broad spectrum of engineering design activities; activities which are similar for other safety-related systems, components, and structures. Secondly, the IDR reviewed the work of each major S&L engineering discipline; disciplines which contribute in a similar manner to the design of other safety-related systems, components and structures; also selected, complex interactions between them. Finally, S&L implemented an established design process on the Byron Project in which design activities were generally performed in a relatively consistently controlled manner for all systems, structures, and components.

4.2 TREND ANALYSIS

To determine if there were underlying or root causes for the Observations, the IDR team analyzed and classified them.

The result of the analysis indicated that the Observations were mostly related to the following causes: use of undocumented judgements; insufficient control of the FSAR; insufficient review of changes; or noncompliance with code requirements. The other causes appeared to be unique situations.

Table 5 shows a classification of what the IDR believes to be the causes of valid Observations resulting in corrective action. From this table, several trends can be discerned from the frequency of Observations compiled against each cause. Only those Observations which resulted in one of the following situations were considered in this analysis:

1. Those Observations which required a design change to resolve the concern.

2. Those Observations which required a change in documentation (including licensing documents) or procedures to resolve the concern, or where new documents must be created.

3. Those Observations which, in the opinion of the IDR, require additional analysis or revised calculations to resolve the concern or to satisfy a licensing commitment.

The remainder were eventually judged not to constitute a deficiency after evaluation of additional S&L input by the IDR team.

The results indicate that, although the overall design may be judged adequate, there are certain aspects of design activities which appear to be controlled less systematically and rigorously than currently appropriate. In the IDR analyses of the observations, there were certain deficiencies noted which appeared to stem from the same cause, and which indicate trends. However, conditions were subsequently found to be technically adequate and they are not sufficiently significant to justify investigation beyond what has been done or committed.

This analysis leads the IDR team to believe there are several underlying, or root, causes, the absence of any one of which would most likely have averted the Observations. They are as follows:

1. When the work was performed there was insufficient recognition of documenting activities and conforming changes.
2. Cognizant personnel were permitted to make interpretations of requirements and commitments, so that meeting the intent rather than complying with the strict interpretation of codes and standards was acceptable.

From documents seen and discussions held during the review, it appears these conditions are being changed by S&L for ongoing and future work. Further, it is important that the threshold of acceptability in these matters is significantly higher now, than when much of the work was performed.

The significance of the trends is discussed below.

Engineering Judgement

The extent to which engineering judgement is appropriate in the design process is, in itself, a matter of judgement and interpretation. In general, the use of judgement must be viewed in terms of the specific instances in which it is used and the potential consequences of its misapplication. The S&L use of engineering judgements is also complicated by the fact that when these judgements have been employed in the past, they are sometimes not adequately documented such that even an "independent," knowledgeable reviewer can determine when a judgement was made or the basis for that judgement. In several instances this required the IDR reviewer to request extensive analysis and documentaton to establish the design adequacy. In response to recent documentation concerns, S&L has committed in the future to document, in general, the engineering judgement and its basis.

Regarding the inappropriate use of judgement, the IDR did not discover a judgement which, when questioned, did not prove to result in a technically adequate present design. In several cases, S&L performed reanalysis or revised calculations, but in all cases their original judgement was verified as adequate based on the design adequacy of the system, structure, or component in question. It is the conclusion of the IDR that this verification of the use of judgement is not a coincidence. Qualified, experienced engineers made these judgements based on their previous experience and on generally sound technical reasoning. Further the S&L basic system designs were inherently conservative, generally possessing sufficient design margins which permitted successful use of engineering judgement.

In some cases, where the IDR believed that a judgement should be supported by a calculation or other documentation, S&L provided such documentation. In the context of an independent review, the documentation enabled the reviewer to establish a higher level of confidence in the design of the system in question. Such documentation is a regulatory or licensing requirement only to the extent required by Reg. Guide 1.64 and its referenced ANSI N45.2.11 Standard, or specific, applicable code requirements. The lack of it does not substantially reduce confidence in the safety of the plant or increase the risk to the public.

Based on the responses to individual Observations and the IDR review of the S&L design process, there is no reason to believe that similar use of judgement would not have been successful for other safety-related systems, structures, and components.

FSAR Control

The FSAR is the principal document by which the applicant provides information to the NRC regarding plant safety. As stated in NUREG-0800 (formerly NUREG-75/087), Standard Review Plan (SRP), the "...SAR must be sufficiently detailed to permit the staff to determine whether the plant can be built and operated without undue risk to the health and safety of the public. Prior to submission of an SAR, an applicant should have designed and analyzed the plant in sufficient detail to conclude that it can be built and operated safely." Although there were observations made which indicated that the FSAR did not accurately reflect the actual design or that certain FSAR design statements were not fully incorporated into the design, there was no indication that these cases represented a pervasive situation in the Byron FSAR and affected the safety of the plant.

The FSAR has not been intentionally neglected or purposefully misconstrued. It was used as a vehicle to present the basic design of the plant and to interface with the NRC; it was apparently not used as a design criteria document per se which needed updating and revisions on a constant basis. The Byron FSAR does, however, serve its intended purpose.

Use of the FSAR as a design requirement document necessitates understanding its limitations. One of the unique situations created by the requirements of an IDR is that a group of engineers generally not familiar with the specific and sometimes unique design criteria of a plant, are asked to perform a detailed review and to make a subsequent assessment. One of the readily available and convenient tools for basing this review is the FSAR. This is because the FSAR contains a wealth of information about a plant and because the NRC has used the document as a primary means of reviewing the plant. What is not often appreciated or judged in light of the overall design process is that the detailed design criteria or requirements of a plant are contained in thousands of other design documents (i.e., drawings, specifications, procedures) which are not fully described or detailed in the FSAR. At certain times in the design process, these criteria or requirements can change without having an impact on plant safety or the design/analysis as reflected in the FSAR. This generally was the situation observed during the IDR of the Byron FSAR. Where FSAR changes were required as a result of an Observation for clarification or to better define commitments, S&L stated that such changes would be made.

Review of Changes

The process of design change control can very basically be broken down into three subprocesses assuming that design change itself has been accepted as technically sound. These processes are 1) engineering coordination, 2) design implementation, and 3) "as-built" reconciliation.

The review of the S&L design process indicated that each of these processes was controlled, but IDR Observations were made for each area related to reviewing changes and coordinating them within S&L. This indicated that certain minor deficiencies may exist in the S&L process but does not lead the IDR to conclude that the process is generally inadequate. None of the Observations related to a design change control deficiency was judged safety-significant (with one possible exception discussed below) and none resulted in a substantive change in the S&L procedures.

In one case, a system modification will be made to maintain system pressures below the established design pressure. The situation noted (OR 8.38) was the result of the designer (Westinghouse) postulating continued system operation concurrently with component failure, not a condition normally expected during normal plant operation. Accordingly, the IDR team believes that the condition leading to the concern was not a realistic one for normal operation, upon which the Code requires design pressure to be based.

S&L provided detailed explanation of their process, and the IDR examination of this process has resulted in the IDR conclusion that, although the process implementation had imperfections, there is adequate confidence that the design change control works and provides the commensurate level of safety when a design change is made.

Code Compliance

As to code compliance, the design of a nuclear power plant encompasses thousands of detailed criteria and requirements. These criteria are found in regulations, regulatory guidelines, codes, standards, and a variety of other documents. During the review of the Byron Station, it was determined that some specific aspects of the design do not strictly comply with certain detailed code requirements. It is not the role of the IDR to judge the basis for the code requirements, but in all cases where a noncompliance was noted, S&L verified that the design of the given system, structure, or component could perform its intended safety function.

Based on the large number of code and licensing requirements reviewed, and the relatively minor nature of the deviations relative to the basic design requirement for systems to perform necessary safety functions, it can be concluded that such noncompliances do not constitute a significant safety concern. This should not be construed as meaning that code noncompliances are an acceptable means of design, but in the context of this review, the code noncompliances observed did not (and would not if they occurred elsewhere) significantly lower the degree of assurance in the technical adequacy of the plant.

4.3 CONCLUSIONS

In summary, the IDR team has technically evaluated the design of three meaningful systems. Then it evaluated each resulting Observation and the S&L proposed resolution and, has concluded that no individual Observation resulted in a significant safety concern. The Observations were then analyzed for apparent root causes and for the potential trends resulting from the causes. These trends were then evaluated to determine if the trend itself had a broader implication of safety concerns. It was concluded that no such broad concerns were evident.

Based on this analysis, the IDR team concludes that, although there may be some shortcomings in the way in which the S&L design process functioned, these shortcomings, when viewed individually or collectively, do not represent concerns which alter the assessment of design adequacy of the Byron Station to a degree which significantly impacts on the assurance that there is no undue risk to the public.

Therefore, the results of this IDR support a conclusion that there is a reasonable assurance that the overall design of the Byron Station is technically adequate. The bases for this conclusion are as follows:

- There were very few Observations made in relation to the large number of design details, documents, and criteria reviewed.
- None of the Observations made was considered by the IDR team to be a safety-significant concern.
- Those changes to procedures, documents, or components which were made as the result of an Observation were generally minor in nature and, if the change had not been made, there would not have been a significant reduction in the degree of protection provided to the public.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:)
) Docket No. 50-454 OL
COMMONWEALTH EDISON COMPANY) 50-455 OL
)
(Byron Nuclear Power Station,)
Units 1 and 2))

CERTIFICATE OF SERVICE

I hereby certify that I have, on this 12th day of September, 1984, served copies of Intervenors' Motion To Reopen the Record in the Byron Proceeding To Include the Byron Station Design As An Issue and the Memorandum In Support thereof on the following persons by having said copies placed in envelopes, properly addressed and postaged (first class) and depositing them in the U.S. mail at 109 North Dearborn (or, as indicated by an asterisk, sent by Federal Express), except that Mr. Miller's copy was hand-delivered.

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