NRC INSPECTIONS AT BYRON STATION

Year	Number of Inspections	Infractions	Unresolved Items
1974	3	1	3
1975	5	4	2
1976	6	16	2
1977	12	14	13
1978	11	4	13
1979	17	12	12
1980	25	28	16
1981	17	7	9
1982	26	37	15
Total	122	123	85

NOTE: Excludes reports 77-01, 02, 03

EXHIBIT F

ENERGY INCORPORATED

REF: CS-033-83

February 8, 1983

2-14-83

Mr. Walter Shewski
Manager, Quality Assurance
COMMONWEALTH EDISON COMPANY
Quality Assurance Department
Marquette Building
6th Floor
P.O. Box 767
Chicago, IL 60690

Subject: Energy Incorporated Independent Assessment of S&L Design Control Area

Dear Mr. Shewski:

Energy Incorporated has been involved in two technical assessments of Sargent and Lundy for Commonwealth Edison in the design control area. In June of 1982, EI participated in a management audit of S&L and did a thorough assessment in the design control area on the Byron and Braidwood and the LaSalle County Projects. Again, in October, 1982, EI participated in the INPO Self-Initiated Evaluation of the Byron and Braidwood Nuclear Station Construction Project. On this evaluation, EI was responsible for assessing the effectiveness of the Design Control area on the Byron and Braidwood Project. In both efforts, EI found that S&L is doing a very effective and thorough job in the design of the plants and has imposed a very effective design document control system.

During these two efforts, EI's assessment covered the following areas:

- o Engineering administrative procedures
- o Design criteria
- o Drawing
- o Equipment & System specifications
- o Stress analysis reports
- o Design document control system
- o Design interface controls (internal & external)
- o Class 1E equipment qualification program
- o Design review and verification program
- o Computer program verification

The approach used for the assessment was to review S&L Quality Assurance Manual, various Department Standards, and the Project Instructions, covering the design process to determine if these documents were thorough and, if properly implemented, could result in a well controlled design process. The specific areas named above were then evaluated through document review; interviews; and observations to determine if the engineering procedures were effectively implemented. As a result of these evaluations, it was found that design control program is very thorough, well understood by the engineering staff, and effectively implemented.

S&L's Quality Assurance Manual gives the overall direction for the design process quality program. This manual contains the procedures (GQs) which give additional direction to the staff concerning implementation of the quality program. Specifically, GQ-5.01, Project Instructions, requires the development of Project Instructions for additional direction to the staff members assigned to the project. These instructions contained most of the design interface and review requirements and contained tracking requirements to assure the various design interfaces occurred. It should be noted that all the project instructions reviewed during the evaluations contained the level of detail necessary to assure continuity throughout the program. It was found that the project design staff was very familiar with these instructions.

In addition to the GQs and Project Instructions, each department within S&L has its own department standards. These standards contain instructions covering the engineering work completed by the given department. Again, the department standards reviewed during the course of the evaluations were found to be excellent training and instructional documents well understood by the department staffs.

The engineering documents (drawings, specifications, analysis reports, and criteria) were all well done and cross referenced. Specifically, the stress analysis reports thoroughly referenced the drawings and criteria documents by both number and revision. This thoroughness seemed to be consistent in all documents reviewed.

To aid the staff members in applying the correct design criteria, the projects had developed general project design criteria documents. These documents were not necessarily a program requirement but were generated to aid the staff during the design and analysis activities. These documents are excellent reference documents and will be invaluable during the life of the plant for future reference.

At the conclusion of the evaluation, in EI's opinion, S&L has a very thorough program in the Design Control area. The program is well documented, understood by the staff, and effectively implemented.

Sincerely,

R. J. Harris
Department Director
Consulting Services

RJH:clh

DESIGN EVALUATION REPORT

OF SARGENT & LUNDY FOR

COMMONWEALTH EDISON COMPANY

APRIL 4, 1983

ENERGY
INCORPORATED

ENERGY INCORPORATED

DESIGN EVALUATION (AUDIT) REPORT OF SARGENT & LUNDY FOR COMMONWEALTH EDISON COMPANY

APRIL 4, 1983

PREPARED BY: D. BIGBEE
R. N. CURRAN
R. F. FARMAN
R. J. HARRIS
C. VAN BLARICUM

APPROVED BY: R J Harris DATE: 4/4/83
R. J. HARRIS
DIRECTOR, CONSULTING

ATTACHMENTS

A - Audit Checklist Questions and Responses - R. J. Harris

B - Audit Checklist Questions and Responses - R. N. Curran

C - Audit Checklist Questions and Responses - J. D. Bigbee

D - Audit Checklist Questions and Responses - R. F. Farman

E - Audit Checklist Questions and Responses - C. H. VanBlaricum

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I. SCOPE, RESULTS, AND ASSESSMENT

1.0 SCOPE

Energy Incorporated (EI) has completed a technical assessment (audit) for Commonwealth Edison Company (CECo) of Sargent & Lundy's (S&L) design and design control program as implemented on the Byron/Braidwood Project and on a limited basis on the LaSalle Project. This audit was performed at the S&L office in Chicago, Illinois on March 7 through 11, 1983. The technical assessment was completed concurrently with a regularly scheduled CECo QA Department audit. However, EI audit team worked completely independent of the CECo audit team.

The intent of this assessment was to extend the results of two earlier technical assessment audits of S&L completed by EI. In the earlier audits, EI was concerned with the design control program and the implementation of this program versus the details of the engineering design. In these assessments, EI found that S&L had a very thorough design control program. This program is well documented in S&L's QA Manual, Department Standards, and Project Instructions. The program gave detailed instructions for many of the important aspects of design control (document control, interface control, design reviews, and second level reviews). In addition, EI found that the S&L staff members involved in the design activities were very knowledgeable of the design control program.

In this evaluation, EI's intent was to review various aspects of the design to determine if the program is resulting in adequate designs. To do this, the EI team looked in detail at a cross section of design input and output documents, including drawings, analysis reports (both stress and thermal-hydraulic), equipment specifications, test reports, and control loops. The specific items covered were:

(1) A review of the auxiliary feedwater system on the Byron/Braidwood Plant. The review included:

(a) System classification and operational modes,

(b) Thermal-hydraulic operational analysis,

(c) System P&ID for proper design requirements,

(d) Control requirements for operational and safety considerations,

(e) System design drawings for proper carrythrough of the P&ID and functional requirements,

(f) Control loop diagrams for proper controls, and

(g) Completeness of the design drawing package.

(2) Review of fluid system thermal-hydraulic analysis for proper modeling methodology and use of the input and output data on the Byron/Braidwood project.

(3) Review of pipe whip analysis for proper modeling methodology and use of the input and output data on the Byron/Braidwood project.

(4) Review of piping stress analysis reports for proper input, proper use of the output, compatibility with the design drawings, completeness of the model, and adherence to the codes and standards on the Byron/Braidwood project.

(5) Follow-up on the design control portion of the INPO Self-Initiated Evaluation on the Byron/Braidwood project and an extension of these criteria, on a limited bases, to the LaSalle Project.

Mr. George Marcus, Director, Quality Assurance - Engineering/Construction, CECo, coordinated the overall activities of both the CECo and EI teams. Mr. Robert Harris of EI functioned as the EI team leader. The selection of the auxiliary feedwater system was made just prior to the assessment. S&L was not informed of the system selection. The design documents and analysis reports reviewed were selected during the assessment.

2.0 RESULTS

The results of the EI evaluation are as follows. The details of the observations and comments are provided in subsequent sections of this report for each auditor. The audit checklist questions and responses for each team member are included in Attachments A, B, C, D, and E of this report.

2.1 Findings

No findings were noted during this audit.

2.2 Observations

(1) The equipment specification for the diesel generators on the Byron/Braidwood Project requires that seismic testing be completed to the requirements of the IEEE 344,1971 standard. This specification should be changed to reflect the fact that the IEEE 344,1975 standard was actually used.

(2) The equipment specification for the hydrogen recombiner on the Byron/Braidwood Project does not give a specific definition of the containment environment regarding chemical sprays following an accident. The containment atmosphere circulation blower and motor on the recombiner is subject to the containment accident environment. Thus, no specific environmental conditions are available for determining if the proper environmental test conditions are being used. These conditions should be added to the specification and action should be taken to assure the test envelopes these conditions.

(3) P&ID symbol definitions, particularly the class and/or piping design table change marker, are not accurately defined. The letter/number in the symbol should be clearly defined, including possible combinations.

(4) The Auxiliary Feedwater System response time criteria were not spelled out in the system design criteria document. The design criteria document should be updated to be consistent with the FSAR.

(5) The Byron pipe whip calculations audited do not clearly identify the major references/procedures on which they are based. Calulations should clearly identify major references and sources on which they are based. If specific technical procedures are used, the calculations should reference the applicable revision level.

2.3 Comments

(1) Project Instruction, PI-BB-17, Rev. 1, as it applies to cable tray weight overloads, identifies an interface between the electrical and structural departments. The responsibilities of the two departments are not defined in the instructions. The project instruction should be updated to specify these responsibilities.

(2) Analysis reports which establish the basis for design should clearly state the purpose and results of the calculations. The calculation packages containing the auxiliary feedwater system hydraulic analysis should be amended to include an introductory section containing a statement of objectives. A results section should also be added.

3.0 ASSESSMENT

It is the assessment of the EI team that the final design resulting from S&L's design activities is adequate and well documented. The design documents (drawings, analysis reports, and test documents) reviewed were well done and adequately cross referenced. This assessment is consistent with the results of previous evaluation of S&L by EI on the Byron/Braidwood

and LaSalle Projects. This evaluation however was distinctly different than earlier assessments in that it concentrated on the design output versus the design control program. With this evaluation, EI has had an opportunity to assess not only the design control program but also the resulting design. EI's conclusion in previous evaluation was that S&L had a very thorough and well documented design control program. With the design control program as implemented and the results of this evaluation, EI would expect the completed design on both projects to be adequate.

II. FOLLOW-UP ON THE INPO SELF-INITIATED EVALUATION CRITERIA (R. J. HARRIS - TEAM LEADER)

1.0 INTRODUCTION

The follow-up on the INPO Self-Initiated Evaluation Criteria in the design control area was done by Mr. R. J. Harris and R. N. Curran. This section of the report discusses the results of Mr. Harris' evaluation. Mr. Harris' work involved functioning as the EI team leader, and extending the work completed during the INPO self-initiated evaluation on the Byron/Braidwood Project and on a limited basis, extending these criteria to the LaSalle Project. A portion of the objective evidence reported herein was obtained during the INPO evaluation. The INPO criteria specifically addressed during this evaluation were: in-service inspection and maintenance space requirements, function testing and qualification of safety-related equipment, as-built activities, design criteria documents, and design review activities.

The approach used in the audit was the review of design documents and staff interviews. Documents reviewed included system and equipment specifications, test reports, drawings, analysis reports, and project status reports. The S&L staff members interviewed included project engineers, design engineers, and document control personnel.

This section of the report covers the results of Mr. Harris' audit. Audit questions and responses are contained in Attachment A of this report.

2.0 ASSESSMENT

It is Mr. Harris' assessment after completing the evaluation in the stated areas that S&L has a very thorough and well understood design control program. The program requires (through S&L procedures) the design activities to be planned, tracked, and documented at a level beyond the explicit requirements stated in the NRC's quality assurance program. This documentation, such as status reports and extensive equipment lists, is

III. FOLLOW-UP ON THE INPO SELF-INITIATED EVALUATION CRITERIA AND CONTROL LOOP DIAGRAM REVIEW (R. N. CURRAN AUDITOR)

1.0 INTRODUCTION

The subject area of the audit was conducted by Mr. Robert Curran of Energy Incorporated. Mr. Curran's portion of this audit dealt with a re-evaluation of selected areas of design interfaces and design output evaluated in the previous INPO evaluation. Mr. Curran's portion of the audit also dealt with the design of instrumentation and control systems.

This section of the audit report covers the results of Mr. Curran's audit. Mr. Curran's audit questions and responses are contained in Attachment B of this report.

2.0 ASSESSMENT

Mr. Curran's audit approach was to review S&L quality assurance procedures, department standards, and project instructions as they apply to design interfaces and design output activities and to determine if these procedures, standards, and instructions are sufficient. Specific design activities were then evaluated to determine if existing instructions and procedures were effective and were being effectively applied. Except for one condition noted in Section 3.0, Findings, Observations, and Comments, it was found that S&L's procedures, standards, and instructions are thorough, effective, being effectively implemented, and are thoroughly understood by the engineering staff.

S&L Quality Assurance Manual provides overall direction for the quality program. The GQ Procedures, which are part of the manual, provide additional direction in the implementation of the quality program. The responsibilities for establishing design interfaces, both internal and external to S&L, the preparation, review approval and distribution of S&L Standards, and design control requirements for the preparation of design output documents are addressed by the GQ Procedures.

At the conclusion of the audit, it was the opinion of Mr. Curran that S&L has an effective and thorough quality assurance program. The engineering staff has a thorough knowledge of the program, specifically in the areas of design interfaces and design outputs, and were effectively implementing the program requirements. In one area where explicit interface responsibilities were not defined (see Questions B-I-1), both of the interfacing departments had a complete understanding of their responsibilities for that interface.

3.0 FINDINGS, OBSERVATIONS, AND COMMENTS

3.1 Findings

None.

3.2 Observations

None.

3.3 Comments

Project instruction PI-RB-17, Rev. 1, as it applies to cable tray weight overloads, identifies an interface between the electrical and structural departments. The responsibilities of two departments are not defined in the instruction.

Discussion: The instruction should be revised to define departmental responsibilities for the interface. Specifically, the interface requirement stated in the instruction requires that if a cable tray weight overload is detected the cable tray hangers will be analyzed and reinforced if required. Monitoring for cable tray overloads is an electrical department responsibility and analysis and redesign of cable tray hangers is a structural department responsibility.

prudent and should result in a thorough design and a high degree of confidence that all items and activities were considered at the conclusion of the project. Except as noted in Section II-3.2, all documents and activities review were found to be excellent. The S&L staff was able to produce all the documents requested during the review from the project equipment and activities lists. The current status of these documents was as noted in the status reports.

The areas that Mr. Harris felt were exceptionally well documented were the "as-built activities", the equipment qualification program, and the ISI program. The thoroughness of this documentation and the activity tracking mechanism in place are very good. In addition, the S&L staff members interviewed were found to be very knowledgeable of S&L design control program, as well as the technical requirements of their job.

3.0 FINDINGS, OBSERVATIONS, AND COMMENTS

3.1 Findings

None.

3.2 Observations

(1) The equipment specification for the diesel generators on the Byron/Braidwood Project required that seismic testing be completed to the requirements of the IEEE 344, 1971 Standard. Per the FSAR seismic testing must be completed to the IEEE 344, 1975 Standard.

Discussion: The requirement for seismic testing on the Byron/Braidwood Project has changed from the IEEE 344, 1971 to IEEE 344-1975 Standard. The time frame for this change could not be documented, but the PSAR did call for the 1971 standard. In checking the seismic test plan and test reports for the seismic testing already completed on the diesel generator system, it was

found that in all cases the testing has been completed to the 1975 standard. A review of test reports for other equipment revealed the 1975 standard is also being used. It appears this is an isolated case where the equipment specification did not get updated to include the 1975 standard. This specification should be updated to eliminate the possibility of the future testing being completed to the wrong standard. See response to Question 4, Attachment A.

(2) The equipment specification for the hydrogen recombiner does not give a specific definition of the containment environment regarding chemical sprays following an accident. The containment atmosphere circulation blower and motor on the recombiner is subject to the containment accident environment. Thus, no specific environmental conditions are available for determining if the proper environmental test conditions are being used.

Discussion: The recombiner is classified as safety related and therefore the equipment must be qualified to the requirement of the IEEE 323-1974 Standard. This standard requires all adverse environmental conditions to be considered. A review of the test plan for the recombiner determined that the blower-motor assembly had a chemical spray environment included in the test plan. However, with no chemical environment specified in the recombiner specification, no judgement can be made concerning the validity of the chemical spray environment used in the test. The chemical spray environment should be added to the equipment specification. See response to Question 4, Attachment A.

3.3 <u>Comments</u>

None.

IV. AUXILIARY FEEDWATER SYSTEM REVIEW (J. D. BIGBEE AUDITOR)

1.0 INTRODUCTION

The fluid system chosen for review was the Auxiliary Feedwater System (AFWS). This evaluation was conducted by Mr. J. D. Bigbee of Energy Incorporated with certain specific items covered by other auditors. Mr. Bigbee's area of concern was system classification and operational modes, system P&ID for proper regulatory and code requirements, control requirements for operational and safety considerations, and design drawings for proper carrythrough of P&ID and functional requirements.

This section of the audit report covers the results of Mr. Bigbee's audit. The audit questions and responses are contained in Attachment C of this report.

2.0 ASSESSMENT

Mr. Bigbee's approach was to review the AFWS against both system functional requirements and regulatory concerns. In some instances, such as functionality of instruments and controls, the AFWS was examined directly; in other instances, such as protection from high energy pipe break, the Sargent and Lundy basic methodology for Byron Station was examined. Evidence was gathered from examination of documents and interviews with responsible personnel. In some instances, such as consideration of system functional testing, the only available evidence is the system as it existed at the time of the audit; i.e., if the system is capable of easily being functionally tested, then functional testing must have been considered. Except for conditions noted in Section 3.0, Findings, Observations, and Comments, it was found that S&L's overall design capability results in a well-engineered system which can be expected to perform its intended functions and meet regulatory requirements.

The primary documents used in the audit were the design criteria document, P&ID, pipe plan drawings, and FSAR. The design criteria for the Auxiliary

Feedwater System did not contain some later information that was in the FSAR (see Section 3.0). The system P&ID and pipe plan drawings were good, well maintained working documents with the exception of items noted in Section 3.0. The P&ID was easy to follow and provided a more than adequate amount of information. The FSAR section on AFWS in Chapter 10 was well written, clear, and usable.

The overall system was examined for functionality. It was found that the system was well designed for all phases of operation from initial flushing to emergency operation. Proper instrumentation was provided in a well thought out manner in both the control room and at the remote shutdown station. Barring the loss of the condensate storage tank, no automatic functions are required for the system to feed the steam generators except for starting the pump. This is an excellent design practice that was well carried out.

Design areas that involve protection of AFWS components from hazards such as pipe whip, compartment overpressurization, flooding, and inadequate cooling were examined generally by looking at the S&L basic methodology. Interviews with the individuals responsible for each area garnered an understanding of the basic methodology which was being used. In each instance, the individaul was very knowledgeable in his field and was very cognizant of his interface requirements. These individual engineers used systematic methods to ensure completeness. In each instance, it was felt that the area of concern was well and completely covered, and hence, the AFWS and all other systems at Byron Station would be adequately protected from these potential hazards.

3.0 FINDINGS, OBSERVATIONS, AND COMMENTS

3.1 Findings

None.

The auxiliary feedwater system head loss and flow distribution calculations are contained in packages designated as AFJK-1, October 14, 1977. The calculations were reviewed to assess their procedural correctness and were found to be satisfactory. The hydraulic performance of the system is shown to be consistent with the requirements defined by Westinghouse.

A second calculation package designated as AFJD-1, June 26, 1979, determines suction line head loss. This calculation was also reviewed and found to be satisfactory.

All calculations were judged to have been correctly performed. However, the review was complicated in a minor way by the absence of any introductory discussion of objectives or summary of results in the calculational packages. This auditor recommends that the calculations should be amended accordingly to facilitate any future review of a similar nature.

Since no hydraulic transient was performed in connection with the auxiliary feedwater system, an analysis performed on the main feedwater system was reviewed. The transient in question was a feedwater pump trip from design operating conditions. The calculation was performed using a Sargent & Lundy computer program called HYTRAN. HYTRAN uses a conventional method for analyzing transient fluid dynamics, namely the method of characteristics. The Sargent & Lundy computer library retains a copy of a verification analysis that was performed to assess the validity of the program. This document contains five cases of sample problems which compare HYTRAN solutions with known textbook solutions which show good agreement with the code. This verification indicates that the solution procedure and the code structure are valid.

During this part of the audit, all Sargent & Lundy personnel who were interviewed were found to be cooperative and all possessed a good understanding of the subjects that were discussed.

3.0 FINDINGS, OBSERVATIONS, AND COMMENTS

3.1 Findings

None.

3.2 Observations

None.

3.3 Comments

As mentioned above, it is suggested that the calculation packages containing the auxiliary feedwater system hydraulic analyses should be amended to include an introductory section containing a statement of objectives. They should also be ended with a summary.

3.2 Observations

(1) P&ID symbol definitions, particularly the class and/or piping design table change marker, are not accurately defined. The letter/numbers in the symbol should be clearly defined, including possible combinations. See response to question 31.

DISCUSSION: The class and/or piping design table change marker letter/number combinations were well understood by those interviewed. The lack of definition did not result in the application of inappropriate codes or seismic class. Specifically DI, although not really defined, was understood to be power piping code pipe that is seismically supported. Where DI was used, that is exactly what the system should be. The question is whether this should always be shown on the P&ID or not shown on the P&ID.

(2) The Auxiliary Feedwater System response time criteria were not spelled out in the system design criteria document. The design criteria document should be updated to be consistent with the FSAR. See response to question 1.

DISCUSSION: It appears that the design criteria document may not be in full use, and it has not been updated since 1976. The response time was spelled out in the FSAR and was met; hence, the only difficulty is listing the criteria in both places where they would be expected.

3.3 Comments

None.

V. THERMAL-HYDRAULICS ANALYSIS REVIEW (R. F. FARMAN, AUDITOR)

1.0 INTRODUCTION

The thermal-hydraulic aspects of the evaluation were performed by Dr. R. F. Farman of Energy Incorporated. The objectives of this portion of the evaluation were to identify the hydraulic design requirements, review the design procedure, and compare the results of the design analysis with the specifications. This evaluation was applied to the auxiliary feedwater system of the Byron Station. Additionally, the method used for analysis of hydraulic transients was reviewed.

This section reports the results of Dr. Farman's evaluation. Audit questions and responses are contained in Attachment D of this report.

2.0 ASSESSMENT

The evaluation of the thermal-hydraulic design was begun by reviewing the Sargent & Lundy design specification. This document is titled, "Commonwealth Edison Company, Byron Station Units 1 & 2, Braidwood Station Units 1 & 2, Design Criteria for Auxiliary Feedwater Systems", DC-AF-01-BB. The bases for these criteria are defined by the NSSS vendor, namely, Westinghouse Electric Company, in the following documents:

(1) Westinghouse Standard Information Package 10-1

(2) Letter number CAW-1839, February 23, 1977

(3) FSAR

The procedures used by Sargent & Lundy for determination of hydraulic performance are contained in a document designated as MES 2.10, dated June 24, 1971 and a newer version dated June 29, 1982.

apparent during interviews with division personnel that the division takes pride in the documents and does use them for both training and as a reference source.

2.2 Pipe Whip Analysis Methods and Application

The pipe whip calculations audited contain no reference to the procedure (or other source) on which they are based. Thus, there is no direct means to determine what procedure (including revision level) was used for the calculation for a specific subsystem. The procedure (EMD TP No. 24) has four revisions.

Methods described in the FSAR include use of specific figures from specific papers to calculate forces. The procedure being used is based on an earlier paper by the same author. Because of these variations and the fact that the calculations refer to neither the procedure nor other reference source, a detailed engineering review would be required to verify consistency between the FSAR, the technical procedure, and the calculations. This does not imply that inconsistencies are expected. On the surface, the methods, equations, and figures used to determine pipe whip forces appear to be in general agreement.

3.0 FINDINGS, OBSERVATIONS, AND COMMENTS

3.1 Findings

None.

3.2 Observations

The Byron pipe whip calculations audited do not clearly identify the major references/procedures on which they are based.

Discussion: Calculations should clearly identify major references and sources on which they are based. If specific technical procedures are

used, the calculations should reference the applicable revision level. The calculations appear to be in general agreement with the description of methods given in the procedure and the FSAR, but since no references are stated in the calculations, a detailed technical review would be required to verify that the procedure was invoked.

3.3 Comments

None.

VI. PIPING/PIPE WHIP ANALYSIS REVIEW (C. H. VAN BLARICUM - AUDITOR)

1.0 INTRODUCTION

This section audit was conducted by Mr. C. H. Van Blaricum of Energy Incorporated.

The purpose of the pipe stress analysis portion of the audit was to provide an overall evaluation of the quality and completeness of the stress reports with respect to design input, design process, and design output.

Two subsystem stress reports were selected by the auditor for evaluation. The two reports are identified as follows:

Report #1 — Feedwater 1FW-16
Revision 03F1 Dated 8-10-82
Accession No. EMD-030786
included: Addendum A dated 12-7-86
Addendum B dated 12-21-82

Report #2 — Auxiliary Feedwater 1AF-03
Revision 03F0 Dated 11-20-81
Accession No. EMD-034501
included: Addendum A dated 4-22-82
Addendum B dated 8-20-82
Addendum C dated 1-27-83

The objective of the pipe whip portion of the audit was to determine if the procedures used for the calculation of pipe whip forces were consistent with the methods described in the FSAR and that the procedures were being invoked.

Methods described in the FSAR were compared with those in EMD Technical Procedure No. 24. Calculations for the Byron project were audited to determine if they were based on the procedure.

This section of the report covers the general results of this portion of the audit. Detailed audit questions and responses are contained in Attachment E of this report.

2.0 ASSESSMENT

2.1 Pipe Stress Analysis Reports

The piping stress analysis reports audited were well prepared and documented. Design input documents are adequately referenced or are included in the stress reports. There is complete traceability as to the revision level of input documents which the stress reports have considered and the revision level of output documents (such as loads on support drawings) resulting from the analysis.

The stress analysis was performed using S&L pipe stress computer program PIPSYS. The computer printout (contained on microfiche in each stress report) gives a clear presentation of the input data, ASME Section III Code service load combination and stress evaluation, and support load results. Computer models of the piping subsystems appeared to be complete with due consideration to details such as maximum member length and consideration of value operator eccentricity. Terminology for service levels and stress equation evaluation is consistent with that used by ASME Section III, Class 2/3, since the Winter 1976 addenda.

While training was not within the scope of this part of the audit, it was noted that the Engineering Mechanics Division uses two excellent documents for both training piping stress analysts and for reference manuals for the experienced analyst. These documents are: EMD-TP-1, "Lesson Plan for Training Personnel in Piping Analysis", and EMD-TP-3, "Lesson Plan for Training Personnel in Coding Piping Systems". These documents appear to be professionally prepared and cover every detail required for performing piping stress analysis with up-to-date techniques. Subjects include computer modeling techniques, NRC Regulatory Guide requirements, seismic analysis techniques and criteria, and ASME Code requirements. It was

ATTACHMENT A

AUDIT CHECKLIST QUESTIONS AND RESPONSES

R. J. HARRIS

RESPONSE TO AUDIT CHECKLIST QUESTIONS

Checklist Question Number	Question/Response

Question 1: How do the design criteria and function requirements get disseminated to the design staff and is this information controlled?

Response

Information from previous evaluation (INPO):

Byron/Braidwood (By/Br) project: The FSAR is considered to contain the most current design criteria information by the project staff. The FSAR, Appendix A, gives a detailed listing of the codes and standards, including editions, which must be applied. Specifically the requirements for the Class 1E electrical equipment qualification were reviewed. Per the FSAR, the NSSS vendor equipment was to be qualified to IEEE 323-1974 and the BOP to IEEE 323-1971. However, it was pointed out by the staff that all Class 1E equipment was being qualified to the 1974 standard per a commitment to NRC by CECo.

In addition to the FSAR, S&L has developed a series of design criteria documents for major systems or design activities on the plant. These documents are being used as the design bases by the staff. A review of some of these documents found them to be very thorough and useful and as such should result in better system designs. It is the project engineer's responsibility to prepare these documents. They include references to the FSAR, regulatory guides, standards, and codes which must be imposed on the design.

Documents reviewed were:

(1) DC-EE-01-BB, Design Criteria. Cable Separation, Rev. 9, original release date 10/10/74.

(2) DC-ST-03-BB, Structural Project - Edison Company, Rev. 8.

Both documents were thorough. Other criteria documents for systems or design activities included response spectra, remote shutdown design criteria, engine loading design, and the communication system.

Additional checks were made to determine if these documents were controlled and maintained. The By/Br project document control staff did maintain the criteria documents. In addition, they prepare and distribute a "Design Criteria Status Report" which lists all the criteria documents and their current status. A review of the status list showed the same revision for the cable separation criteria document as was being used by the electrical staff, revision 9.

The development and use of these documents during the design phase should result in a better final design. It is an excellent means to get the design requirement to the design staffs.

Current Audit:

The design criteria documents for the By/Br Project are still being controlled and are active documents.

On the LaSalle project, the design criteria documents are no longer active documents because the design activities have

been completed for several years. Criteria documents were generated and used during the design phase of the project.

Question 2: Does a program exist to use the experience gained on previous and current projects when procuring safety-related equipment on current projects?

Response

Information from previous evaluation (INPO):

Past equipment experience gets factored in through equipment specialists and the mechnical specification department. In the electrical department, equipment specialists are designated as defined in the Electrical Department Administrative Procedure EAP-13. These staff members are used to review equipment specification and to survey vendors for placement on the approved vendors list.

For mechanical equipment, the Mechanical Specification Division prepares the equipment specification. This department has an extensive program to maintain records on vendors and equipment. This program includes obtaining information from the project staff on equipment purchased. This is done by form MAS 13.6, Rev. A, as instructed in the Mechanical Administration Standard. The design staff will furnish the equipment functional requirements to the specification department staff and they will prepare the specification, including the functional testing requirements. This appears to be a good method for establishing consistent equipment specifications and factoring past experience into the current specifications.

Question 3: Has physical space been reserved for equipment maintenance and removal, and for in-service inspections?

Response

Information from previous evaluation (INPO):

By/Br Project: Both maintainance and equipment removal access space requirements drawings, and in-service inspection (ISI) drawings designating have been generated on the project. The M-27 multi-sheet drawing (17 sheets) designates equipment access and removal aisle both horizontal as well as the required vertical space. Additional drawings have been made to show space equipment for special problem, drawing M1210, sheets 1 through 7. All these drawings have been distributed to the construction and installation contractors. In addition, S&L holds monthly meetings with the construction staff to discuss and resolve any vic ation to the reserved space. The minutes of these meetings are published by R. Salsburg and distributed to a number of people on the construction staff. The minutes included definition of new problem areas and items resolved from previous meeting. This appears to be a very good program.

A similar program exists for ISI. S&L has developed a new set of P&IDs which identifies all systems which require ISI. This was done by color coding the existing P&ID drawing to show the ISI requirements, adding a new drawing number, and releasing them as information only. The drawings have different color codes for surface, volume and surface, and visual inspection. These drawings are numbered M-1001 to 1017. The drawings have been given to all contractors involved in installing pipe supports and the ISI base line data contractor. In addition, the general instruction drawing M-919 drawing "Component Support Installation Guidelines and

Tolerances, Sheet 4 of 14, Rev. B, note number 5; used by the piping installation contractor references the ISI series of drawing and defines clea-.nce requirement between the welds requiring inspection and the supports.

Monthly meetings are held with the construction staff to discuss and resolve violation to the ISI clearance requirements. This also appears to be a very active and thorough program.

Current Audit:

The equipment removal and maintainance spare allocation and the in-service inspection requirements programs are still active on the By/Br projects.

On the LaSalle project, drawings were prepared which allocated spare for equipment removal and maintainance, drawing #M 26, sheets 1 through 12. These drawings show the aisle space needed to remove major equipment and show the locations of hatches for raising and lowering equipment to other floors. The drawings are organized by building and elevations.

S&L is not currently involved in the ISI program. However, the design drawings for pipings and the piping installation specification specified ISI requirements and access requirements. The piping installation specification J-2530, Amendment 7, dated 5/29/75 imposed S&L's Standard Form 278, "Standard Specification for ASME Section III Piping System". This standard requires the pipe fabricator to get approval from S&L for all weld joint locations (Section 3.3.11, page 3-6) for ISI considerations and also requires that all welds requiring ISI be ground smooth (Section 3.3.12, page 3-7). In addition, the thermal insulation specification, J-2576,

Amendment 6, dated 5/10/76, in section 405 required that removable insulation must be used over welds and components requiring in-service inspection.

In addition to these requirements, S&L was in the process of furnishing a listing of all pipe welds requiring ISI based on the stress criteria to the ISI contractor for LaSalle. These welds were being specified by weld number as noted on the Morrison Construction Co. piping isometric drawing. These were drawings prepared by Morrison for the purpose of ISI. S&L had just completed this work and the report identifying these welds was not available for review.

Although S&L is not currently involved in the ISI program on LaSalle, it appears that ISI requirements were factored into the design and CECo has a current program for ISI. Both projects have very good programs in these areas.

Question 4: Are functional and environmental testing required and documented for safety-related equipment?

Response

Information from previous evaluation (INPO):

Two systems were reviewed to determine if functional testing was required on major safety-related equipment. The systems were the combustible gas control system and the diesel generator sets on the By/Br Project.

The combustible gas control system was reviewed on P&IDs, M-47, Rev. K, 8/4/82, which showed the hydrogen recombiner system. Dual isolation valves were included and the drawing was stamped "Safety Related". The ordering specification for

the recombiner was reviewed for required testing. Specification reviewed was:

#F2845, Amendment 4, 5/27/80, with an original release date of 8/16/76.

This specification required functional testing for 150 minutes at various conditions and in addition required environmental testing to the requirements of IEEE 323,1974, per the FSAR.

In addition, the plant included a purge system (feed and bleed), defined on P&ID M-105, Revision k, 7/14/82, "Diagram of Containment Purge/Pressure and Vacuum Relief System B/B".

The combustible gas control sytem was constant with the general requirement of 10 CFR Part 50.44.

The diesel generator equipment specification was also reviewed for functional test requirements:

Specification F-2742/L-2742, 9/26/77 "Diesel-Engine Generator Sets".
Byron Station - 1&2
Braidwood Station - 1&2
Amendment #2, 5/14/79.

This specification included very thorough functional testing requirements.

Current Audit:

Both the hydrogen recombiner and the diesel generator were reviewed for the By/Br Project to determine the requirements and the status of the environmental and seismic testing on both items. Per the requirement of the FSAR, the equipment

specification referenced above for the recombiner required the environmental testing to be completed per IEEE 323,1974, and the seismic testing per IEEE 344,1975. All the testing for the equipment has not been completed. The environmental conditions specified in the equipment specification did not give the specific makeup of the containment accident conditions for chemical sprays. These conditions will be necessary to test the blower-motor assembly which is subjected to the containment accident environmental conditions.

The vendor test plan submitted to S&L (the test has not been completed) does include a definition of the containment accident environment to be used in the actual test; however, no judgement can be made as to the acceptability of these conditions because they are not specified in the recombiner specification. The test plans reviewed were:

> Rockwell document #N019PP120007, "Environmental Qualification Plan for the Hydrogen Recombiner Motor/Blower Assembly", 7/22/80; and N019PP120009, "Environmental Qualification Plan for Hydrogen Recombiner PWR", 3/12/79.

It would appear that these conditions were specified by S&L, but there is no evidence available to the reviewer to verify this. To assure that the test includes the proper environmental conditions, these conditions should be explicitly specified in the recombiner specification.

The seismic qualification results are still under review by S&L; however, it appears the seismic qualification has been completed. The following reports were reviewed:

> Rockwell Document # N139TR120-009, 6/1/79, and #N139TR120-008, Rev. A, 8/25/80

The -009 report is the specific report for the By/Br recombiner and -008 report is the generic report for a similar recombiner. All testing was complete to IEEE-344, 1975. A combination of testing and analysis was used to qualify the unit.

Per the Component Qualification Department (CQD) status report dated 2/26/83 (see response to Question 11), some of the instrumentation on the recombiner has not been seismically qualified. Per Mr. R. Salsburg, Mech. Engineer, these instruments, hydrogen monitor analysis Panels 00G05J and 00G07J are no longer 1E because hydrogen monitoring is being done by an in-containment system. This change is under review and appears to be progressing, as well as other instruments on the status list which are shown as not having the seismic qualification completed.

The equipment specification for the diesel generators required the seismic testing to be completed per IEEE-344-1971. This is inconsistent with the commitment made to test to the 1975 edition of the standard. To determine if the testing was completed to the 1975 edition, the following documents were reviewed (it should be noted that all these documents were included on the CQD Department status list):

(1) CQD document #EMD-031533 (Wyle Test Lab Report #17441-1, Qualification Plan, dated 5/15/81).

(2) CQD document #EMD-018815 (Wyle Test Lab Report #44369-2, Seismic Test of Engine/Generator Panels, dated 6/27/79).

The review showed that the test plan did call for the seismic qualification to be completed to the IEEE 344,1975 Standard. In addition, the test for the panels was also completed to the

1975 addition. It appears that S&L had properly imposed the 1975 edition of the IEEE 344 Standards. However, the equipment specification for the diesel generator should be revised to note this change.

It should also be noted that much of the electrical equipment included in the diesel generator system has not been seismically qualified to date. Management at S&L has reacted to this, but it is not clear if schedules and commitments have been established to assure this work will be completed by the startup date.

For the LaSalle Project, see response to question 10. The equipment specifications on both projects require testing. The program instituted for the review of the testing documentation should discover inadequate testing of equipment. The review of the test reports is tracked on the status lists (see response to question 10).

Question 5: Are design reviews planned and documented?

Response

Information from previous evaluation (INPO):

By/Br Project: The overall requirements for design reviews are stated in the S&L Quality Assurance Manual, GQ 3.10. In addition, the various department administration standards have additional requirements. In the structural area, Structural Administrative Standard, SAS-2.1, "System and Structural Design Review", requires the Structural Project Engineer to define which structures require design reviews and schedule these reviews (this standard also references GQ 3.10).

This requirement has been satisfied by the report "System and Structural Design Review Status Report", 10/1/82, Rev. 25. This report gives the status of the design reviews and was a very thorough listing. The design review report DRR-SD-073-BB was checked. This report was well documented and thorough.

The other departments, Mechanical and Electrical, maintains similar status reports showing their respective design review status. In addition, if a system undergoes major design changes, another design review will be held. This, however, is up to the project engineering to schedule a re-review.

In this regard, the main feedwater system (which has undergone major design changes under the mechanical project engineer) was checked on the status report to determine if the design changes had undergone a design review. The change had. The original system design review was completed on 1/31/78, report DRR-MS/FW-001 BB. The second design review was completed on 9/27/82, DRR-FW-001-BB. These reports were very extensive design review reports. It appears that S&L has a very thorough program for design verification through the use of design review reports. This program also has good status reports.

Current Audit:

The By/Br Project is continuing their design review program. On the LaSalle project, the designs are complete and no activities are ongoing in this area. The instructions used to control design review are very thorough and have resulted in a well documented design review program.

Question 6: Are instructions in place which define the "As-built" activities and are the organizations responsible for "As-built" activities defined?

Response

Information from previous evaluation (INPO):

On the By/Br Project it is CECo's construction department's responsibility to develop the "as-built" information on marked up drawings. This information is either developed by CECo personnel or by the installation contractors and the marked up drawings are transmitted to S&L for updating of the design drawings. To monitor the progress and status of the as-built activities, S&L puts out weekly reports. These reports include a tracking of the as-built activities by subsystem. S&L report reviewed was:

> Piping Support Design Weekly Summary Report No. 16 dated 10/15/82.

This report was very thorough and gives a good status of the activities.

Current Audit:

Both the By/Br and the LaSalle Projects have a very thorough program for documenting current status and tracking the ongoing as-built activities.

On the LaSalle Project, the "as-built" activities are defined in Project Instruction PI-LS-19. The piping "as-built" information will be incorporated into S&L piping plan and section drawing from the marked up drawing received from the CECo. These drawings only give the pipe routing and not the pipe support "as-built" information. Three status lists are maintained to track and assure all systems have been as-built. The lists reviewed were:

(1) Containment small bore,

(2) Outside containment small bore, and

(3) Large bore both inside and outside containment.

In checking the list for small bore inside containment, dated 12/21/82, it was determined that all small bore piping inside containment has been "as-built".

In addition, the following drawing was reviewed to determine how the information is incorporated:

(1) M939, Sh 12, Revision T, 1/3/83. This revision incorporated FCR #34003.

To determine what the "as-built" change involved, the FCR would have to be reviewed.

The piping supports are "as-built" in the final line walkdown (requirement stated in PI-LS-33). The "as-built" information generated during these walkdowns is incorporated into S&L pipe support drawings. The status of the pipe support "as-built" program is maintained on two reports. There is one for computer analyses line and one for hand calculated lines (small cold piping). The reports are titled "Final Line Walkdowns Status Report", dated 3/1/83. The reports noted all lines which have been completed. These lists were very thorough and should result in all lines being considered.

The instructions for the final load check on the structural steel are included in PI-LS-27. These activities are documented in bimonthly meeting minutes such as, "Final Load Schedule", dated 2/23/82, letter to Mr. T. Watts from V. Reklaitis. These load checks are done at the individual beam

level with an accounting system to note which beams have been checked. This is a very extensive and well documented program.

On the By/Br Project, the instruction for the piping and pipe supports "as-built" program is contained in Project Instruction PI-B/B-18, 26, and 27. These instructions are very thorough.

For the two-inch and under piping, S&L's isometric drawing will become the "as-built" record. This is defined in the piping installation specification F-2739/L-2739, Section 301.11. CECo is responsible for getting the "as-built" information to S&L for incorporation into the drawings. These are the M 2500 series of drawings.

For the large bore piping, S&L's plan and section drawings will be used for the "as-built" records (S&L didn't make isometric drawings for the large bore piping). Again, CECo is to submit the as-built information to S&L for both the piping and supports by subsystem.

S&L maintains status reports of this effort such as:

- "Piping Support Design Weekly Summary Report", dated 2/22/83 as a letter from J. Washington to J. Deress.

The report gives the status of the as-built activities for all systems including supports. A good report.

The By/Br project has a special problem in that there are two sites. Currently there are unique piping drawings for both units 1 and 2 of each plant. However, as the plants are built, the drawings may have to be split for the two sites

because of the differences in the as-built configuration. This problem is currently being addressed by management.

The final load check instructions are given in PI-BB-34, Documentation of Larger Loads. Both the steel and concrete structures will be included in the checks. Due to the major changes to the structural steel in-containment, a major rework and final load check program has been initiated. This includes a new series of drawings which shows all the beams and defines which beams have been checked and modified. This program is being tracked by meeting notes, "Final Load Check Task Force". Again, this is a very thorough program with a good system for tracking the progress.

Both projects have a very extensive and well documented "as-built" program.

Question 7: Are the construction packages thorough and are the related design documents defined in the packages?

Response

Information from previous evaluation (INPO):

By/Br Project: Two installation packages being used by the crafts people in the field were checked to determine if the design drawings were included and if the instructions were thorough enough to complete the installation as designed. At the Byron site, an installation package, prepared by Hunter, for pipe support M-ICC01053X, Rev. B, 8/27/82, was checked. The package was defined as traveler report #AH2-5018A. The workers were familiar with the requirement for installing the concrete expansion anchors. The traveler required the installation to note if the S&L standard, By/Br/CEA, for the installation of expansion anchors, was being used. The

installation package was checked against the requirements of Hunter's QA program, Site Implementation Procedure SIP #4.000, Rev 9, and found to be consistent. The package contained the design drawings and appeared to have proper QC hold points for inspections.

At the Braidwood site, an installaton package for the installation of a valve by the Phillip Getschow crafts was checked. The valve was in the fuel pool cooling system and was defined on a Southwest Fabrication Isometric drawing, SW #6058-FC-Iso, #FC-17. The package contained the design drawings and referenced the general S&L installation specification FL 2739. The package was very thorough. It included instructions for the disassembling of the valve before welding to prevent heat damage to nonmetal parts. Inspection hold points were also noted and the use of temporary alignment blocks was also controlled by procedure.

In both cases, the installation package contained the design documents (drawings and specifications) required for proper installation. The crafts people using the packages were knowledgeable of the procedures they were using for the installation.

Current Audit: The area was not investigated in this audit.

Question 8: Are the design requirements for subcontractor involved in design activities defined?

Response

Information from previous evaluation (INPO):

On the By/Br Project, several subcontractors are being used in the design and analysis of piping in the balance of plant.

The design criteria used by these contractors were reviewed to determine if they were defined and if they were consistent with those used by S&L.

Westinghouse has a majority of the piping in containment and some in the auxiliary building. The scope and design criteria were defined in the document:

(1) ."Interface Control Agreement Westinghouse Piping and Structural Evaluation Program For Byron Station Unit 1, Rev. 2, 1/8/81.

This document specified the use of the 1977 ASME Code, Summer 79 addenda, not the 1974 Code, Summer 75 addenda, as required by the FSAR. The use of this edition of the codes was considered acceptable by both S&L and CECo because the design rules in the edition of the code are approximately the same. Additional definition of work scope between Westinghouse and S&L was defined in a Westinghouse letter to S&L, CAW-4303 from W. Kortier to D. Leone. These two documents gave a thorough description of the design criteria.

In addition, Westinghouse has developed a code design specification for use by their design staff. The specification reviewed was Specification 955297, Class 1 Systems, Rev. 0, 9/8/80. Again, this was a well prepared design specification. The piping analysis was being completed using their piping analysis computer program WESTDNY. This program has been verified in a Westinghouse topical report to NRC.

Nuclear Power Service (NPS) is designing the small bore piping supports (two inch and under) in the auxiliary building. The scope and design criteria were specified in an S&L specification:

Specification for Piping Support Design and Related Activities Consulting Services; #109, 3/6/8/9 Amendment 1 - 3/1/82.

This specification imposes the 1974 ASME Code, Summer 75 addenda and the 1973 B31.1 standard. The design criteria were well stated in this specification.

- Power, Azco, Pope (PAP) has only limited design activities involved in the installation of the instrumentation. The scope and design criteria are stated in S&L's specification:

  - Instrumentation Installation Work Byron Station Units 1 and 2, #F2906, 8/18/77 with Amendment 4; 8/9/82.

The above document contained a good definition of the design criteria for the subcontractors involved in design activities.

Current Audit: There are no subcontractors involved in design activities on the LaSalle project at this time. Therefore, no additional checking was done in this area.

Question 9: Are design deficiencies noted on other projects investigated on these projects?

Information from previous evaluation (INPO):

The actions of the By/Br Project were reviewed regarding the deficiency noted on the Clinton project concerning the analysis procedures on small bore piping. They initiated three reviews of the small bore analysis on B/B by NPS. Two of the reviews were completed by the Mechanical Department and the Engineering Mechanics Department resulted in no findings. These reviews were reported in:

(1) S&L Interoffice Memo, review of small piping analysis performed by NPS, 12/11/81, from L. G. Vetler to W. Cleff.

(2) S&L Interoffice Memo, NPS Hot Piping Review, 8/27/82, from Mech/EMD Depart. to W. Cleff.

The first review covered the application of S&L standard analysis procedures by NPS for the analysis of small bore cold piping. They found NPS was properly applying these procedures. The second review covered the application of the analysis procedures for the analysis of hot piping and again it was found that NPS was properly applying these procedures.

A third review is in progress which is being completed by the same staff members who found the problem on the Clinton project. This is being done to assure no problems exist on the By/Br project. This appears to be a very extensive program.

Current Audit:

The By/Br projects review of the small bore piping issue is still in progress.

The LaSalle project completed a similar review to assure that the problems noted on the Clinton Project were not also common to LaSalle. Results of this review were noted in a letter:

(1) SDA-L, 1-12-83, Summary of Results on the Re-review work of Calculations for Loads and Locations for Two-Inch and Under Hand Calculations.

The review found no generic problems. Some minor analysis items were noted, but they did not require any changes.

S&L reactions regarding this area are considered to be extensive.

Question 10: Is a status list of safety-related equipment maintained?

Current Audit: S&L has a Component Qualification Department (CQD) that is responsible for the qualification of safety-related equipment. This department is used for both the By/Br Project and the LaSalle project.

By/Br Project:

These plants are a category I plant per NUREG 0588. The commitments made for the qualification of safety-related equipment are:

(1) Completion of all seismic qualification by startup.

(2) Completion of the environmental qualification of all 1E equipment in harsh environment by startup or justification must be given for allowing startup without the given equipment qualified.

(3) Completion of the environmental qualification of 1E equipment in mild environment by the first refueling.

The handling of the equipment qualification program is documented in PI-BB-19, "Review and Processing of Environmental Qualification Documentation for Safety-Related Equipment". This project instruction gives the data handling procedures for tracking and routing the qualification documents. The system in use is consistent with this PI.

CQD has developed a very thorough tracking system for all safety-related equipment which includes three index listings for equipment concerning environmental qualification.

(1) 1E equipment, harsh environment
(2) 1E equipment, mild environment
(3) Mechanical equipment

These lists are developed from the equipment list generated by the project staff for each system.

For tracking the seismic qualification of safety equipment, one index listing exists and is maintained by equipment specification number.

All the index lists are very thorough and give the current status of the qualification for the equipment. If the qualification is complete, it is noted as such and the qualification report numbers are noted on the index. These index lists give management quick access to the current status of the equipment qualification program for proper reaction to equipment needing attention. The status lists reviewed were:

(1) Status Report for Environmental Qualification of BOP - Class 1E Electrical Equipment Harsh environment.

(2) Status Report for Environmental Qualification of BOP - Class 1E Electrical Equipment "Mild Environment"

(3) Status Report for Environmental Qualification of BOP - Class 1E Electrical Equipment "Active Safety-Related Mechanical Equipment in Harsh Environment".

The following equipment list which was used to form the CQD status listing of equipment was reviewed.

(1) Mechanical Department Equipment List B1 Commonwealth Edison Co. By/Br Station Unit #1, Project 4391, page 1 of 1.

This list was for the auxiliary feedwater system and was originally prepared on 3/30/73 with the last update as Revision 16, 7/15/81. Included on the list was the equipment quality class (A, B, C, or D), seismic class (Cat. I or II), and the equipment specification number. A similar list existed for Unit 2 of both plants. There was an instrument index and valve list for each system. See R. Curran's Attachment B of this report for additional checking of these lists.

LaSalle Project:

This plant is a Category II plant as defined in NUREG 0588 for the original equipment. New equipment added will be qualified per the requirement for Category I.

S&L has an ongoing program for equipment qualification for both mild and harsh environments that has been committed to by CECo with the NRC. Seismic qualification for both mechanical and electrical equipment has been completed. As with the By/Br Project, the CQD department has a very thorough tracking system to note the qualification status of the equipment. The listing reviewed was:

Document # CQD-004154, "Safety-Related Equipment List for Environmental Qualification," dated August 1982.

This listing showed the current status of the equipment. In addition, the qualification documents for an electric motor, noted on the list as being qualified, were reviewed. CQD was readily able to locate the motor qualification documentation by the document number of the equipment list. Report reviewed was:

Document #CQD-003578, "Environmental Qualification of Reliance Electric Company Motor, Frame-256TCZ, TEAO," dated October 11, 1982.

This report was well documented.

Again, the LaSalle project has a very thorough program for documenting the current status of the equipment qualification.

AUDIT CHECKLIST

ENERGY INCORPORATED

DATE: 3/7-11/83

ORGANIZATION TO BE AUDITED:		AUDIT NO:	AUDITOR:
SARGENT AND LUNDY BYRON PLANT			R. J. Harris

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
1. How does the design criteria and functional requirements get disseminated to the design staff and is this information controlled?	By/Br Project: R. Netezl, SPE T. Thorsell, EPE M. Camba, Project Document Control LaSalle Project: R. Pollock, MPE C. Rible, Project Document Control	ACC	See Response to Audit Checklist questions in this attachment.
2. Does a program exist to use the experience on previous and current projects when procuring safety related equipment on current projects?	By/Br Project T. Thorseil, EPE R. Rakowski, MPE L. Letfow- Mech. Spec. Department	ACC	

* DISPOSITION: ACC.= ACCEPTABLE OBS. = OBSERVATION DEF. = DEFICIENCY

CHECKLIST APPROVED BY: ____________

FORM QA-014 (REV. 2, 4-82)

AUDIT CHECKLIST
CONTINUATION SHEET

ENERGY INCORPORATED

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
6. Are instructions in place which define the "as-built" activities and are the organizations responsible for the "as-built" activities defined?	LaSalle Project B. Parduhn, MPE S. Kanza, Sup.Str Design Engineer By/Br Project R. Rakowski, MPE G. Williams, Str. Engineer R. Netezl, SPE	ACC	
7. Are the construction packages thorough and are the related design documents defined in the packages?	By/Br Project A. Finnan, Hunter J. Young, Hunter B. Higgins - PG J. Brom - PG	ACC	
8. Are the design requirements for subcontractors involved in design activities defined?	By/Br Project D. Fraser- $\overline{W}$ A. Stone-NPS B. D'Donnell-NPS M. Donahue-PAP	ACC	

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AUDIT CHECKLIST
CONTINUATION SHEET

ENERGY INCORPORATED

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
3. Has physical space been reserved for equipment maintenance and removal, and for inservice inspections?	LaSalle Project R. Pollock, MPE J. Johnson, Proj. Sup. Mech. Drafting M. Gonzalez, EMD B. Pandit, MPE By/Br Project R. Rakowski, MPE R. Salsbury, ME	ACC	
4. Are functional and environmental testing required and documented for safety-related equipment?	By/Br Project K. Adlon, PE, QCD T. Thorsell, EPE R. Salsbury, ME	OBS.	
5. Are design reviews planned and documented?	By/Br Project R. Netezl, SPE T. Thorsell, EPE R. Rakowski, MPE	ACC	

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FORM QA-014 (REV. 2, 4-82)

ENERGY INCORPORATED

AUDIT CHECKLIST

CONTINUATION SHEET

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
9. Are design deficiencies noted on other projects investigated on these projects?	LaSalle Project B. Pardnhn, MPE S. Taylor, QA B. Mazza, PD By/Br Project B Cleff R. Rakowski	ACC	
10. Is a status list of safety-related equipment maintained?	LaSalle Project J. Sinnappan, CQD M. Spisak, Sr. Engr. By/Br Project R. Rahejq, Sup. CQD K. Adlon, DE-CQD	ACC	

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FORM QA-014 (REV. 2, 4-82)

ATTACHMENT B

AUDIT CHECKLIST QUESTIONS AND RESPONSES

R. N. CURRAN

RESPONSE TO AUDIT CHECKLIST QUESTIONS

Checklist Item Number	Question/Response
I	Follow-up on the INPO Self-Initiated Evaluation Criteria
I-1	What revisions have been made to PI-BB-17 since the INPO evaluation?

Response

Information from Previous Evaluation (INPO)

The S&L QA Program Topical Report, SL-TR-1A, assigns responsibility for defining internal interfaces to the project manager and external interfaces to the QA Department.

Eight Byron/Braidwood project instructions were reviewed with respect to identification of interface requirements and definition of responsibilities. In seven of the instructions reviewed, it was found that interface requirements were identified and responsibilities well defined. Reviewed were: PI-BB-08, 12, 14, 17, 19, 24, 34, and 36.

In reviewing PI-BB-17, Rev. 1, "Procedure for the Control of Cable Tray Loading", an interface between S&L structural and electrical departments was identified; however, responsibilities for the two departments were not defined.

The subject interface requires that in the event that maximum cable tray weight loading limit is exceeded the cable tray hangers will be analyzed and reinforced if required. Monitoring of cable tray loading is an electrical department function and the analysis and reinforcement of cable tray hangers a structural department function. In interviewing structural and electrical department personnel, I found, although not defined in the project instruction, the responsibilities of both departments were well understood.

The Senior Electrical Project Engineer informed me that PI-BB-17 was currently being revised and the definition of departmental responsibilities would be included in the revision.

Also found in interviewing electrical department personnel was a need to revise project instruction PI-BB-19, Rev. 1, "Review and Processing of Environmental Qualifications Documentation for 1E Equipment", because of the transfer of this responsibility to the Component Qualification Division (CQD).

Information from Current Audit

Byron/Braidwood

Project instruction PI-BB-19, Rev. 2, was reviewed and found to be completely revised, reflecting the transfer of responsibility for review and processing of qualification documentation from engineering to CQD.

Project instruction PI-BB-17, Rev. 1, the same revision reviewed in the INPO evaluation, was found to be in effect. The Engineering Assistant for Document Control,

in the Project Manager's office, was contacted and he verified that revision 1 of the instruction was the latest revision and to his knowledge no revision was forthcoming.

LaSalle County

A review of PI-LS-14, the LaSalle County project instruction controlling cable tray loadings, was found to have no interface requirement equivalent to Byron and Braidwood PI-BB-17 for cable tray weight overload. PI-LS-14 requires that in the event that a weight overload occurs, cables will be rerouted to eliminate the overload.

I-2 What changes have been made to Standard EB-146 to clarify installation of flexible conduit?

Response

Information from Previous Evaluation (INPO)

During the walkthrough of Byron Unit 1 containment building, an installed flexible conduit, associated with a category I isolation valve, was found to exceed six feet in length.

S&L Standard EB-146, which covers installation of flexible conduit, was reviewed. The standard limits the length of flexible conduit, regardless of size, to six feet. General notes drawing 6E-0-3390 was also reviewed and found to require flexible conduit to be installed per Standard EB-146.

An interview with electrical department personnel revealed that a general revision of Standard EB-146 was in progress. I also found that the subject of the standards requirements for flexible conduit installation had been under consideration since December 1981. I was provided with five documents to review, which traced the flexible conduit subject. The documents contained the following information:

(a) Minutes of Nuclear Projects Meeting No. 220, 12/4/81, Action Item No. 3, "Seismic Qualification of Flexible Conduit by Analysis", agreed to discuss with the structural department the documentation of the basis for maximum lengths of unsupported flexible conduit.

(b) Interoffice memo, Mr. Stensland to Mr. Erler dated 1/14/81, which requests that analysis be performed to confirm that the six feet maximum conduit length specified by EB-146 would meet seismic requirements.

(c) Letter, Electro-Flex to Mr. Gazda, dated 3/30/82, which transmitted specifications for their flexible conduits sized 3/4 inch to 4 inches.

(d) Interoffice memo, Mr. Smiesko to Mr. Duffy, dated 5/18/82, which transmitted to Electro-Flex specifications to the structural department for analysis.

(e) Interoffice memo, Mr Duffy to Mr. Stensland, dated 8/13/82, which reported that, for seismic acclerations of 5.5 g horizontal and 4.3 g vertical, straight lengths of flexible conduit can be safely used up to eight feet and "U" shaped conduit

vertically mounted was adequate for up to seven-foot lengths.

Eight drawings relating to the subject flexible conduit installation were reviewed with the conclusion that the conduit could have been installed using less than six feet of conduit. This led to interviews with construction personnel.

Mr. Gorski of the design control team interviewed construction engineers to determine how they interpreted the drawing and standards requirements. The concensus of the construction personnel was that drawings take precedence over standards and if equipment, between which flexible conduit is installed, is located according to construction drawings, then the installed conduit is within specifications even though it exceeds the standards limit of six feet.

The conclusion drawn from the above discussion is that there is a need to clarify the responsibility of the construction contractor in reporting installations involving flexible conduit exceeding six feet in length.

- In addition to the above review, I was requested to review the subject of qualification of cable grips. This request was made by INPO evaluation personnel who remained at the Byron and Braidwood sites during the evaluation and therefore did not have access to the information beyond that provided in Standard EB-200 which addresses the use of cable grips.

In an interview with electrical department personnel, I was provided with four letters and two interoffice memos to review. The four letters transmitted cable grip test

data from three venders to the S&L electrical department. The first interoffice memo, dated June 29, 1979, transmitted the vendor's data from the electrical department to the structural department and requested that the data be analyzed.

The final interoffice memo, dated July 24, 1979, from the structural department to the electrical department recommended size limitations for the different vendors for 1E applications. This memo resulted in the February 8, 1989 version of Standard EB-200.

Information from Current Audit

Byron/Braidwood

Section 7.3 of Standard EB-146 entitled "Standard Specification for the Installation of Seismic Category I Conduit Systems Containing Class 1E Cables" was reviewed. It was found that no changes were made to the six-foot limitation for flexible conduit installations. However, the following requirement was added to Section 7.3.1: "Where Electrical Installation Contractor determines that any of the above requirements cannot be met, the Electrical Installation Contractor shall notify S&L or the purchaser's representative".

The revision of EB-146 was dated January 22, 1983 and was issued as Amendment 26 dated February 10, 1982. Document Control was contacted and it was found that the Amendment 26 version of the standard was transmitted to the Byron site on February 11, 1983.

The letters and interoffice memos associated with Standard EB-200 were again reviewed in greater detail with

the result that no further information, beyond that reported above, was found.

I-3 What changes have been made to General Notes Drawing 6E 0-3390?

Response

Information from Previous Evaluation

Because of the conclusion drawn in I-2 above for the need for a clarification of responsibility of the construction contractor in reporting flexible conduit installations exceeding six feet, one consideration was a revision of the general notes drawing 6E-0-3390.

Information from Current Audit

In view of the revision to Standard EB-146, and since the general note drawing requires adherence to Standard EB-146, it is deemed not necessary to also revise the drawing.

I-4 What changes if any have been made to the contractor's data documents due to 2 and 3 above?

Response: Because the revised Standard EB-146 had been in the field for less than one month, there was no knowledge of any changes or reports of any instances of flexible couduit installation requiring more than six-foot lengths.

Note: The following questions were directed to the LaSalle County project.

I-5 What standard addresses flexible conduit installation at LaSalle?

Response: In an interview with electrical department personnel, it was determined that a September 9, 1976 version of Standard EB-146 was invoked for LaSalle County construction. A review of this version of EB-146 revealed that the six-foot maximum length limit for flexible conduit was in force at the time. I was also informed that installation of flexible conduit in lengths greater than six feet were allowed with the installation of a supported coupling installed between less than six-foot lengths of flexible conduit.

In the same interview it was found that the June 10, 1972 version of Standard EB-200 was invoked for LaSalle County construction. This version of the standard pre-dates the above-described analysis which resulted in size limitations of certain vendors' cable grips.

I-6 What electrical drawings contain general installation instruction, notes, etc., for flexible conduit at LaSalle?

Response: General Installation Note drawing 1E-0-3070 contains two references to Standard EB-146. One reference is a general reference to the applicability of the standard for installation of 1E equipment. The second reference to the standard concerns substituting Electro-Flex conduit for Anaconda conduit for sizes up to four inches.

I-7 What has been the experience at LaSalle for installations requiring greater than six-foot lengths of flexible conduit? How were discrepancies reported when installation could not meet requirements of 5 and 6 above?

Response: In an interview with Mr. R. Shiavoni, I was informed that he was not aware of any installations exceeding six feet in length which were unsupported. See response to I-5 above. Therefore, no discrepancies have been reported.

Checklist Item Number	Question/Response
II	Auxiliary Feedwater System (AFWS) Instrumentation and Control
II-1	Where are the electrical design requirements of the AFWS defined?
	<u>Response</u>: Design requirements are found in the FSAR, Design Criteria for Auxiliary Feedwater Systems, DC-AF-01-BB, and in Specification for Miscellaneous Control Systems FL2812. The AFWS control and primary instrumentation systems are categorized as 1E systems. One requirement, that of system response time, was found in the FSAR but not in the design criteria document. This item is treated in detail in Mr. Bigbee's audit checklist.
II-2	What standards (ANSI, IEEE, etc.) apply to the AFWS? Where are these standards defined?
	<u>Response</u>: Standards that apply to the AFWS were found in detail in the procurement specification for the AFWS. IEEE standards 279-71, 308-74, 323-74, 336-7, 344-75, and 420-70 are specified. ASME Boiler and Pressure Vessel Code, Section III 1974, including addenda and code cases in effect as of the purchase order date and ANSI B31.1, were also specified. Applicable S&L standards and CECo standards were also specified.
II-3	What are the instrumentation and control interfaces between S&L and the NSSS supplier for the AFWS? Where are these interfaces defined? How are these interfaces controlled?

Response: The NSSS supplier provides logic signals to the AFWS to autom? ically place the system in operation when required. This interface is documented in the FSAR and is found on drawings such as the P&ID M-37.

This interface is controlled by the document "Interface Control Agreements for Electrical FCNs between Westinghouse, CECo, and S&L".

II-4 What drawings exist for the AFWS instrumentation and control? Do these drawings satisfy the design requirements and the P&ID?

Response: Samples of numerous drawings applying to the AFWS were reviewed. Included in the review were logic diagrams, electrical instrumentation location drawings, schematics, wiring diagrams, mechanical instrument location drawings, installation detail drawings, instrument location drawings, and the P&ID.

To the extent possible, in the time available, the review of these drawings convinced me that the drawings satisfy the design requirements and confirm that the design conforms to design depicted by the P&ID.

II-5 Where are the environmental requirements for the AFWS electrical systems defined?

Response: Environmental requirements, including seismic requirements, were found in the procurement specification for the AFWS.

Environmental considerations such as flooding, missile protection are considered in deta:" in Mr. Bigbee's audit

checklist and seismic considerations in Mr. Harris' audit checklist.

II-6 What qualification reports were provided by vendors confirming that the electrical equipment supplied meets the design and environmental requirements? Have these qualification reports been reviewed and approved? By whom?

Response: The required qualification reports and certification of compliance were specified in the procurement specification.

Mr. Karl of CQD informed me that the CQD is handling the review and approval of vendor qualification reports and these are about 75% completed at this time. A random sample of AFWS components qualification reports was reviewed; some had been completed, one reviewed but not approved, and two reports were expected in April 1983.

II-7 Where are manual controls for the AFWS located?

Response: Manual controls for the AFWS are located in the main control room with a redundant set of controls located in the remote shutdown control room. Controls are provided in both locations for pumps and valves. Transfer switches are available in the remote shutdown control room to transfer control between the remote and main control rooms.

II-8 What instrumentation is provided to verify correct operation? Where is the information available to the operator?

Response: Flow rate information to each steam generator and valve position information is provided in both the main control room and in the remote shutdown control room. Also, information not specifically required for system operation is provided on local panels. Steam generator level information is also available; see Mr. Bigbee's audit check, Questions I-7 and I-20.

II-9 What are the sources of power to the AFWS pumps? What diversity of power sources is used?

Response: One AFWS pump is electrically powered; the other is a direct diesel drive which provides for diversity of AFWS pumping power. In addition, instrumentation and control power for each pump is supplied by redundant 1E power sources.

II-9 What electrical provisions are provided for operational testing?

Response: In addition to the aforementioned instrumentation and controls, local pressure instrumentation has been installed for testing purposes. Mr. Bigbee's audit Question I-26 also addresses testing.

AUDIT CHECKLIST

ENERGY INCORPORATED

DATE: 3/7-11-83

ORGANIZATION TO BE AUDITED:		AUDIT NO:	AUDITOR:
SARGENT AND LUNDY			R.N. Curran

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
I. FOLLOW-UP ON THE INPO SELF-INITIATED EVALUATION CRITERIA			
1. What revisions have been made to PI-BB-17 since the INPO evaluation?	PI-BB-17 Rev. 1	DEF	See Response to Audit Checklist questions, Attachment B.
2. What changes have been made to Standard EB-146 to clarify installation of flexible conduit?	EB-146	ACC	
3. What changes have been made to general notes drawing 6E-0-3390?	6/20E-03390 6/29/82	ACC	
4. What changes if any have been made to contractor's data documents due to 2 and 3 above?	G. Sensmeier	ACC	

* DISPOSITION: ACC. = ACCEPTABLE OBS. = OBSERVATION DEF. = DEFICIENCY

CHECKLIST APPROVED BY: [signature]

FORM QA-014 (REV. 2, 4-82)

ENERGY INCORPORATED

AUDIT CHECKLIST

CONTINUATION SHEET

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
5. What standard addresses flexible conduit installation at LaSalle?	EB-146 9/21/76 J2559	ACC	See response to audit checklist questions, Attachment B.
6. What electrical drawings contain general installation instructions, notes, etc. for flexible conduit at LaSalle?	1E-0-3070	ACC	
7. What has been the experience at LaSalle for installations requiring greater than 6 foot lengths of flexible conduit?	R. Shiavoni SEPE LaSalle Co.	ACC	
a. How were discrepancies reported when installation could not meet requirements of 5 & 6 above?	R. Shiavoni SEPE LaSalle Co.	ACC	

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FORM QA-014 (REV 2, 4-82)

AUDIT CHECKLIST

DATE: 3/7-11/83

ENERGY INCORPORATED

ORGANIZATION TO BE AUDITED: SARGENT AND LUNDY		AUDIT NO:	AUDITOR: R. N. CURRAN
CHARACTERISTIC	**REFERENCE**	**DISP.***	**COMMENTS**
II. AUXILIARY FEEDWATER SYSTEM INSTRUMENTATION AND CONTROL			
1. Where are the electrical design requirements of the AFWS defined?	FSAR DC-AF-01-BB FL-2812	ACC	See response to audit checklist questions, Attachment B.
2. What standards (ANSI, IEEE, etc.) apply to the AFWS? Where are these standard requirements defined?	FL-2812	ACC	
3. What are the instrumentation and control interfaces between S&L and the NSSS supplier for the AFWS? a. Where are these interfaces defined? b. How are these interfaces controlled?	FSAR M-37 Attachment A to Interface Control Agreements for Electrical FCN's between West-CECo & S&L	ACC	

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CHECKLIST APPROVED BY: ____________

FORM QA-014 (REV. 2, 4-82)

AUDIT CHECKLIST
CONTINUATION SHEET

ENERGY INCORPORATED

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
4. What drawings exist for the AFWS instrumentation and control? a. Do these drawings satisfy the design requirements and the P&ID?	M-37 1PMOGJ 1AF04 1AF05 0-3323 1-4030AF10 828-9 334A & 5B	ACC	See response to audit checklist questions, Attachment B.
5. Where are the environmental requirements for AFWS electrical systems defined?	FL-2812	ACC	
6. What qualification reports were provided by vendors confirming that the electrical equipment supplied meets the design and envrionmental requirements? a. Have those qualification reports been reviewed and approved? b. By Whom?	Qualification Reports for 1FT-AF015 1PSL-AF051 1PSL-AF052 A. Karl	ACC	

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AUDIT CHECKLIST

CONTINUATION SHEET

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
7. Where are manual controls for the AFWS located? a. What controls are provided?	FSAR M-37 Instrument List G. Sensmeier	ACC	See response to audit checklist questions, Attachment B.
8. What instrumentation is provided to verify correct operation? a. Where is this information available to the operator?	FSAR M-37 Instrument List G. Sensmeier	ACC	
9. What are the sources of power to the AFWS pumps? a. What diversity of power sources is used?	FSAR M-37 G. Sensmeier	ACC	

* DISPOSITION: ACC.= ACCEPTABLE OBS.= OBSERVATION DEF.= DEFICIENCY

AUDIT CHECKLIST
CONTINUATION SHEET

ENERGY INCORPORATED

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
10. What electrical provisions are provided for operational testing?	M-37 Instrument List	ACC	See response to audit checklist questions, Attachment B.

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FORM QA-014 (REV. 2, 4-82)

ATTACHMENT C

AUDIT CHECKLIST QUESTIONS AND RESPONSES

D. BIGBEE

RESPONSE TO AUDIT CHECKLIST QUESTIONS

Checklist Item Number	Question/Response

I. Auxiliary Feedwater System (AFWS)

I-1 Where are the design requirements for the Auxiliary Feedwater System (AFWS)? How were they assembled, and what was done to assure completeness?

Response: The design criteria are found in Design Criteria For Auxiliary Feedwater Systems DC-AF-01-BB, Revision 1, dated 11-29-76, and in the FSAR. A review of the design criteria document found useable information, but it did not contain the requirements for AFWS response time; i.e., what is the maximum allowed time from system initiation signal to full flow. The response time was included in the FSAR. The design criteria document should be updated to be consistent with the FSAR. This document contained appropriate references, but generally the text did not cite specifically where each criterion came from. In an interview with Mr. Greg Sensmeier, it was noted that the three individuals who signed the document were no longer with S&L. The design flow rates were verified from source to use by Dr. Farman's response to his question 1.

I-2 Is system classification correct? Safety class and seismic category?

Response: The AFWS is safety class 3, corresponding to ASME B&PV code Section III, Class 3. Electrically it is 1E, and

it is seismic category I. This is consistent for a cooling system and corresponds to other power plants' classification for this system.

I-3 Are design conditions (pressure, temp., flow rates) adequate and is their basis documented?

Response: The system design pressure should be the shutoff head of the pump, which is provided. Design temperature was 100°F up to the last shutoff valve which is reasonable for either emergency service water or the condensate storage tank. The design flow rates were verified from source to use by Dr. Farman's response to his question 1. Also see response to 1 above.

I-4 What are the functional requirements time to achieve rated flow rate, etc.? Will this system recover level in all S/Gs prior to losing level on the worst case event (probably a load reject with loss of off-site power)?

Response: The time to achieve rated flow is given as one minute in the FSAR but is not provided in the design criteria document. The minimum flow to unfaulted steam generators was in the design criteria document, but this was changed somewhat in the FSAR. See Dr. Farman's response to his question 3.

The questions relative to steam generator level become moot because of the specific design provided by Westinghouse. In an interview with Mr. Ken Green, it was determined that Westinghouse no longer has the requirement of not feeding a dry steam generator as long as it is fed through the upper feed nozzle since this path puts the cold water on top of

the shroud and thus ensures the water is heated prior to reaching the tube sheet. In view of this, keeping level on scale is not required.

I-5 Will the instrumentation and controls actually function such that the system can meet the requirements above? How was this checked?

Response: This area was covered by Mr. Curran.

I-6 What prevents feeding a dry S/G? Is it possible to get a dry S/G with AFWS feeding it? Will AFWS keep up with one stuck relief valve?

Response: Moot point. See response to 4 above.

I-7 Are S/G levels easily readable from the proper operating position for the system controls?

Response: Wide range steam generator levels are provided on the AFWS control panel, per interview with Mr. Greg Sensmeier, Sr. Project Engineer, Control and Instrumentation.

I-8 Are instruments and controls easily recognizable; i.e., are these grouped by individual system so as to minimize confusion of the operator?

Response: Per interview with Mr. Greg Sensmeier, instruments and controls on the AFWS control panel are grouped first by train and then by steam generator so that flow paths can be followed and controlled without undue confusion. It should be noted that additional human factors are

being considered in the control room at this time; however, the design is quite adequate by the standards generally in use at the time this design was done.

I-9 If system is used for startup and shutdown, how is the transition from AFWS to main feed made? Is this easy and controllable by the operator?

Response: The AFWS is not used for startup, shutdown, or normal operations per the design criteria document and the FSAR.

I-10 Prevention of pump failure due to overheating; i.e., is there a mini flow line? How was it sized? Is there a mechanism to ensure this is checked?

Response: Each AFWS pump has a mini flow line routed back to the condensate storage tank or the emergency service water system, whichever source is in use. From interviews and the pump specification, it was determined that the flow requirement was provided by the pump vendor in specification F/L 2758C. There is a mechanism to ensure this cooling flow is considered. S&L has a generic specification for feedwater pumps. This generic specification specifically requires the vendor to supply minimum circulation through the pump both in the text and in the data sheets. Since S&L does use these generic specifications, the mini flow requirement will not be overlooked.

I-11 Is instrumentation available to the operator to allow determination of system functional condition? Is there flow indication, etc., to show that system is functioning?

Response: Flow rate is provided on the AFWS control panel for AFWS flow to each steam generator. Lights are provided

for valve position information. This was determined from both the P&ID and the FSAR. The operator can determine whether or not the system is functioning.

I-12 If system is seismic category I, how was this this verified? Where were calculations used? Where were shake tests used?

Response: The AFWS is seismic category I. The area of seismic qualification was reviewed by Mr. Bob Harris.

I-13 If shake test used (control equipment), how were test criteria selected (hot, cold, response spectra, mounting configuration, etc.)? What system was used to review test results such as:

a) Mounting Configuration?
b) If energized how was lack of relay charter verified?
c) Were response spectra satisfied?
d) Were all external connections made for test?
e) Was test report complete so that all applicable conditions are apparent?
f) How is assurance made that mounting at site is the same as for test?
g) Adequacy of aging prior to test?

Response: The area of seismic qualification was reviewed by Mr. Bob Harris.

I-14 How is it verifed that all safety portions of the system were inside seismic category I structures?

Response: A review of the P&ID and pipe plan drawings verified that all of the safety portions of AFWS were in fact inside the auxiliary building. The system for ensuring this is showing the building boundary changes and system

classification on the P&IDs. It is within the scope of the engineer to recognize which buildings are seismic category I.

I-15 How is it verified that the system is protected from:

a) Flooding
b) External missiles (special attention to condensate storage)

Response: Protection from flooding and external missiles is verified by keeping the system within the confines of the auxiliary building. Note that the condensate storage tank is not considered to be satety related even though it is the preferred source of water to the AFWS because of its water quality. The secondary and safety-related source of water is the emergency service water system.

I-16 What is the system's worst missile? Are there other trains in the same room as this missile? Can this missile penetrate any wall or floor of the room it is generated in? Are there potential missiles from this or other systems that can affect this system? Is there a system for verifying missile protection?

Response: The FSAR states that this system does not generate any missiles. This question is applicable to plants using a turbine-driven auxiliary feedwater pump. Since Byron uses a diesel-driven pump, no components of the system could be expected to generate a significant missile.

I-17 Protection from pipe whip and jet impingement requires a systematic method of evaluation. What method is used? Are rooms (walls, floor, ceiling) considered, as well as other systems in a given area?

Response: From an interview with Mr. Baykar Tatosian. Mr. Tatosian is responsible for intiation of pipe break analysis for the Byron project. The overall method was examined in part because high energy pipe break need not be considered on AFWS lines since the system is not used for normal start-up, shutdown, or operation. From the interview, Mr. Tatosian starts with a list of high energy lines. Each line is then broken down into subsystems. Each subsystem has a stress report. Each subsystem is then analyzed for break locations per MEB 3.6.1. Care is taken when doing this on subsystems that are in two rooms to keep the break in the applicable room. From this, restraint locations are determined. Procedure TB-24 is used to analyze subsystems. Before that, no written procedures are available; however, this is well within the engineer's capabililty. Mr. Tatosian then assembles the applicable information such as break location, pipe movement, thermal pipe movement, impingement data, etc., and transmits the data to the Structural Group.

An interview with Mr. Dino Pattel, who is responsible for this area, revealed that Mr. Pattel's group then provides a detailed restraint design and analyzes any structures to ensure that the loads are acceptable. Should any loads be unacceptable, a process is initiated to resolve the issue.

I-18 How are rooms housing AFWS protected from overpressure which could result from line breaks?

Response: Note: Flooding, usually from potential moderate energy pipe breaks, is included in this response.

From an interview with Mr. Norm Weber of the Nuclear Licensing and Safeguards Division, it was determined that no formal written procedure is used in determining rooms to be

analyzed. This is considered to be within the engineer's capability.

Mr. Weber's group starts with a list of high energy and moderate energy lines. These lines are traced on a set of composite drawings, and each room containing one of these lines is identified and a break is postulated. Then each room along with contiguous spaces is modeled for pressurization or flooding as applicable. Studies are completed and pressure temperature profiles or flooding data are sent to structural, initially for design purposes and later to verify structural capability. Significant effort is spent ensuring that project personnel are aware of the significance of moving pipes to previously unaffected rooms and other changes that could impact this subject.

From an interview with Mr. Dino Pattel of structural, the above data are received and the affected structures are initially designed to accept the loadings and later analyzed to verify that loadings from pressure or flooding are acceptable. A significant safety factor is added to initial data at the design phase to minimize the possibility of having unacceptable loadings as design is completed. Any unacceptable loadings are flagged and a resolution is pursued by Mr. Pattel.

I-19 Are any portions of AFWS shared between Units 1 and 2?

Response: No part of AFWS is shared between units, as easily determined from the P&ID.

I-20 AFWS can be utilized in a prompt hot shutdown and subsequent cooldown. Can this be accomplished from the control room and also from a location outside the control room?

Can the plant be maintained in hot shutdown and be subsequently cooled down to RHR transfer pressure using only safety grade equipment as requested by Branch Technical Position RSB 5-1 (from control room only)?

Response: From an interview with Mr. Greg Sensmeier and review of the AFWS P&ID, it is clear that all required instrumentation and controls are available on one panel in the control room to allow operation of the AFWS. The remote shutdown panel has pump switches, stop valve switches, throttle valve switches, flow indication, and steam generator level indication. Hence, complete system operation can be accomplished from the remote shutdown panel. From an interview with Mr. Ken Green, there is no problem with AFWS insofar as shutting down and cooling down with only safety-related equipment as requested by Branch Technical Position RSB 5-1. There is some difficulty with supplying adequate boron at certain times in core life with only safety-related equipment which can result in a rather lengthy time requirement to achieve cold shutdown.

I-21 Can AFWS remove heat from the Rx core at a sufficient rate between hot shutdown and RHR transfer?

Response: Westinghouse provided the design flow rates which would ensure sufficient cooldown capability; hence, this responsibility does not lay with Sargent and Lundy.

I-22 Are AFWS rooms and equipment sufficiently cooled by safety grade equipment to perform their cooldown function (room cooling and especially as relates to control equipment)?

Response: In an interview with W. B. Paschal, HVAC, the method used to ensure adequate cooling in any room was

determined. Early in the project, HVAC zones are established based on expected equipment types within the zones. The zone temperatures are set down in Table 3-11 of the PSAR and later FSAR. The engineers who purchase electrical and control equipment use Table 3-11 and the location of the equipment to determine what temperature will be maintained. That temperature is included in the equipment specification. As design progresses, HVAC calculates heat loads from vendor data such as motor ratings. Lighting heat loads are included. All heat loads are tabulated for each space, which in turn allows the final air flow rate to be calculated for each space. This methodology appears adequate.

Since the AFWS is used to deal with a total loss of AC power, cooling for the diesel-driven pump train was questioned. The diesel is supplied with an engine-driven fan which provides adequate air cooling.

I-23 Can AFWS meet single failure criteria with either off-site or on-site power? How was this determined? Does AFWS meet Branch Technical Position ASB 10-1 as relates to pump drive and power supply diversity?

Response: The AFWS P&ID was reviewed and the system was determined to meet the single failure criterion mechanically and with respect to power sources. No documentation was found to verify consideration of single failure criteria; however, the actual design verifies that single failure was considered and met. In addition, the design criteria requirement for AFWS to be operable during a total loss of AC power was considered and met by use of a diesel-driven pump and DC power backup to that train's instrumentation.

It is apparent that the AFWS does not meet the specific desires of Branch Technical Position ASB 10-1. Since this system was designed well before ASB 10-1 was published, this is not surprising. An interview with Mr. Ken Green indicates that considerable discussion has taken place on these differences and hence has been carefully examined.

I-24 Does AFWS have the capability to isolate components, subsystems, or piping, if required, so that the system safety function will be maintained? (Example: if one S/G depressurized, will others be fed properly?) How was this shown? Was AFWS reliability examined in light of NUREG-0611?

Response: No automatic isolation is required on AFWS since the system was designed to meet cooling requirements by use of orifices and excess flow capability to ensure adequate flow to the unaffected steam generators. Once the AFWS is operating the only automatic functions are switchover to emergency service water, including mini flow realignment, with backflow protection by check valve and automatic pump start. All normal flow paths are via normally open valves. The minimization of automatic functions significantly improves system reliability.

I-25 How were provisions included in the design of AFWS to allow for appropriate in-service inspection?

Response: The area of in-service inspection consideration was covered by Mr. Bob Harris.

I-26 How was AFWS designed to permit appropriate functional testing? Can leak tightness be verified during a functional test? Can flow rates be verified during the test? Can response times be verified during the test?

Response: A review of the AFWS reveals that a test connection is provided in each header just prior to the tie-in to the feedwater system and a flange fitting is included such that the flow path to the steam generator can be blinded off and the water routed through the normally blind flanged test connection. This allows functional testing using Emergency Service Water (ESW) without putting ESW into the steam generators. With condensate storage water, the AFWS can be tested for most functions while at power. High flow indication can be verified when the steam generators are sufficiently low in pressure. Functional testing was considered in the system design.

Additionally, a pump suction strainer and local indicators are provided for startup testing.

Leak tightness can be verified for the most part visually since the system is not insulated and vent/drain connections are capped. The leak paths which are not easily verifiable are those back through the check valves into condensate storage and the pump casing drain. The one particular problem of Emergency Service Water (ESW) leakage into the system is handled by double valve protection with a leak-off line between the double valves which is kept open and includes a bullseye. Thus, any leakage out the leak-off line can be seen.

Flow rates can be obtained from installed instrumentation and can be verified during pre-op testing by condensate storage tank drawdown.

Response times can be verified with no particular problem.

Overall, these aspects of system design have been well done.

I-27 Is there anything in the design of AFWS that would require an input to the tech specs? (Some design features can be simplified by tech spec limitation such as minimum flow requirements.) Is there a method that ensures that any requirements are entered into the tech specs?

Response: Surveillance test criteria, such as pump discharge head at minimum flow, are required in technical specifications as criteria used to verify system operability. An interview with Mr. Terry Hottle, System Engineer, revealed that this information is sent to the Nuclear Licensing and Safeguards Division for transmittal to Commonwealth Edison.

I-28 Can AFWS be manually initiated from the control room?

The AFWS can be initiated from the control room or the remote shutdown station by use of the pump start hand switches.

I-29 What method is provided to detect system leakage?

Response: Included in response to 26.

I-30 Are provisions made to isolate portions of the system to control excessive system leakage or to isolate malfunctioning components?

(a) Are these controls manual-automatic or both?

Response: Included in response to 24.

I-31 P&ID Review - General

Response: The P&ID was reviewed for overall design and clarity of definition. One difficulty was encountered with the symbol for class and/or piping design table change marker defined on P&ID M-34, Sheet 2 of 5, Rev. G. This is a diamond symbol and is used to identify codes and seismic category for the lines involved. The letters and numbers use in each half of the symbol are not defined on the P&ID. An interview with Mr. Jeff Tenwinkel indicated that the letters/numbers came from the piping line list format and procedure MES-2.7. Rev. A was examined. Section 6.0, paragraph F, defined the letters A, B, C, D, and others. Section 6.0, paragraph L, defined the numbers I and II as seismic category. These definitions do not allow for a designation of DI which was used on the P&ID. DI is intended to mean power piping code (nonsafety related) pipe that is seismically hung due to its location in the plant. This is not defined nor could a statement be found that stated that the above definitions are to be used in the diamond marker on the P&IDs. The letters and numbers used should be defined on P&ID M-34 or their definition should be referenced.

I-32 P&ID review against pipe plan drawings.

Response: The P&ID was checked against the plan piping drawings (see notes for drawing numbers and revisions used).

Only piping 2-1/2 nominal and up could be checked since that is all that is routed on the plan views.

Discrepancies:

(1) Two valves, IAF029 A and B, were not yet on the P&ID but were on the plan views. This is not a problem since the change was very recent and there is documentation on the change.

Configuration differences:

(1) In two locations there is a configuration difference concerning 4" lines 1AF02CA, CD, CE, and CG between the P&ID and the piping plan. This involves the use of reducers and Tees versus reducing Tees. These are not considered discrepancies.

All other applicable items were checked and found to be in conformance.

NOTES:

(1) Where the P&ID is referred to, it always means P&ID M-37, Revision V.

(2) Where the design criteria document is referred to, it always means Design Criteria for Auxiliary Feedwater Systems DC-AF-01-BB, Revision 1, dated 11-29-76.

(3) Pipe plan drawings used were:

M-541, Sht. 1, Rev. AC; Sht. 2, Rev. J; Sht. 3, Rev. J; Sht. 4, Rev. J; Sht. 5, Rev. J; Sht. 6, Rev. L; Sht. 7, Rev. J; Sht. 8, Rev. L; and Sht. 9, Rev. F.

AUDIT CHECKLIST

ENERGY INCORPORATED

DATE: 3-7-11/83

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ORGANIZATION TO BE AUDITED:	AUDIT NO:	AUDITOR:
Sargent and Lundy Byron Plant		J. D. Bigbee

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
1. Where are the design requirements for the Auxiliary Feedwater System (AFWS)? How were they assembled, and what was done to assure completeness?	DC-AF-01-B FSAR	OBS	See response to audit questions following this audit checklist.
2. Is system classification correct? Safety class and seismic category?	See 1	ACC	
3. Are design conditions (pressure, temp., flow rates) adequate and is their basis documented?	See 1	ACC	
4. What are the functional requirements time to achieve rated flowrate, etc.? Will this system recover level in all S/Gs prior to losing level on the worst case event (probably a load reject with loss of off-site power)?	See 1 K. Green	ACC	

* DISPOSITION: ACC. = ACCEPTABLE OBS. = OBSERVATION DEF. = DEFICIENCY

CHECKLIST APPROVED BY: [signature]

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AUDIT CHECKLIST

CONTINUATION SHEET

ENERGY INCORPORATED

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
5. Will the instrumentation and controls actually function such that the system can meet the requirements above? How was this checked?	See 1	NA	See response to audit questions following this audit checklist.
6. What prevents feeding a dry S/G? Is it possible to get a dry S/G with AFWS feeding it? Will AFWS keep up with one stuck relief valve?	See 1 G. Sensmeier	NA	
7. Are S/G levels easily readable from the proper operating position for the system controls?	G. Sensmeier	ACC	
8. Are instruments and controls easily recognizable, i.e., are these grouped by individual system so as to minimize confusion of the operator?	G. Sensmeier	ACC	

* DISPOSITION: ACC.= ACCEPTABLE OBS.= OBSERVATION DEF.= DEFICIENCY

AUDIT CHECKLIST
CONTINUATION SHEET

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
9. If system is used for startup and shut-down, how is the transition from AFWS to main feed made? Is this easy and controllable by the operator?	See 1	NA	

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ENERGY INCORPORATED

AUDIT CHECKLIST
CONTINUATION SHEET

DATE: 3-7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
10. Prevention of pump failure due to over-heating, i.e. is there a mini flow line? How was it sized? Is there a mechanism to ensure this is checked?	FL2758C	ACC	
11. Is intrumentation available to the operator to allow determination of system functional condition? Is there flow indication, etc. to show that system is functioning?	FSAR M-37	ACC	
12. If system is seismic catagory I, How was this verified? Where were calculations used? Where were shake tests used?	GDC-2	NA	
13. If shake test used (control equipment) How was test criteria selected? (Hot, cold, response spectra, mounting configuration, etc.) What system was used to review test results, such as: a) Mounting configuration? b) If energized, how was lack of relay charter verified? c) Were response spectra satisfied? d) Were all external connections made for test? e) Was test report complete so that all applicable conditions are apparent ? f) How is assurance made that mounting	GDC-2	NA	

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CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
at site is the same as for test? g) Adequacy of aging prior to test?			
14. How is it verified that all safety portions of the system were inside seismic catagory I structures?	GDC-2	ACC	
15. How is it verified that the system is protected from:	GDC-2	ACC	
a) flooding	GDC-4		
b) external missiles (special attention to condensate storage)			
16. What is this systems worst missile?			
Are there other trains in the same room as this missile? Can this missile penetrate any wall or floor of the room it is generated in?	GDC-4	NA	
Are there potential missile from this or other systems that can affect this system? Is there a system for verifying missile protection?			

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ENERGY INCORPORATED

AUDIT CHECKLIST
CONTINUATION SHEET

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
17. Protection from pipe whip and jet impingement, require a systematic method of evaluation. What method is used? Are rooms (walls, floor, ceilings) considered, as well as other systems' in in a given area?	GDC-4	ACC	
18. How are rooms housing AFWS protected from over pressure? Which could result from line breaks?	GDC-4	ACC	
19. Are any portion of AFWS shared between units 1 and 2?	GDC-5	ACC	
20. AFWS can be utilized in a prompt hot shut down and subsequent cool down. Can this be accomplished from the control room and also from a location outside the Control Room? Can the plant be maintained in Hot shut down and be subsequently cooled down to RHR transfer pressure using only safety grade equipment as requested by Branch Technical Position RSB 5-1 (from Control Room only)?			

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AUDIT CHECKLIST

CONTINUATION SHEET

ENERGY INCORPORATED

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
21. Can AFWS remove heat from the R_x core at a sufficient rate between hot shut down and RHR transfree?	GDC-34	ACC	
22. Are AFWS rooms and equipment sufficiently cooled by safety grade equipment to perform their cool down function? (Room cooling and especially as relates to control equipment.)	GDC-44	ACC	
23. Can AFWS meet single failure criteria with either offsite or on-site power? How was this determined? Does AFWS meet Branch Technical Position ASB 10-1 as relates to pump drive and power supply diversity.	GDC-34 & 44	ACC	
24. Does AFWS have the capability to isolate components, subsystems, or piping if required, so that the system safety function will be maintained? (Example: If one S/G depressurized, will others be fed properly?) How was this shown? Was AFWS reliablity examined in light of NUREG-0611?	GDC-34 & 44	ACC	

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AUDIT CHECKLIST

CONTINUATION SHEET

ENERGY INCORPORATED

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
25. How were provisions included in the design of AFWS to allow for appropriate in-service inspections?	GDC-45	NA	
26. How were AFWS designed to permit appropriate functional testing? Can leak tightness be verified during a functional test? Can flow rates be verified during the test? Can response times be verified during the test?	GDC-46	ACC	
27. Is there anything in the design of AFWS that would require an input to the Technical Specifications? (Some design features can be simplified by Tech. Spec. Limitation such as minimum flow requirements.) Is there a method that ensures that any requirements are entered into the Tech. Specs?		ACC	
28. Can AFWS be manually initiated from the control room?	R.G. 1.29 Rev. 3	ACC	
29. What method is provided to detect system leakage?		ACC	

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AUDIT CHECKLIST
CONTINUATION SHEET

ENERGY INCORPORATED

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CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
30. Are provisions made to isolate portions of the system to control excessive system leakage or to isolate malfunctioning components? a. Are these controls Manual-Automatic, or both?	See 24	ACC	
31. P&ID Review General.	M-37	OBS	
32. P&ID Review aganinst pipe plan drawings.	M-37 M-541	ACC	

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ATTACHMENT D

AUDIT CHECKLIST QUESTIONS AND RESPONSES

R. F. FARMAN

RESPONSES TO AUDIT CHECKLIST QUESTIONS

Checklist Item Number	Question/Response

I. Design Analysis

I-1 Is there a functional specification for the design of the auxiliary feedwater system?

Response - The Sargent & Lundy design document is numbered as DC-AF-01-BB and titled, "Commonwealth Edison Company, Byron Station Units 1 & 2, Braidwood Station Units 1 & 2, Design Criteria for Auxiliary Feedwater Systems". The criteria are derived from Westinghouse Electric Company specifications, as follows:

(1) Westinghouse Standard Information Package 10-1

(2) Letter number CAW-1839, February 23, 1977

(3) FSAR

I-2 What procedures and standards are employed in hydraulic system design?

Response - Sargent & Lundy's procedures for hydraulic design analysis are contained in a document designated as MES 2.10 dated June 24, 1971. The current version is dated June 29, 1982.

I-3 Were analyses performed to establish the auxiliary feedwater system design, including system and pumps?

Response - The auxiliary feedwater system hydraulic design calculations are contained in calculation packages designated as AFJK-1, October 14, 1977, and AFJD-1, June 26, 1979.

The design problem addressed by Sargent & Lundy in calculation no. AFJK-1 was: find the size of a set of flow-limiting orifices that satisfy the system flow specifications. The flow requirements are as follows:

(1) Total system flow = 890 gpm

(2) Flow to each of three unfaulted steam generators = 160 gpm

The design basis condition for the system is a steam line break in one steam generator with only one auxiliary feedwater pump available. The analysis demonstrates that the system functions according to specification when the orifices have a value of b (diameter ratio) of 0.22.

The other secondary system accident condition involving the auxiliary feedwater is one in which there is a rupture in the main feedwater system. The auxiliary feedwater system performance was reanalyzed for this condition. For this case, it was found that the flow delivery to the unfaulted steam generators was 153 gpm, each. While this is 7 gpm below the original specification, it corresponds to the value presented in the FSAR, Chapter 15 for the analysis of the feedwater line break transient. Since the results of the transient analysis indicate that the system functions acceptably, it is concluded that the auxiliary feedwater system design conforms to all flow requirements.

A second requirement of the system is to provide the required net positive suction head to the auxiliary feed pumps. The pump specification requires NPSH = 23 ft. Calculation no. AFJD-1 analyzes a modification to the original system wherein a 20-inch line is permanently connected between the condensate storage tank and the auxiliary feed pump suction line.

In the analysis it is assumed that the rated flow of both auxiliary feed pumps is imposed upon the suction piping. The calculations show that under this condition the available NPSH is 21 ft. when the condensate storage tank level is zero. Since the normal head in the condensate storage is 40 feet and the switchover to essential service water occurs at a level of seven feet, it is concluded that the NPSH requirements for the system have been satisfied.

II. Transients

II-1 Was the transient behavior of the auxiliary feedwater system analyzed to determine:

(1) Water hammer effects?

(2) Startup response characteristics?

Response - These analyses were not performed for the auxiliary feedwater system. The decision as to whether or not to perform these analyses on a given system depends upon Sargent & Lundy's experience with similar systems, and auxiliary feedwater systems have no history of water hammer problems. Water hammer can result from the following conditions:

(1) Voids in the system at the beginning of startup.

(2) Backflow against fast-acting check valves.

(3) Rapid closure of fast-acting stop valves or control valves during operation.

The auxiliary feedwater system is protected against voids as follows:

(1) The system is entirely below the level of the condensate storage tank so that, once filled, leakage will not empty the system.

(2) Backflow from the main feedwater system (which might flash in the auxiliary feedwater system) is prevented by two check valves in series.

The system contains no quick-closing valves and the check valves are damped to assure a soft closure. Thus, none of the conditions necessary to create a water hammer condition exists in this system.

II-2 Does the safety analysis of the plant involve the behavior of the auxiliary feedwater system? If so, how was this behavior analyzed?

Response - The behavior of auxiliary feedwater system is included in some safety calculations. It is conservatively assumed that no auxiliary feedwater is available until 60 seconds after the actuating signal. At this time, the design flow rate is assumed to exist. This procedure for accounting for auxiliary feedwater in the safety analysis requires no further calculations.

AUDIT CHECKLIST

ENERGY INCORPORATED

DATE: 3/7-11/83

PAGE: 1 OF 2

ORGANIZATION TO BE AUDITED:		AUDIT NO:	AUDITOR:
SARGENT AND LUNDY			R. F. FARMAN

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
I. DESIGN ANALYSIS			
1. Is there a functional specification for the design of the auxiliary feedwater system?	S&L Document DC-AF-01-BB W documents; SIP 10-1, CAW-1839 FSAR. T. Hottle	ACC	See response to audit questions
2. What procedures and standards are employed in hydraulic system design?	MES 2.10 Hottle	ACC	
3. Were analyses performed to establish the auxiliary feedwater system design, including piping system and pumps?	Calc nos. AFJK-1, and AFJD-1 T. Hottle	ACC	
II. TRANSIENTS			
1. Was the transient behavior of the auxiliary feedwater system analyzed to determine:	B. Tatosian W. Cleff	ACC	
a. water hammer effects			

* DISPOSITION: ACC.= ACCEPTABLE OBS.= OBSERVATION DEF.= DEFICIENCY

CHECKLIST APPROVED BY: [signature]

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ENERGY INCORPORATED

AUDIT CHECKLIST
CONTINUATION SHEET

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
b. start-up response characteristics?			
2. Does the safety analysis of the plant involve the behavior of the auxiliary feedwater system? If so, how was this behavior analyzed?	FSAR	ACC	

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ATTACHMENT E

AUDIT CHECKLIST QUESTIONS AND RESPONSES

C. VAN BLARICUM

RESPONSE TO AUDIT CHECKLIST QUESTIONS

Checklist Item Number	Question/Response

I Piping Stress Analysis Reports

1. Input

   a. Do the stress reports refer to the latest revision of the design specification?

   b. Do the stress reports use the latest revision of drawings?

Response

The stress reports contain reference to the design specification revision used and copies of the revision level of analytical drawings upon which the analysis was based. When revisions are made (by others) to these documents, the new revision is either reconciled with the stress report or the report is updated to reflect the changes. The new revision level is then initialed and included in the stress report. The result is that the stress report clearly identifies the revision level of the documents on which it was based. The responsibility of determining if the revision levels are current lies with another division, Project Management Division (PMD).

Since interdepartment control of documents was not within the scope of this portion of the audit, the use of the information contained in the stress report by PMD was not pursued.

The two subsystem stress reports audited contained the required reference to the revision level of the piping design specification and initialed analytical drawings which indicate the revision level on which the analysis was based. Thus, the input documents for the stress analysis were considered to be properly identified.

Checklist

Item Number | Question/Response

I.2 Computer Programs

a. Are programs used properly identified in the report?

b. Was the revision used on the approved program library list?

Response

Both subsystem stress reports audited used the PIPSYS computer program. The full identification of the version used is documented on page 12 of both reports. Most of the computer printout appears on microfiche and is included in the stress report. The microfiche are identified by program version and these matched the identification in the body of the report. Control of use of approved versions of the program is maintained by the Computer Library. The analyst does not have access to unreleased versions of the program. (Enforcement of this control by the Computer Library was not verified by the auditor.)

Checklist

Item Number | Question/Response

I.3 Analysis

a. Are all specified loads considered and are they evaluated with respect to appropriate code equations?

Response

Table 401 of the design specifications identifies general loads to be considered. Specific data including pressures, temperatures are given on the analytical drawings included in the stress report. (Use of the analytical drawings as the source of detailed data is required by the design

specification.) ASME Code requirements are identified by "quality group" on the analytical drawings and the quality group-code relationship shown in 3.2-2 of the FSAR. Report #1 analytical drawing identified all portions of the subsystem to be Group B, while report #2 identified both Group B and Group C. These relate to ASME Code Classes 2 and 3, respectively. Since the analysis requirements of the two ASME classifications are identical, distinction between the two is not necessary with respect to evaluation of loads per code equations.

Both subsystem stress reports contained the required dead weight and seismic loads. Thermal expansion was considered only in report #1. Investigation revealed that all temperatures specified by the subsystem 1AF-03 on the analytical drawing used for report #2 were below 150°F. Document EMD-TP-2 (identified as being Byron/Braidwood project unique) states that thermal expansion will be considered only for temperatures greater than 150°F. The validity of using EMD-TP-2 as an "official" document was not verified by the audit; however, the cutoff temperature seems reasonable and the matter was not further pursued.

The detailed computer printout (on microfiche) identifies the ASME Code NC/ND equations 8, 9, 10, and 11 and also relates them to the service loadings (Levels A, B, etc.) being considered. (Note: the computer printout in report #1 identifies consideration of the 1974 edition through the Winter 1976 addenda. Thus, the ASME Code terminology for service conditions which has been in effect since the Summer 1976 revision to NA-2140 and the Winter 1976 addenda for Subsection NC is being used.)

Spot checking of the loads and the code equations being used to evaluate them revealed no inconsistencies. The computer printout clearly indicates the evaluation with respect to the code equations.

Checklist
Item Number

Question/Response

I.3 Analysis (continued)

b. Are valve weights and operator eccentricities considered?

Response

Both subsystem stress reports audited contained valve and flange weights (e.g., page 13 of stress report #1). The computer plot of the models showed modeling of eccentricities at some valve locations. While details such as amount of eccentricity, correct weight, etc., were not checked, it is evident that consideration of valve weights and eccentricities is being incorporated into the analysis of the piping subsystems.

Checklist
Item Number

Question/Response

I.3.c. Are specified materials and temperatures used for the determination of basic allowable stresses?

Response

Pipe materials were identified on the analytical drawings in the stress reports. The computer printout (microfiche) identifies six sets of material properties, including allowable stress versus temperature. The material is flagged by set number in column 20 of the element cards and the element information printed out includes the set number being used for each element. Both subsystem stress reports audited had the same material listed on the analytical drawings and both used material set no. 1 in the computer analysis. Correlation of the material tables shown in the computer printout with ASME Code tables and selection of allowable stresses versus temperature by the computer program was not verified by the auditor (computer program verification is beyond the scope of this portion of the audit).

However, both subsystem stress reports audited indicate that due consideration is being made to determine allowable stresses versus temperature and material.

Checklist Item Number	Question/Response

I.3.d. For computer models, what checks on geometry are provided (such as geometry plots, total length, start-end coordinates)?

Response

Both stress reports audited contained computer plots of the modeled subsystem. These plots are made to scale (with scale indicated) and would serve as an overall check for gross errors in the computer model geometry.

Checklist Item Number	Question/Response

I.3.e. Does the computer model appear to be complete?

1. geometry
2. all anchor/support points considered
3. material properties
4. member properties
5. response spectra

Response

A general comparison of the computer plots with the analytical drawings for both subsystems audited was made. While every detail was not checked, there were no apparent inconsistencies. Spot checking of valve locations, general arrangement, and support locations was made. See response to I.3.c of this report for discussion of material properties. Member properties are identified in the computer printout (microfiche) for each member. Spot

checks of the member properties (pipe diameter, thickness) shown on the computer printout against the analytical drawings were made for both subsystems audited. No inconsistencies were found. Response spectra for both OBE and SSE were located in the computer printout for both subsystems audited. The source of the response spectra is identified on page 4 of both stress reports.

Checklist Item Number	Question/Response
I.3.f.	For seismic analysis:

1. Were sufficient degrees of freedom used?

Response

The basis for judgment used by the auditor is that presented in the ASME publication "Pressure Vessels and Piping Analysis and Computers" (Library of Congress Catalog Number 74-78840), page 68. To have at least two masses in each half wave length at 40 hertz frequency, individual element frequency would have to be 360 hertz or more. The computer printout includes element frequencies and none of those scanned in both stress reports audited was less than 360 hertz. It was therefore concluded that sufficient degrees of freedom were being used.

Checklist Item Number	Question/Response
I.3.f.	

2. Was combination of modal responses done by regulatory guide, SRP, or other justifiable method?

Response

Computer printout for both stress reports audited show that combination of modal responses were done by the Double Sum Method (Reg Guide 1.92, paragraph 1.2.3). Combination of effects due to three spatial components was done by the SRSS method (Reg Guide 1.92, paragraph 2.1).

Checklist
Item Number — Question/Response

I.3.f.

3. Are damping values per Regulatory Guide 1.61 or other justifiable source?

Response

Computer printout for both stress reports shows that 1% and 2%, respectively, were used for OBE and SSE. Since the diameter of all pipes for these two subsystems were less than 12 inches, the damping used in the analysis is consistent with Table 1 of Regulatory Guide 1.61.

Checklist
Item Number — Question/Response

I.4 Output

a. Do results clearly show that all stresses are within acceptable limits?

Response

Computer results in both stress reports audited show tables of allowable stress identified by ASME Code equations and service loading. Also, each member is listed with stress results by code equation and a notation of

"pass" or "fail". In stress report #2, it was noted that Tee joint no. 392 showed "fail"; however, the situation is acceptably explained in note 5 on page 13 of the stress report. The computer printout also provides a summary of "failed" points (if any). Thus, the results are very clearly shown.

Checklist Item Number	Question/Response
I.4.b.	Are anchor and support loads determined by proper combination of individual loads?

Response

Yes. Table 401 in the design specification gives requirements for load combinations. The computer printout for both stress reports clearly shows load combinations. In each set of combinations, loads are determined by absolute sum method.

Checklist Item Number	Question/Response
I.4.c.	Is the stress report revision level shown on anchor/support load sheets?

Response

Support drawings (which include support loads) are included in the stress reports. Each support drawing revision level is initialed by those responsible for the stress reports (Engineering Mechanics Division). If a different revision of a support drawing is sent to EMD for reconciliation with the stress report, the reconciliation is made and so noted in the stress report. Also, a copy of the new revision of support drawing is included in the stress report. In other words, the revision level being initialed by EMD shows that the drawing has been reconciled with the stress

report and the presence of a copy of the drawing in the stress report is the record of the latest revision which has been considered by the stress report.

The purpose of this question was to determine if the loads specified for supports are traceable to the revision level of the stress report which determined the loads. The method described above adequately provides that traceability.

Checklist Item Number	Question/Response

II. Pipe Whip Analysis

II.1 What standards and/or procedures are being used for pipe whip analysis?

Response

Byron/Braidwood FSAR, Amendment 34, dated November 1981, paragraph 3.6.1.1.2, states commitment to the requirements specified in the December 1972 letters from Deputy Director A. Giambusso. Also, the FSAR states that the "O'Leary letter dated 1973, APCSB3-1, and MEC3-1 (sic) have been employed to the extent possible and practical given the stage of design/construction ...". Paragraph 3.6.2.2.2 of the FSAR addresses "Analytical Methods to Define Forcing Functions and Response Models for Piping Excluding Reactor Loop Piping". Engineering Mechanics Division document EMD Technical Procedure No. 24 was presented as the basis used for doing pipe whip calculations by that division.

II.2 Do the methods used meet the SRP requirements for:

(a) Dynamic Analysis Criteria,
(b) Dynamic Analysis Models for Piping Systems, and
(c) Dynamic Analysis Models for Jet Thurst Forces?

Response

Pipe whip analysis and evaluation responsibility is spread among different divisions. For example, Engineering Mechanics Division (EMD) is responsible for calculating the thrust forces and jet impingement forces. These forces are given to the division responsible for evaluation of supports. Due to the limited time available for this portion of the audit, investigation was limited to the determination of thrust forces and jet impingement forces as calculated by EMD. The question applicable to this limitation is 2.C. The methods described in the FSAR and EMD TP No. 24 are based on the methods developed by M. J. Moody. SRP 3.6.2 recognizes these methods as indicated in paragraph III 2.C. (4) and III 3.f.

Checklist
Item Number — Question/Response

II.3 Are there records for when the procedures were invoked and what systems were evaluated using them?

Response

EMD Technical Procedure No. 24 was presented as the applicable procedure. This procedure indicated the following revision levels:

Rev. 1 dated 10-13-77
Rev. 2 dated 1-17-78
Rev. 3 dated 7-10-78
Rev. 4 dated 11-23-79

The "Byron Pipe Rupture Book" containing EMD calculations was reviewed. None of the calculations references the procedure or revision level. There are no records indicating the specific reference or procedure on which calculations for subsystems are based.

Checklist
Item Number — Question/Response

II.4 Does a representative sampling of pipe whip analysis substantiate that these procedures were invoked and properly carried out?

Response

As noted in item 3, the calculations do not refer to the procedure on which they are based. The calculations appear to be in general agreement with the description of methods given in the procedure, but since no references are stated in the calculations, a detailed technical review would be required to verify that the procedure was invoked.

AUDIT CHECKLIST

ENERGY INCORPORATED

DATE: 3/7-11/83

ORGANIZATION TO BE AUDITED:	AUDIT NO:	AUDITOR:
SARGENT AND LUNDY		C.H. VAN BLARICUM

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
I. STRESS ANALYSIS REPORT	Baykar Tatosian Project Manager Byron/Braidwood		1. See response to audit questions following this audit checklist. 2. Initial references are applicable to all items on checklist
1. Input	Stress Reports 1FW-16 1AF-03		
a. Do the stress reports refer to the latest revision of the design specification?		ACC	
b. Do the stress reports use the latest revision of drawings?		ACC	
2. Computer Programs			
a. Are programs used properly identified in the report?		ACC	
b. Was the revision used on the approved Program Library List?		ACC	

* DISPOSITION: ACC. = ACCEPTABLE OBS. = OBSERVATION DEF. = DEFICIENCY

CHECKLIST APPROVED BY: [signature]

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AUDIT CHECKLIST
CONTINUATION SHEET

ENERGY INCORPORATED

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
3. Analysis			
a. Are all specified loads considered and are they evaluated with respect to appropriate code equations?	ASME Section III NC/ND 3650	ACC	
b. Are valve weights and operator eccentricities considered?		ACC	
c. Are specified materials and temperatures used for the determination of basic allowable stresses?		ACC	
d. For computer models, what checks on geometry are provided (such as geometry plots, total length, start-end coordinates)?		ACC	
e. Does computer model appear to be complete?		ACC	

* DISPOSITION: ACC.= ACCEPTABLE OBS.= OBSERVATION DEF.= DEFICIENCY

ENERGY INCORPORATED

AUDIT CHECKLIST
CONTINUATION SHEET

DATE: 3/7-11/83

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
1. Geometry		ACC	
2. all anchor/support points considered		ACC	
3. material properties		ACC	
4. member properties		ACC	
5. response spectra		ACC	
f. For Seismic Analysis:			
1. Were sufficient degrees of freedom used?		ACC	
2. Was combination of modal responses done by Reg Guide, SRP, or other justifiable method?	Reg. Guide 1.92	ACC	

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AUDIT CHECKLIST

ENERGY INCORPORATED

DATE: 3/7-11/83

ORGANIZATION TO BE AUDITED:		AUDIT NO:	AUDITOR:
CHARACTERISTIC	**REFERENCE**	**DISP.***	**COMMENTS**
3. Are damping values per Reg Guide 1.61 or other justifiable sources?	Reg Guide 1.61	ACC	
4. Output			
a. Do results clearly show that all stresses are within acceptable limits?		ACC	
b. Are anchor and support loads determined by proper combination of individual loads?		ACC	
c. Is the stress report revision level shown on anchor/support load sheets?		ACC	

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CHECKLIST APPROVED BY: __________

FORM QA-014 (REV. 2, 4-82)

AUDIT CHECKLIST

ENERGY INCORPORATED

DATE: 3/7-11/83

ORGANIZATION TO BE AUDITED:		AUDIT NO:	AUDITOR:
SARGENT AND LUNDY			C. H. VAN BLARICUM

CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
II. PIPE WHIP ANALYSIS METHODS AND APPLICATION			See respnse to audit questions following this audit check list.
Background			
US NRC SRP 3.6.2 states that "analysis methods used should be adaquate to determine the resulting loadings in terms of kinetic energy or momentum induced by the impact of the whipping pipe, if unrestrained, upon a protective barrier or a component important to safety and to determine the dynamic response of the restraints induced by the impact and rebound, if any, of the ruptured pipe. Acceptance criteria are included in Section III of the SRP.	Baykar Tatosian, Project Mgr. B/B John Gray Sr. Systems Analyst		Initial reference applicable to all items.
1. What standards and/or procedures are being used for pipe whip analysis?	Byron/Braidwood FSAR EMDTP24	ACC	

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CHECKLIST APPROVED BY: __________

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AUDIT CHECKLIST

CONTINUATION SHEET

ENERGY INCORPORATED

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CHARACTERISTIC	REFERENCE	DISP.*	COMMENTS
2. Do the methods used meet the SRP requirements for:			
a. Dynamic Analysis Criteria		N/A	
b. Dynamic Analysis Models for Piping Systems.		N/A	
c. Dynamic Analysis Models for Jet Thrust Forces?	SRP 3.6.2	ACC	
3. Are there records for when the procedures were invoked and what systems were evaluated using them?	EMDTP No. 24 Byron Pipe Rupture Calculations	OBS	
4. Does a representative sampling of pipe whip analysis substantiate that these procedures were invoked and properly carried out?	Byron Pipe Rupture Calculations	OBS	

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FORM QA-014 (REV. 2, 4-82)