U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

DIVISION OF QUALITY ASSURANCE, SAFEGUARDS, AND INSPECTION PROGRAMS
QUALITY ASSURANCE BRANCH

Report No. 50-483/82-22

Docket No. 50-483

Licensee: Union Electric Company
P. O. Box 149
St. Louis, Missouri 63166

Facility Name: Callaway Plant, Unit 1

Inspection at: Callaway Plant, Fulton, Missouri; Union Electric Company, St. Louis, Missouri; Nuclear Projects Incorporated, Gaithersburg, Maryland; Bechtel Power Corporation, Gaithersburg; Maryland, and Westinghouse Electric Corporation, Monroeville, Pennsylvania

Inspection Conducted: November 10-November 19, and November 29-December 14, 1982

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1. INTRODUCTION AND SUMMARY

1.1 Objectives

In August 1982 the NRC staff undertook a number of initiatives to improve assurance of quality in design and construction of nuclear projects. One of those initiatives was to develop and implement an integrated design inspection program to assess the quality of design activities, including examination of as-built configuration. The objective was to expand the NRC examination of quality assurance into the design process. The approach would provide a comprehensive examination of the design development and implementation for a selected system. (Reference 1.56).

Since this was both the first inspection in that program and a trial inspection, it had a dual objective - evaluating the design process for the Callaway Plant and developing the methodology for conducting future inspections. This report covers only the first objective, evaluating the design process based on examination of the auxiliary feedwater system.

1.2 Definitions

Findings

In our evaluation we found many design actions that were being well executed. Some of these positive findings are described in the text of the following sections. They are not flagged and numbered in the text nor listed at the front of this report since follow-up is not required.

Negative findings include such items as procedure violations, errors and inconsistencies. They are described in the text of the following sections. The negative findings are flagged and numbered in the text since followup action is required for licensee resolution and NRC evaluation of the resolutions.

This interoffice NRC effort was structured as an inspection of the Callaway Plant, for which the NRC's Region III Office is responsible. Accordingly, NRC follow-up on these items will be managed and tracked by the Region III Office with assistance as required from the Region IV Office which manages the vendor inspection program and the Office of Inspection and Enforcement which managed this inspection.

Some of the items identified may form the bases for enforcement action. The Regional Offices will review them and initiate enforcement action as appropriate.

Unresolved Items

Unresolved items are questions for which the inspection team did not develop enough information to reach a conclusion. These items could become findings, depending upon the nature of further information. Unresolved items are described in the text of the following sections. They are flagged and numbered since licensee response and NRC evaluation are required. As with the findings, the NRC follow-up will be managed by the Region III Office with assistance as required from other offices.

Observations

The report contains a number of other observations that are flagged and numbered. These represent cases where it is considered appropriate to call attention to matters that are not specific findings or unresolved items. They include items recommended for licensee consideration but for which there was no specific regulatory requirement.

1.3 Callaway Project Organization

The Callaway Plant, Unit 1 (Union Electric Company) and the Wolf Creek Generating Station (Kansas Gas and Electric Company and Kansas City Power and Light Company) are two standard plants being constructed under the Standardized Nuclear Unit Power Plant System concept (SNUPPS). This concept has included other units and other utilities but, currently, only Callaway 1 and Wolf Creek remain under active construction. Our inspection was conducted for the Callaway Plant, Unit 1. Since the designs are standard, some of our findings and conclusions apply equally to the Wolf Creek Generating Station. A copy of this report will be forwarded to the Wolf Creek licensee for information. However, separate responses with respect to Wolf Creek will not be needed.

Union Electric Company holds the construction permit for the Callaway plant and is responsible for assuring proper design. Union Electric and the other utilities participating in SNUPPS have contracted with Nuclear Projects Incorporated (NPI) to assist them in carrying out this responsibility. Basically, NPI takes an item such as a proposed design, a decision to be made, or a problem to be resolved, obtains comments from the utilities' engineers, facilitates resolution of the comments until a single position has been agreed upon and then promulgates that position. Utility decisions affecting design are reached in this manner primarily through the operation of a Technical Committee, although other committees such as a Management Committee and a Quality Assurance Committee are also important. NPI is also sometimes called the SNUPPS Project Office. However, we will refer to it as NPI in this report to avoid confusion with the SNUPPS project organization at Bechtel Power Corporation.

The power block is that part of the plant encompassed in the SNUPPS concept. It includes the reactor building, auxiliary building, turbine building, diesel building, control building, fuel building, radwaste building and hot machine shop. Bechtel Power Corporation is the architect-engineer responsible for design of the power block. In addition, Bechtel is responsible for designing the ultimate heat sink and the associated cooling water systems. The Bechtel scope of design includes all the areas relevant to our inspection of the auxiliary feedwater system. Accordingly, we did not conduct any inspections of Sverdrup and Parcel which is the architect-engineering firm responsible for designing items such as administration buildings, warehouses, shops and switchyard facilities.

Bechtel Power Corporation, which is organized by projects, executed the design of the SNUPPS units (Callaway and Wolf Creek) as a single project known as the SNUPPS project. The two units have the same design within the power block. The ultimate heat sinks, although not the same at the two units, are designed by the same SNUPPS project organization. The utilities provide guidance and exchange information with Bechtel via the NPI organization as discussed above. In turn, Bechtel manages the contract with the reactor manufacturer, Westinghouse Electric Company, so that interchange of information with Westinghouse is via Bechtel.

Daniel International Corporation is the constructor responsible for building the Callaway Plant and conducting the quality control portion of the quality assurance program for construction. Daniel does not perform design work. However, Daniel does develop and exchange information related to design with Bechtel such as Field Change Requests to resolve design and construction problems.

There is, in essence, no field engineering function; design work is performed at the Bechtel Gaithersburg office. Bechtel does have a site liaison engineering group at the construction site which processes documents such as Field Change Requests. However, it functions as a liaison group - not as a design organization.

1.4 Inspection Effort

We selected the auxiliary feedwater system for this inspection. This is a system important to nuclear safety. The components, functions and interfaces involved are typical of those found in a number of other safety systems.

The inspection was an interoffice NRC effort conducted with contractor assistance. Team selections were made to provide technical expertise and design experience in the disciplines listed. Half the team members had previous experience as employees with architect-engineering firms working on large commercial nuclear power plants. The others had related design experience such as working elsewhere on commercial nuclear facilities, test reactors or naval reactors.

Beginning on October 20, 1982 the inspection team devoted 3 weeks to the study of background information and preparation of inspection plans. Then 4 weeks of direct inspection activities were conducted at Union Electric Company, Nuclear Projects Incorporated, Bechtel Power Corporation, Westinghouse Electric Company and the Callaway Plant, concluding on December 14, 1982. A more detailed chronology of inspection activities is provided in Section 7 of this report.

The inspection team reviewed the organizations' staffing and procedures and interviewed personnel to determine the responsibilities of and the relationships among the entities involved in the design process. The general levels of personnel qualification and the guidance provided were also noted. Primary emphasis was placed upon reviewing the adequacy of design details (or products) as a means of measuring how well the design process had functioned in the selected sample area. In reviewing the design details the team focused on the following items:

(1) Validity of design inputs and assumptions.

(2) Validity of design specifications.

(3) Validity of analyses.

(4) Identification of system interface requirements.

(5) Potential indirect effects of changes.

(6) Proper component classification.

(7) Revision control.

(8) Documentation control.

(9) Verification of as-built condition.

In some areas, such as the review of piping stress analyses, the sample was narrowed to include only a part of the auxiliary feedwater system. In other areas, such as electrical power, the sample was broadened into areas that were not related solely to the auxiliary feedwater system. More detailed descriptions of the review are provided in following sections of this report.

1.5 Conclusions

Although the inspection sampled a very small part of the design effort, the team did review hundreds of specific items. The most significant deficiencies are summarized as follows:

(1) There was a lack of formal control over Bechtel's use of plant design newsletters. Thus, these newsletters, which described acceptable modeling and stress analysis techniques, were not being applied uniformly to project design work (Section 3.1.2).

(2) The auxiliary feedwater pump turbine exhaust pipe was not classified as Seismic Category I and safety grade throughout its entire length. No justification available. This represented incomplete detailed analysis to support pump operability requirements. A similar classification was identified in two other systems (Section 2.4).

(3) The ability of motor controllers to withstand fault currents had not been considered or assured. This represented an instance of improper detailed design (Section 5.2).

(4) The team identified needs for improvement in control of the design process at Bechtel in certain areas such as those related to high energy line break analyses (Section 2.4), guidance for two design groups (Sections 3.1.4 and 3.2.4), interface definitions (Section 4.4) and baseplate design (Section 4.5).

(5) Three instances were identified where specific FSAR commitments were not met, one of which involved the turbine exhaust pipe discussed above (Sections 2.3, 2.4, and 6.2).

Prompt attention is needed for the resolution of these specific deficiencies and others identified in the following sections. However, the team concludes that these items are not indicative of any pervasive breakdown in the design process.

With the exception of the matters identified in the findings and an instance of delay in resolving a design issue (Observation 4-1), the team considered the general project management to be a strength. Several utilities' staffs were involved in the development of design criteria and guidance. Effective follow-up and project management assistance were provided by NPI. Bechtel utilized a competent project organization to execute the detailed design work. Interfaces, including those with Westinghouse, were generally well controlled as evidenced by the consistency of design documents. Nearly all the detailed design information reviewed was adequate and consistent, indicating a controlled design process.

Sections 2 through 6 below provide more detailed descriptions of our evaluations in the five discipline areas that we reviewed. Section 7 provides a chronology, lists of documents reviewed or referenced and lists of personnel interviewed.

2.0 Mechanical Systems

The objective of this portion of the inspection was to evaluate the mechanical systems aspects of the design with emphasis on the exchange and control of interface information. The team reviewed the system design and a number of sample areas of work which focused primarily upon the Bechtel Mechanical/Nuclear Group.

2.1 Design Information

This section summarizes the basic mechanical systems design information reviewed.

Design commitments to the NRC are contained in the FSAR and related correspondence submitted in support of the operating license application. The basic system design, design bases, functional requirements, failure analyses and component data are described in these documents along with more general information such as relevant accident analyses, high energy line break analyses and seismic requirements. These licensing commitments were prepared and submitted by NPI acting on the behalf of Union Electric Company and other SNUPPS utilities, with considerable assistance from Bechtel Power Corporation and Westinghouse Electric Company. An area of emphasis in our inspection was to determine whether or not the actual design met the licensing commitments.

The reactor manufacturer's basic design recommendations and interface information are contained in the Westinghouse Steam System Design Manual. This information has been augmented considerably by correspondence between Bechtel and Westinghouse over the life of the project. A great deal of the correspondence that we reviewed was related to exchange of information about the plant safety analyses described in the FSAR, which were performed by Westinghouse. One aim of our inspection was to determine whether or not this information had been properly considered and whether the actual design was consistent with the interface needs of the nuclear steam supply system.

The Mechanical/Nuclear Group at Bechtel is a central focus for system design and for coordination with other entities such as NPI, Westinghouse, and Bechtel's Stress Analysis Group. The Mechanical/Nuclear Group produces a number of documents describing the auxiliary feedwater system design, including the following principal documents:

(1) A system description which describes such items as design bases, system functions and operation, component data, instrumentation requirements, and single failure analysis.

(2) A flow diagram which describes flow paths and calculated flows, temperatures and pressures for various conditions of operation.

(3) A piping and instrumentation diagram which describes the schematic arrangement of the piping, pumps, valves and instruments.

(4) Numerous other documents such as general mechanical/nuclear design criteria, the auxiliary feedwater pump specification, and specific calculations.

The Mechanical/Nuclear Group at Bechtel also takes a lead and coordinating role in the performance of high energy line break analyses.

The results of our review of the mechanical systems aspects are described in the following sections.

2.2 Personnel and Guidance

This section summarizes the basic staffing and guidance information reviewed in the mechanical systems area.

The supervising engineer at Union Electric responsible for the mechanical and electrical areas on the SNUPPS project had held that position for more than 6 years and had 26 years professional experience with Union Electric. The mechanical engineer responsible for the auxiliary feedwater system (among other systems) had held that position for 1½ years and had 14 years professional experience with Union Electric. In addition, the NPI staff contained a number of individuals with considerable experience in regulatory matters and nuclear plant systems design.

The team briefly reviewed the organization for the Mechanical/Nuclear Group at Bechtel. The group supervisor had been in that position for the SNUPPS project for 1.5 years. The three supervisors reporting to him had each been working on the SNUPPS project for at least five years. The Mechanical/Nuclear Group had a total of 21 engineers (including the above supervisors). Five had masters degrees and 6 were registered professional engineers. The average experience included 8.8 years of engineering, 5.5 years on nuclear applications, and 2.6 years on the SNUPPS project.

Prior to October 1981 new engineers in the group had attended lectures on the basic quality procedures involved, Bechtel Engineering Department Procedures (EDP) and Engineering Department Project Instructions (EDPI). Attendance sheets for these lectures were retained by the project quality engineer. For those assigned to the group since October 1981 (8 individuals) the instructions were assigned and read on a self-study basis. A training record was maintained indicating the instructions assigned for reading and the date they were read. Engineers also attended technical training courses, which were voluntary. Subject courses included (1) nuclear plant design overview, (2) fossil plant design overview, (3) technical seminars on components (e.g., feedwater pumps), and (4) Engineer-In-Training and Professional Engineer in-house review courses.

Our interviews indicated that engineers in the Mechanical/Nuclear Group generally were familiar with the instructions and followed them. The supervisors reflected substantial knowledge of nuclear plant design and regulatory requirements in the mechanical/nuclear area.

The results of our review of design details in the mechanical systems area are described in the following sections.

2.3 System Design

The objective of this portion of the inspection was to evaluate the adequacy and the control of basic auxiliary feedwater system design information.

The team reviewed the basic auxiliary feedwater system design information contained in the FSAR, the system description (Reference 2.27) the piping and instrumentation diagram (Reference 2.36) and the system flow diagram (References 2.23 and 2.24). In addition, the applicant had submitted the results of an auxiliary feedwater system reliability study (Reference 2.37) and had discussed the system design extensively at a meeting with the NRC staff (Reference 2.38).

The auxiliary feedwater system included two motor driven pump trains powered and controlled from separate Class IE alternating current power supplies. Each motor driven train fed two of the plant's four steam generators. The system also included a steam turbine driven pump train controlled from direct current electrical power supplies. The turbine driven pump train fed all four of the plant's steam generators and had about twice the pumping capacity of a single motor driven train. Modulating control valves were employed in the motor driven pump discharge lines to each steam generator to avoid excessive flow to postulated broken lines. Fixed orifices were employed in the turbine driven pump discharge lines to avoid excessive flow. The system was not intended to be employed for normal startup and shutdown operations since an electric driven feedwater pump had been provided for this purpose in the main feedwater system. Appropriate automatic starting signals and indications were provided. The auxiliary feedwater system would start and run without operator action when needed due to pipe breaks, loss of offsite power or loss of the main feedwater system. The turbine driven train was capable of operating for at least two hours during a loss of alternating current power supplies (including the diesel generators). The normal supply of auxiliary feedwater was from a non-safety grade condensate storage tank. Automatic transfer functions were provided to switch the pumps' suction to the safety-grade essential service water system in the event of low suction pressure from the condensate storage tank. The switchover function did depend upon alternating current electrical power supplies.

The basic system design as documented in the licensing submittals, had been previously reviewed and found acceptable by the NRC staff (References 2.44 and 2.45). In the areas reviewed during this inspection, acceptability of the basic design in accordance with regulatory guidance was generally confirmed. In addition, further details were reviewed as described below to determine their adequacy and consistency.

The team reviewed the auxiliary feedwater pump specification (Reference 2.33) and found it to be consistent with other design documents and the system design. A few examples are discussed below to illustrate the nature of this review. Two turbine overspeed trip devices were specified, set at 110% and 115% of rated speed. These setpoints were consistent with assumptions used in system flow and pressure calculations (Reference 2.22). The trip and throttle valve was specified to open within 10 seconds and the pump was specified to come up to rated flow and head within 20 seconds which was consistent with Westinghouse recommendations and the plant safety analyses. Although no minimum closing time was specified, we found that Bechtel's files contained documentation of a telephone conversation with the vendor which indicated that testing had shown the valve to close in a range of 0.5 to 0.9 seconds. This supported the assumptions used by Bechtel's Stress Analysis Group in evaluating the effects of a turbine trip on the steam supply line. The environmental qualification conditions were the same as given in the FSAR for the pump rooms. Flow, temperatures, pressures, water quality and functional requirements were all generally consistent with values contained in numerous other documents that we reviewed.

During the team's mechanical components review, an instance of improper classification was found on a portion of the system. For the turbine exhaust line a boundary anchor had been provided at the auxiliary building penetration where the pipe changed to non-seismic and non-safety and ran through the non-Category I auxiliary boiler room. The anchor was designed for piping collapse loads from the downstream pipe. However, we considered the non-Category I sections of pipe to be contrary to FSAR Section 3.9(b).3.2.2.1 which classified the auxiliary feedwater pumps as active components and stated that active components were qualified for operability during safe shutdown earthquake conditions. As was indicated in the Westinghouse design recommendations for this system, the turbine vent piping should normally be safety grade since, if it were blocked, turbine operations would be affected. We did note that Figure 10.4-10 of the FSAR showed the class change on the turbine exhaust line. Nevertheless, no justification was available to demonstrate that the auxiliary feed pump turbine met the requirements for an active component since the exhaust path was not completely qualified. Also, a brief review of the piping and instrumentation diagrams indicated similar class changes for the diesel generator exhaust pipes and the atmospheric steam dump exhaust pipes. This appeared to represent incomplete detailed support for pump operability requirements. It was one of three examples of failure to meet FSAR commitments. Findings 2-7 and 6-3 provide discussions of the other examples. (Finding No. 2-1)

The team reviewed the environmental qualification temperature specified for the turbine driven pump room. The maximum room temperature specified in the FSAR Tables 3.11(B)-1 and 3.11(b)-2, for both accident and normal conditions, was 150 F. The turbine driven pump was being qualified for conditions at least that severe. Since the room did not have safety grade ventilation or cooling, room temperature would be assumed to be controlled by heat transfer to adjacent spaces when the turbine pump was operating. The two worst cases to be considered were (1) operating after a main steam line break when the space above would be heated by escaping steam and (2) operating for at least two hours following a loss of alternating current electrical power.

We found that the available air conditioning calculations did not support the specified temperature of 150F; however, on a judgment basis it appeared that the specified temperature could be supported. A series of calculations had addressed temperatures in the turbine driven pump room. The first calculation, GF 175, was performed in 1975, approved in 1977 as a final calculation and superceded in 1978 (Ref. 2.39). The result was a calculated long term (steady state) temperature of 170 F based on heat transfer to adjacent spaces at 122 F. This answer was too high for the purpose of this discussion and heating of adjacent spaces had not been assumed. However, since the analysis was conservative and the actual accident conditions would be transitory rather than steady state, this did not indicate that the room would actually exceed 150 F. The superceding calculation, GF 274, had been voided prior to approval. The third calculation HV 319 (Ref. 2.40), was performed in 1981. It addressed room temperature based on normal ventilation system flow with outside air at various temperatures, which was not a worst case condition. A fourth calculation, GF-415, was in progress during our inspection. This calculation was intended to address the worst case conditions and, thus, the validity of the environmental qualification temperature specified. It appeared from the heat loads and heat transfer paths involved that the validity could be demonstrated. These efforts should be completed to determine whether this question might have any effect on design (Unresolved Item No. 2-1).

The system description, system flow diagram and some of the underlying calculations were changed during our inspection. We reviewed both the latest revision and the previous versions of these documents. The changes consisted of updating information to reflect such items as design changes that had been made and actual pump performance data. In general, we found the details contained in these documents to be technically sound and consistent with the other documents we reviewed.

The team reviewed the Calculation AL-22 (Ref. 2.22) concerning system pressure. Five conditions were evaluated, representing various operating modes. The maximum pressure was calculated for a condition where suction was taken from the alternate source (the essential service water system) since this provided water at a higher pressure than the condensate storage tank. The electric driven pumps were assumed to be running with no flow to the steam generators - essentially placing them at their maximum shutoff head based on actual pump capabilities. All pressures were within the design pressure of the piping.

There was an erroneous assumption in the maximum pressure case. Flow had been assumed in the pump discharge line with attendant pressure drops taken from calculations for other cases. This was inconsistent with the assumption of no flow to the steam generators and resulted in an underprediction of pressure for three points in the discharge piping by 4, 10, and 35 psi, respectively. Since the team found no similar errors, this did not appear to be a systematic error. It had no effect on the design. The corrected pressure result for the three points would be 1814 psia, the same as at the pump discharge. The design pressure for the piping at these points was 1915 psia, the same as at the pump discharge. (Finding No. 2-2).

The team reviewed Calculation AL-20 (Reference 2.4) related to total pump head requirements for the turbine driven pump and Calculation AL-16 (Reference 2.19) concerning suction head available for the pumps. No significant problems were found with either calculation. The assumptions and results were generally consistent with system functional requirements. They supported the values used in containment pressure analyses, assuring that auxiliary feedwater flow through the steam generator to a ruptured main steam line would not add excessively to the containment pressure. Appropriate interface information had been exchanged with Bechtel's Nuclear Staff Group on this matter and care had been taken to assure that revisions did not void the consistency of the two efforts.

There was an error in Calculation AL-20. A value for head loss in the flow restriction orifices that appeared on page 2 of the calculation had been changed from 350 feet to 425 feet in Revision A. The same value had not been changed where it also appeared on page 8. This did not appear to be a systematic error. It had no effect on the results since more than enough margin had been allowed in subsequent steps. (Finding No. 2-3).

The team also noted that Bechtel and Westinghouse had exchanged information several times concerning maximum flow under accident conditions. This appeared to have been properly considered and it resulted in design changes to assure that the pumps would be protected from conditions of inadequate suction head at high flow rates.

As discussed above, Findings 2-2 and 2-3 involved detailed calculational deficiencies that had no apparent adverse effect on the design and did not appear to indicate systematic weaknesses. Finding 2-1 concerning classification of the turbine exhaust pipe appeared to be more significant. It represented incomplete detailed support for pump operability requirements and similar classifications appeared to exist for exhaust pipes in other systems. The other system design features reviewed were adequate and consistent, indicating a controlled design process.

2.4 High Energy and Moderate Energy Line Breaks

The objective of this portion of the inspection was to evaluate the adequacy and control of high and moderate energy line break analyses related to the auxiliary feedwater system.

Bechtel procedures for inter-discipline coordination and documentation of high energy line break analyses on the SNUPPS project were detailed in a memorandum from the Project Engineering Manager (Reference 2.31). The Bechtel Stress Group performed the stress analyses necessary to determine postulated pipe break locations and produced pipe-break isometric drawings indicating the locations and type of breaks to be considered. The Mechanical/Nuclear Group calculated thrust and jet forces, determined what targets might be affected by pipe whip or jet impingement and determined whether any damage would be acceptable for a particular break. Where damage to targets would not be acceptable the Mechanical/Nuclear

Group prepared action plans and provided instructions to other groups to obtain corrective action. For example, the Civil Group might design a whip restraint to preclude pipe whip.

Potential targets for the postulated breaks were determined primarily by reference to the scale model of the plant. After a particular room had been reviewed it was flagged and any changes to the model (and thus to design locations) were controlled by routing through the Mechanical/Nuclear Group. Here they were checked for effects on the high energy line break analyses before being implemented. If necessary, the analyses would be updated. This appeared to be a sound procedure for maintaining the high energy line break analyses as reasonably current working files and for controlling design changes so as to minimize the inadvertent introduction of pipe break vulnerabilities that might require correction later.

The team reviewed six postulated breaks in the steam supply line to the auxiliary feedwater pump turbine, including field inspection of the locations involved, review of the analysis of effects, and review of one associated thrust force calculation. The auxiliary feedwater system was the only safety related system of interest in proximity to these breaks. The system was generally well protected by compartmentalization. For instance, a break in the turbine driven auxiliary feedwater pump room might damage equipment associated with that pump (which also would be lost because of the break) but no equipment associated with the other pumps was located in the compartment. Generally, we found the protection to be adequate and the analyses to be soundly based. However, we did have some concerns about procedures, traceability and control as discussed below.

We found that zone of influence drawings were not being prepared for the high energy line break analyses. This was contrary to the instructions in the Project Engineering Manager's memorandum (Reference 2.31) which required preparation of such drawings. Bechtel personnel indicated that zone of influence drawings were not cost effective. We would agree that the scale model and other documents that were being prepared in accordance with the instructions appeared to be effective and adequate tools for determining the influence of breaks. However, the procedure and actual practice should be consistent. (Finding No. 2-4)

We found that the Dynamic Effects Analysis (target sheet) for high energy break number FC 01-01 erroneously stated that there would be no pipe whip for a postulated break in the steam supply line near the auxiliary feedwater pump turbine. Field inspection indicated that, since there were no anchors close enough to the postulated break to preclude pipe motion, the correct statement would have been that the pipe could whip and the effect on potential targets should have been evaluated. This item had no adverse effect on the design. The conclusions would remain the same because there were no unacceptable targets in that area. We noted that the target sheets for other breaks generally indicated that there would be no pipe whip. However, they did not indicate any basis for the determination, i.e., a comparison to indicate that the moment (thrust times distance to the nearest anchor) was less than the pipe's moment resisting capability. We also had general concerns about traceability and checking as discussed below. Accordingly, based on our work, we could not make a firm determination that this was an isolated error. This matter should be addressed in resolving the item. (Finding No. 2-5)

The break by break Dynamic Effects Analyses (target sheets) were being treated quite informally. For each break these target sheets listed the calculated thrust forces, jet cone characteristics and determinations on pipe whip. They also listed the potential targets and evaluations of the effects on those targets. Our concern was that the sheets were not signed, dated, checked or approved. It was not possible to tell when an analysis had been performed or even what revision of the jet force calculations or the piping isometric drawing they had been based upon. Bechtel personnel stated that they did not consider these analyses to be like design calculations (which would be subject to formal controls for checking, approval and revision). Further, they indicated that, near the end of the project the sheets would be reviewed along with other related calculations before being finalized. It was not intended, however, to bring them under formal control at that time. We concluded that the documents should be better controlled, at least before they are finalized. These analyses provide part of the basis for design documents and they provide back-up for information supplied to regulatory agencies - two of the objectives that define project design calculations in Bechtel Procedure EDPI 4.37-01. (Reference 1.16) (Finding No. 2-6)

In addition to the six breaks discussed above, the team also reviewed protection arrangements and related correspondence for a postulated main steam line break or main feedwater line break in the space above the auxiliary feedwater pump rooms. In the original design, breaks had not been postulated in that area due to the low stress levels and high quality requirements for the piping. In response to developing NRC staff positions, design changes had been initiated to provide protection for such breaks in 1977. The breaks postulated were defined as non-mechanistic breaks. This meant that a single ended guillotine break would be assumed. Structural integrity of walls and floors and environmental qualification of electrical equipment located in the space were required. However, pipe whip and jet impingement protection were not required.

Generally, the protection features described in the licensing commitments had been incorporated into the design. However, we found that, in one instance, the design did not meet a licensing commitment. A letter to the NRC in 1977 (Reference 2.41) and FSAR Section 3.B.4.2 had stated that there would be no drainage (from the break area above the auxiliary feedwater pump rooms) to lower levels of the auxiliary building and that penetrations through the floor would be waterproof. Large drain lines had been installed to shunt drainage from the break areas to the turbine building. Waterproof seals had been provided where piping penetrated the floor. We reviewed the seal designs and found them adequate. However, field inspection indicated that several small drain lines through the floor had remained in place. The appropriate drawings (References 2.42 and 2.43) indicated that these lines had remained in the design, were interconnected with drains from the auxiliary feedwater pump rooms and did drain to lower levels of the auxiliary building. There were no isolation provisions to prevent steam from entering various critical areas via these drains. We did not determine the potential effects on design, which would depend upon how much steam might enter critical areas through the small drain lines. This flow path should be blocked or the safety significance should be addressed and, if justified, the FSAR should be changed. Since the other protection features had been incorporated in the design, this specific item did not appear to indicate a systematic weakness in providing high energy line break protection. It was one of three examples of failure to meet FSAR commitments. Findings 2-1 and 6-3 provide discussions of the other examples. (Finding 2-7)

In general, the moderate energy line hazards analyses had not yet been completed in the area of our inspection. However, several flooding protection calculations related to these analyses had been completed. The team reviewed two sample calculations, FL-01 and FL-13, related to flooding levels in the auxiliary building basement and the auxiliary feedwater pump rooms (References 2.34 and 2.35). Both calculations demonstrated adequate protection for safety related equipment on a conservative basis and indicated compliance with the appropriate FSAR commitments.

As discussed above, we found a need for improved control of certain analyses (break by break dynamic effects analyses) and found an error in one of those analyses. There was one specific failure to meet a licensing commitment that did not appear to be a systematic error. The procedural violation concerning zone of influence drawings had no apparent effect since the actual practices appeared adequate. In other respects, we generally found the protection adequate and the analyses soundly based, indicating adequate control.

2.5 Westinghouse Information

The objective of this portion of the inspection was to evaluate design interfaces with the nuclear steam supply system.

We reviewed the Westinghouse design recommendations and interface information in the Steam Systems Design Manual. We also reviewed about 12 letters between Bechtel and Westinghouse which served to amplify and, in some cases, to modify this information. Westinghouse recommendations were not necessarily requirements that must be met. The team's object was to determine that either the system design was consistent with Westinghouse recommendations or, where this was not the case, to determine that the differences in design features had been evaluated and were known to be adequate.

We found a number of minor differences which Bechtel personnel were readily able to justify on sound technical bases. For example, Westinghouse Steam Systems Design Manual had literally recommended use of automatically closing valves to prevent other systems from depleting the water in condensate storage tank below the required minimum when the auxiliary feedwater system was needed. In the SNUPPS design, the other systems' suction lines were located high in the tank so they were incapable of depleting the condensate storage tank below the required level. This was clearly acceptable.

We reviewed correspondence related to the standard Westinghouse recommendation to employ a safety grade source of condensate quality water as the primary suction source. The SNUPPS design employed, as the primary source, a non-safety grade condensate storage tank. Automatic provisions were provided to switch the system's suction to a safety grade source (the essential service water system) in the event of low suction pressure from the condensate storage tank. This alternate safety grade source was not of condensate quality, being essentially Missouri River concentrated by a factor of four as a result of cooling tower evaporation. From the initial exchanges of correspondence it appeared that Westinghouse had preferred a safety grade condensate quality source (or an equivalent source based on heat exchangers). However, Westinghouse had in the end provided Bechtel a letter stating that the SNUPPS practice was not a safety problem.

Westinghouse personnel demonstrated the basis for this determination. Their calculations indicated that using ultimate heat sink water for one cooldown cycle of about 24 hours would result in a chemical environment far less severe than that which experimental data had indicated might cause steam generator tube failure or tube support sheet failure, even for steam generator designs that were considerably more susceptible to damage than the SNUPPS steam generators.

The team reviewed interface information related to accident analyses involving the auxiliary feedwater system to determine that the values provided by Bechtel to Westinghouse were current and correct. The accident analyses we reviewed were those for main feedwater line rupture, main steam line rupture and main feedwater system failure. Bechtel had provided auxiliary feedwater system flow rates, temperature limits, purge volumes and startup times which were consistent with the actual system design. One of the important considerations was the maintanance of a sustained flow rate of 470 gallons per minute from the turbine driven pump following a main feedwater line break accident. The team checked Bechtel Calculation AL-26 (Reference 2.11) and found that pump flow had been calculated, based on pump and turbine characteristics, for eight conditions corresponding to points after the accident This demonstrated that the necessary flow would be maintained during the course of the accident with the various values of steam pressure and temperature that would be available for the turbine driven pump.

With one exception (classification of the turbine exhaust pipe discussed in Section 2.3 of this report) we found that the design features we reviewed were consistent with Westinghouse recommendations or that the differences had been evaluated and justified, indicating exchange and control of interface information.

2.6 Conclusion

As discussed in the preceeding sections, nearly all of the design information we reviewed was adequate and consistent indicating a controlled design process. We found a need for improved control in certain parts of the high energy line break analyses and we found one instance where the high energy line break protection features did not meet a licensing commitment which did not appear to be a systematic error. Nevertheless, we generally found the high energy break protection adequate and the analyses soundly based. Accordingly, the design process appeared to be controlled.

3.0 Mechanical Components

The objective of this portion of the inspection was to evaluate the mechanical components aspects of the design with emphasis on the control of design information and assumptions used in the evaluations. This review included sample areas of work in the Stress Analysis Group and the Pipe Support Group at Bechtel Power Corporation and sample items of mechanical equipment.

3.1 Stress Analysis Group

3.1.1 - Design Information

This section summarizes the basic design information reviewed in relation to the Stress Analysis Group.

Design information used by the Stress Analysis Group is generally provided by other Bechtel internal design groups. The design data include project specifications for piping, piping isometric drawings and vendor component allowable loads. Drawings and specifications are formally controlled documents containing coordination sign off stamps and are referenced in the stress analysis cover sheets. Valve weight data are contained on the piping isometric drawings. Information on component allowable loads and system operating conditions is transmitted from the Mechanical/Nuclear Group by memoranda and retained in the stress analysis problem file. Seismic response spectra are maintained in Bechtel Computer Program ME 909 (Reference 3.26) and are obtained by specifying the building and elevation data point shown in the civil mathematical models. The stress group leader maintains a notebook containing the civil mathematical models and corresponding spectra. Also contained in the notebook are ME 909 printouts of the spectra. One data point was checked (Data Point No. 11 in the Auxiliary Building). The ME 909 spectra printout for this data point matched the envelope spectra obtained from the civil specification. Spectra enveloping between different buildings and elevations is performed by the computer program.

Loads and pipe movements at pipe support locations are transmitted from the Stress Analysis Group to the Pipe Support Group by memoranda. Movements at small pipe branch connections are maintained in the stress analysis problem file. Since the Pipe Support Group performs the design of small diameter piping, the stress analysis package is checked by that group to obtain the correct movements at attachment points.

Feedback from the field on "as-built" conditions is largely in the form of Field Change Requests (FCR) which must be approved by Bechtel. The design philosophy for the SNUPPS project is intended to limit Field Change Requests by requiring the system to be fabricated within the tolerances contained in Bechtel Specification M-204 (Reference 1.24). As a result, no field change requests for piping were available in the Stress Analysis Group for inspection team review. In addition to limiting the field changes on piping, Bechtel plans to conduct final "as-built" walkdowns when construction is complete. Since support fabrication on the sample system was not complete at the time of the inspection, no assessment could be made of the implementation of "as-built" controls for piping.

The results of our review of sample work areas are described in Section 3.1.3.

3.1.2 - Personnel and Guidance

This section describes our review of training and guidance information related to the Stress Analysis Group.

Inexperienced engineers were first assigned to the Bechtel staff rather than a specific project. There, they received classroom training (approximately 150 hours) which gave them an overview of analysis techniques and procedures for various loading conditions. Once the training was completed, the engineers were assigned to a specific project. There, the first assignments for new personnel were checking and reviewing completed (and previously checked) problems to become further acquainted with the group's work. Then typical work was assigned. No formal training class notes were available to review for class effectiveness. The training program had only been available within the past two or three years.

The Stress Analysis Group uses centralized guidance documents such as computer manuals and stress newsletters. The inspection team studied the stress newsletters and the user's manual for Bechtel computer program ME 101 (Reference 3.27) which was the computer program used for piping analysis. The stress newsletters are a collection of letters issued from time to time by the stress groups of various Bechtel offices indicating acceptable analysis techniques, analysis clarifications, and suggested analytical procedures. We noted that the newsletters had not been evaluated for use on the SNUPPS project. They were being used in some cases but, on the whole, there was no system in place to determine what should be used where. This was in violation of Bechtel Procedure EDPI 4.1-01 (Reference 1.11) which states that "Design criteria on the SNUPPS project are detailed in discipline design criteria documents which shall be revised and documented in accordance with this instruction." (Finding No. 3-1)

Finding 3-2 (Section 3.1.3) concerned an error that might have been avoided by use of the appropriate newsletter. Based on the nature of the newsletters and the lack of controls, there appeared to be a potential for other such errors. In addition, Finding 3-5 (Section 3.1.3) concerned assumptions made at a piping class boundary. This appeared to indicate a need for more formal guidance in other areas as well. These matters should be addressed in resolving the above finding.

One newsletter that the team reviewed dealt with welded attachments to ASME Class 2 and 3 piping systems. During this review, Bechtel personnel indicated that if the loads on the attachment produced a stress less than 8 ksi, the attachment was considered adequate. If the welded attachment resulted in a stress greater than 8 ksi, a more detailed analysis procedure would be utilized. The initial welded attachment stress analysis would be performed by the Pipe Support Group using Bechtel Computer program ME 210 (Reference 3.28). If the results indicated stresses greater than 8 ksi, Class 1 allowable stress limits would be used for comparison of lug stresses combined with the piping stresses for primary upset, primary plus secondary, and faulted load combinations.

Sections NC-3645 and ND-3645 of the 1974 Edition of the ASME Code require the consideration of local stresses in the pipe resulting from attachments but do not define explicit stress allowable criteria. The NRC staff is currently reviewing criteria for piping attachments on a generic basis. However, at present, the Bechtel procedure appears to meet the requirements of the above sections of the ASME Code.

From the team's review of a user's manual for the ME 101 program, it was noted that there might be a non-conservatism in the calculation of seismic anchor movements for skewed restraints. The ME 101 Program Users Manual discussed the method used by the program to compute loads due to seismic anchor movements. For skewed supports (which did not align with east-west, north-south or vertical directions), the anchor movement applied to the support was the global movement multiplied by the cosine vector. This might yield non-conservative results for some cases. This question should be addressed by further study and, if needed, appropriate corrective action should be taken. (Unresolved Item No. 3-1)

For seismic analysis of piping systems, the FSAR referenced Revision 3 of Bechtel Topical Report BP-TOP-1 (Reference 3.5). The Stress Analysis Group Leader had a copy of Revision 2 for reference and there was no documented evidence that the group members had formally reviewed Revision 3. This indicated a lack of awareness of what was specified in the FSAR. However, a brief comparison indicated that Revision 3 incorporated a discussion of closely spaced modes and Class 1 piping cyclic criteria, and specified that three simultaneous directions of earthquake input be utilized. No evidence was found that Stress Analysis Group personnel had violated these criteria.

The Stress Analysis Group Leader also maintained a copy of Bechtel Specification M-200 (Reference 3.3) dealing with design of ASME Section III piping. Stress allowable limits and load combinations were contained on Gaithersburg Power Division standardized forms used by the Stress Analysis Group. For support loads, only maximum design loads were summed. This provided the most conservative load combination to the Pipe Support Group.

A number of general questions arose during the inspection concerning the analytical procedures utilized for the piping system analyses for the SNUPPS project. One question dealt with the analytical procedure for incorporating "missing mass" or zero period acceleration effects. For the SNUPPS project, the Stress Analysis Group was using a 33 Hz frequency cutoff. No zero period acceleration loads were being incorporated into the support load tables. However, Bechtel personnel indicated that SNUPPS Project criteria required that (1) minimum stiffnesses be used, (2) worst case loads (typically faulted) be used to design supports to normal and upset allowable stress levels, and (3) that a minimum design load of 100 lb/inch diameter of pipe be used. The team believes that sufficient conservation exists in the calculation of support loads to cover zero period acceleration effects in these particular circumstances.

Another question concerned checking to see if response spectra peaks were straddled. This would result in an analysis that was sensitive to small changes in input parameters and modeling assumptions. Bechtel did not conduct formalized checks. However, typically the first mode for the piping systems reviewed was greater than the fundamental spectra peaks and, therefore, peak straddling was not observed.

Finally, the stiffness values used in the piping analyses were explored. Bechtel personnel indicated that very high stiffnesses were used in the weight and thermal expansion analyses while realistic minimum stiffnesses were used for the seismic analyses. This meant that thermal expansion results should be conservative, seismic results adequate, and that weight results can be non-conservative. However, the non-conservatism in the weight results would not be of engineering significance.

In summary, the Stress Analysis Group used standardized forms and the ME 101 computer program which provided good assurance of consistent application of the ASME Code requirements specified in the FSAR. In the more judgemental areas of analysis and modeling assumptions, improvements in the guidance were needed as discussed above in relation to Finding 3-1.

The results of our review of specific analyses are described in the following section.

3.1.3 - Analysis Review

The objective of this portion of the inspection was to evaluate the adequacy and control of specific Stress Analysis Group products.

Two stress analysis packages were selected for detailed review: (1) the auxiliary feedwater turbine driven pump discharge line, Problem No. 70, (Reference 3.9) and (2) the steam supply line to the turbine, Problem No. 60, (Reference 3.7). The team reviewed the input information referenced, the assumptions used in the analysis, and the stress and load summary sheets for compliance with FSAR criteria.

Problem No. 60 referred to Revision 13 of Specification MS-1, the Piping Class Summary, whereas Revision 14 (Reference 1.23) had been issued by the time the analysis was finally approved and Revision 15 had been issued by the time of our inspection. A similar situation existed with Problem No. 70. However, the team's review indicated that the later revisions did not affect these analyses. In addition, to demonstrate the procedure for controlling such information, Bechtel personnel provided a memorandum (Reference 3.39) that documented the piping analyses affected by the latest revision (Rev 15) to the Piping Class Summary.

The analyses indicated that 3% damped SSE response spectra had been used as input whereas 2% should be used for small piping. However, we found notes indicating that the 3% spectra analysis results had been multiplied by a factor of 1.25 to conservatively bound the 2% spectra acceleration values. This was a valid practice.

The analysis packages indicated that the main run piping did not have stress intensification factors greater than 1.0 at points where branch piping was located. The plant design staff stated this was a standard procedure for the SNUPPS project. (This applied to cases where the branch pipe was smaller than the run pipe as defined by footnote (6) to Figure NC-3673.2(b)-1 of the ASME Code.) Since the 1974 Edition of the ASME Code was ambiguous in this area, Bechtel's interpretation was that the run piping need not be stress intensified. We believe this approach is not conservative; however the significance is not expected to be major. The Code ambiguity was clarified in the Summer 1979 Addenda where a minimum stress intensification factor of 1.5 was required. However, the licensee is not required to meet the later versions of the ASME Code.

We found that Problem No. 60 had not employed the correct enveloped seismic response spectrum. FSAR Section 3.7(B)3.7 stated that "The seismic design of the piping and equipment included the effect of the seismic response of the supports, equipment, structures, and components." The enveloped response spectra used on Problem No. 60 were not conservative in that they did not include the effects of the main steam lines to which the supply lines in question were attached. A correct response spectrum should have been obtained if the appropriate plant design stress analysis newsletter, as discussed in Finding 3-1 above, had been employed. Since no formal design requirements existed to addresss response spectra input for branch lines, this problem may apply to other analyses where branch lines have been decoupled from larger piping systems. (Finding No. 3-2)

We found that Drawing M-03AB01 (Reference 3.29) did not reflect the correct "as-built" condition at the connection between the steam supply to the auxiliary feedwater pump turbine and the main steam loop 3 header. The pipe fabricator (Dravo) had supplied a different configuration than described in the Bechtel drawing. Revision 5A to the Dravo drawing (Reference 3.30), which had been received at site with the spool shipment, showed the correct "as-built" condition. However, the Bechtel site records maintained by the Bechtel Site Liaison Engineering Group contained the earlier Revision 5, (Reference 3.31), which did not reflect the "as-built" condition. This appeared to be a paperwork error by either Bechtel or Dravo. (Finding No. 3-3)

With respect to the same connection, we found that Problem No. 60 did not contain documentation for the calculation of the stress intensification factor used. This was contrary to Bechtel Procedure EDPI 4.37-01 (Reference 1.16), which required a statement of how design data were developed if detailed calculations were not performed. This was a procedural item which we would not expect to adversely affect the analysis. (Finding No. 3-4)

One additional piping run was reviewed to determine the adequacy of the assumptions used at Seismic Category I boundaries. This was the auxiliary feedwater suction piping from the condensate storage tank Problem No. 44A (Reference 3.8). Review of Problem No. 44A indicated that no anchor was designed at the Seismic Category I boundary where the buried pipe entered the auxiliary building. The effects of the Non-Category I pipe had been considered by modeling approximately ten feet of massless pipe with three directional soil springs located at two foot intervals. It was noted that building settlement was considered in the analysis in accordance with Bechtel Specification M-200 requirements.

We found that Problem No. 44A did not contain an evaluation of the imposed loads and movements due to the thermal expansion of the attached buried piping outside the building. This is contrary to Section ND-3651 of the 1974 Edition of the ASME Boiler and Pressure Vessel Code which states that the design of the complete piping system shall be analyzed between anchors for the effects of thermal expansion. This appeared to be a unique situation involving an interface, without an anchor, between Non-Category I buried pipe and Category I pipe inside a building. (Finding No. 3-5)

In addition, we found that the same problem did not contain an analysis of piping from the condensate storage tank inside the building for the cold condition. This is contrary to Section ND-3624 of the 1974 Edition of the ASME Boiler and Pressure Vessel Code which requires that the design of piping systems take into account forces and moments resulting from thermal expansion and contraction. This specific error in Problem 44A did not appear to be a systematic error since a check of the suction from the Essential Service Water System and the Auxiliary Feedwater discharge piping confirmed they had been analyzed for the low temperature condition. (Finding No. 3-6)

In a meeting with the NRC staff on June 9-10, 1981, the SNUPPS applicants committted to meet the staff's position on functional capability for ASME Class 2 and 3 piping systems (Reference 3.32). At the time of the inspection of the auxiliary feedwater piping system, the analyses had not been checked for compliance with the technical position. Our review of the stress analysis packages indicated that stresses at some points in the piping systems exceeded the minimum limits given in the technical position. Further evaluation is necessary to assure functional capability of these piping systems in accordance with the technical position. (Unresolved Item No. 3-2)

The piping systems required to meet the functional capability criteria in the technical position were identified by marked-up P&ID's that were transmitted from the Mechanical/Nuclear Group. However, no list was available to identify which analysis problems required evaluation for the functional capability criteria. In order to check the implementation of the functional capability criteria on current work, the team checked Stress Analysis Problem No. 12, (Reference 3.33). Review of the stress summary verified that the functional capability criteria had been considered in the analysis.

3.1.4 - Summary

This section summarizes the results of our review concerning the Stress Analysis Group.

As discussed above, three findings related to Stress Analysis Group guidance for analysis techniques and modeling assumptions. The most significant (No. 3-1) involved a lack of control over the use of stress newsletters. The second (No. 3-2) concerned seismic response spectra input for branch lines. The third (No. 3-5) involved the assumptions made at a piping class boundary. Although the majority of assumptions used appeared adequate, the negative findings indicated that more formal guidance was needed for consistent and correct application of design assumptions. (Observation 3-1)

There was one finding (No. 3-3) concerning control of design input information. This involved feedback of "as-built" information from the vendor drawing of the steam supply connection to the main steam line. The overall control over feedback of "as-built" information could not be assessed because system construction had not been completed and "as-built" walk downs had not been performed.

The review of design input information supplied by other Bechtel design groups included system operating parameters, component allowable loads, seismic input and piping class specifications. Based on the inspection sample, design input information appeared to be controlled.

The review of sample calculations indicated that the basic criteria specified in the FSAR for ASME Code allowable stresses and design load combinations were followed. Two findings did not appear to be systematic errors. One (No. 3-4) concerned a lack of documentation for a stress intensification factor and the other (No. 3-6) concerned failure to analyze suction piping for the cold condition. Accordingly, based on the inspection sample, adequate control was indicated.

3.2 Pipe Support Group

3.2.1 - Design Information

This section summarizes the basic design information reviewed in relation to the Pipe Support Group.

The basic input information comes from the Stress Analysis Group in the form of memoranda transmitting the support load summary sheets and piping isometrics showing the location of the supports. Data containing pipe thermal and seismic movements at the support locations are listed on the support load sheets.

Coordination with the Civil Group for structural attachments was achieved by sending the Civil Group the working drawing of the support which, in all samples examined, contained the imposed loads and the location of the support. The Civil Group then stamps the working drawing "Approved" prior to the Pipe Support Group issuing the hanger drawing. Working drawings had been retained for reference, although there was no evidence that this was required by Bechtel procedures. The most recent procedure implemented by Revision 17 to Bechtel Procedure EDPI 4.46-01 (Reference 1.17), requires an index sheet to be maintained for each isometric drawing. The index sheet contains a list of all supports on the piping isometric along with the revisions of the support design. When supports are revised, the index sheet along with all new support revisions are sent to the Civil Group which signs the coordination sheet.

In our review of the sample calculations as discussed in the following sections, we found the original procedure had been followed and the documentation had been retained. Implementation of the current procedure should improve the coordination between groups and the retrievability of the records in the Pipe Support Group.

The majority of the supports on the system selected had not been completed and had not received the field QC check at the time of the inspection. Feedback from the field on "as-built" conditions was similar to that discussed in Section 3.1.1 for piping. The major difference with supports was that the Daniel procedure for field change requests (Reference 3.38) allowed construction to proceed on the basis of the proposed change prior to Bechtel approval of the FCR. This was called a "Red Line Procedure" and it required a "Red Line Tag" be attached to the support until the FCR was dispositioned by Bechtel.

The results of our review of sample work areas are described in Section 3.2.3.

3.2.2 - Personnel and Guidance

This section describes our review of training and guidance information related to the Pipe Support Group.

Interviews with Bechtel personnel indicated the Pipe Support Group conducted a training course for new personnel. The training course consisted of approximately 60 hours of classwork. As with the Stress Analysis Group, it was noted that the training program had only recently been available.

A key document used by the Pipe Support Group was Bechtel Specification M-217 concerning pipe supports (Reference 3.16). This specification listed general design requirements such as required stiffness of supports. Another document used by the Pipe Support Group was Bechtel's Plant Design Hanger Engineering Standards (Reference 3.17). This document contained guidance for items such as evaluation of standard details for welds and attachments.

Standard components such as clamps, snubbers and sway struts were selected based on manufacturers' catalogue load ratings. Supplementary steel framing was generally evaluated using the computer program STRUDL to obtain member stresses and attachment loads. Evaluation of welded attachments to piping was performed by the Pipe Support Group as previously discussed in Section 3.1.2.

The basic design criteria involved evaluation of supports for the maximum loads transmitted by the Stress Analysis Group and maintaining the stresses within the ASME Code upset limits. This was more conservative than the FSAR criteria. Bechtel personnel indicated that more detailed evaluations using FSAR load combinations and stress limits might be used to evaluate the adequacy of existing supports or for evaluation of welded attachment stresses if needed.

The results of our review of specific analyses are described in the following section.

3.2.3 - Analysis Review

The objective of this portion of the inspection was to evaluate the adequacy and control of specific Pipe Support Group products.

Several pipe support calculation sheets were reviewed. Support AL02-C009/135Q was chosen for review because it contained welded attachments to the pipe. The loads matched the loads calculated by the Stress Analysis Group. The welded attachment analysis appeared adequate.

Support AL04-C009/135Q (incorporating two rigid struts) was reviewed. No stiffness calculations had been made. Bechtel personnel indicated that it was standard procedure not to calculate stiffness of struts when Hanger Engineering Standard (HES) number 16, Revision 1 was utilized. This standard limited the angle between two struts (analytically modeled as orthogonal) to be between 30° and 150°. It also illustrated a "cookbook" method for calculating the imposed axial loads. No evaluation was available at the time of the inspection to verify that the strut stiffnesses met the requirements of Specification M-217 for the entire range of allowed angles. Since the piping analysis used the stiffness given in Specification M-217, this question should be addressed to determine whether it has any affect on the design. (Unresolved Item No. 3-3)

In general, lateral vibrations of struts and rods were not considered for the SNUPPS project and no criteria were available for evaluating the frequency of supports in the unrestrained direction. FSAR Section 3.7(B).3.7 stated that the seismic design of piping included the effects of the seismic response of supports. Significant lateral vibration of the support would reduce its buckling capacity and could affect the response of the piping system. This question should be addressed to determine whether it has any effect on the design. (Unresolved Item No. 3-4)

Support AL01-R005/135Q was a box frame on the suction piping providing lateral support in one direction. Attached to the bottom of the frame was spring hanger AL01-H001/135Q. The loads used to analyze the support frame did not match the loads from the piping analysis. However, the loads used in the frame analysis were much higher than the loads from the piping analysis. The frame dimensions used in the STRUDL analysis did not match the dimensions on the support drawing. The STRUDL analysis was dated 10/04/76 and Rev 2 of the support drawing was dated 6/23/78. Apparently, the STRUDL analysis for this case was based on a preliminary design or a similar design of another frame support and was not updated with current loads and "as-built" dimensions because of the conservatism in the loads used in the analysis. Because the loads used in the analysis were much greater than the current piping loads, the frame design should be satisfactory and the apparent assumption was justified. The support design contained an evaluation of the frame stiffness which demonstrated that Specification M-217 requirements had been met.

Field inspection of support AL01-R005/135Q indicated that the frame provided no vertical clearance at the bottom of the pipe. This frame was not intended to provide vertical support. The cause was that the length of the vertical members specified in the bill of materials did not match the dimensions shown on the hanger sketch. This appeared to be a non-systematic error that was not detected in the design checks or the initial field quality control check of the hanger. It is expected that this error would be detected by a system walkdown performed in accordance with the NRC's IE Bulletin 79-14. The support will require rework to obtain the proper vertical clearance. (Finding No. 3-7)

Spring hanger AL01-H001/135Q was attached to the box frame discussed above. The analysis package contained correct loads and movements from the piping analysis. The design of the members was based on a load from a previous analysis revision which was less than the current load. A note in the hanger calculation stated that the new load and movements would not affect the member sizes. This design appeared to be satisfactory.

Support FC01-R020/135Q consisted of two lateral snubbers on the steam supply line to the turbine. The loads and movements used in the support evaluation were the same as those contained in the pipe stress analysis. The evaluation of support stiffness considered only the structural steel elements of the support which, in essence, assumes that the snubbers involved were rigid. We found that this did not meet the requirements of Bechtel Specification M-217 (Reference 3.16). Section 4.2(b.) of the specification required that either the stiffness requirements of Table 1 in that specification be met, the frequency equation be satisfied or the stress problem reanalyzed using the actual stiffness of the support. Test data from Pacific Scientific showed that the snubber stiffness for this snubber (type R/2-.65) was less than the minimum stiffness required by Table 1 of Specification M-217. However, the piping stress analysis, Problem No. 60 had used the stiffness value from the table. (Finding No. 3-8)

Since it appeared that snubber stiffnesses were not generally being checked for compliance with Specification M-217 requirements, similar situations may exist for other supports using snubbers. In addition, unresolved Items 3-3 and 3-6 concerned lack of evidence that support stiffness requirements had been checked for specific struts and I-beam attachments. Apparently, it was generally being assumed that standard components would be satisfactory rather than checking to determine that the project interface requirements in Specification M-217 had been met. In addition, Unresolved Item 3-4 concerned an apparent assumption that standard struts and rods would automatically be satisfactory from a standpoint of lateral vibrations. Based on these considerations it appeared that improved guidance and procedures were needed to assure that project requirements were met for standard pipe support components and structural details. These matters should be addressed in resolution of the above finding.

Anchor AL01-A002/125Q on the auxiliary feedwater suction piping was reviewed to verify the method used to evaluate welded attachment stresses. The evaluation used the ME 210 computer program to evaluate welded attachment stresses at the pipe attachment point. Since the stresses exceeded 8 ksi, an evaluation was performed using ASME Class 1 allowable stress limits for the following load cases: (1) primary upset limits for weight + OBE (2) primary faulted limits for weight + SSE and (3) primary plus secondary limits for weight, thermal, OBE and seismic anchor movements. The items reviewed, which focused on the methods for handling attachment stresses, appeared acceptable.

Anchor FC01-A002/135 was designed by the Civil Group. This anchor was a boundary anchor between the Seismic Category I steam supply line and the non-seismic supply line from the auxiliary boiler. The design loads from the Stress Analysis Group considered piping collapse loads from the non-Category I section of the piping. It was noted during the team's civil engineering review that these moments were reduced by the ASME Code stress intensification factor at the nearby elbow. The Bechtel Civil Group provided procedure TB-011 (Reference 3.21), which had been provided by the Stress Analysis Group. This procedure allowed reduction of collapse moments by the ASME Code stress intensification factor at any fitting located within three piping diameters of a restraint. While this procedure may produce acceptable results for elbows, we considered its general validity questionable since the Code stress intensification factors would not generally correlate with section collapse properties. This matter should be addressed to determine its potential effects on design. (Unresolved Item No. 3-5)

Field Change Request 2FC-1191-MH was reviewed as an example of field feedback. The FCR involved relocation of the structural steel attachment of a sway strut approximately six inches to avoid interference with existing conduit. The relocation was accepted and the Civil Group had signed off on the coordination sign off sheet. The change involved a support which placed an existing structural I-beam in torsion; the change increased the torsional moment on the I-beam. I-beams generally have low torsional stiffness, especially for the case where the load is applied locally through the flange. No evidence existed at the time of our inspection to verify that Specification M-217 stiffness requirements had been considered when this change was approved. This should be addressed to determine whether or not it would have any effect on the design. (Unresolved Item No. 3-6)

3.2.4 - Summary

This section summarizes the results of our review concerning the Pipe Support Group.

As discussed above, there was one finding (No. 3-8) concerning the failure to meet the support stiffness requirements of Specification M-217 with respect to snubbers. In addition there were two unresolved items (Numbers 3-3 and 3-6) regarding a lack of evidence that support stiffness requirements had been met for specific struts and I-beam attachments. The specification provides interface requirements to assure the consistency of piping analyses with support stiffness. Apparently, it was assumed that standard components would automatically be satisfactory rather than checking to determine that the project interface requirements had been met. One additional unresolved item (No. 3-4) relates to an apparent assumption that standard struts and rods would automatically be satisfactory from a standpoint of lateral vibrations. Based on these considerations, it appears that improved guidance and procedures are needed to assure that project requirements have been met for standard pipe support components and structural details. (Observation 3-2)

There was one finding related to control of design information. This finding (No. 3-7) involved an "as-built" discrepancy due to a detailing error on a support design. The review of design information supplied by the Stress Analysis Group included pipe loads and movements at the support locations. On the basis of the sample inspected, control of design information in this area appeared adequate.

The review of sample calculations indicated that the basic criteria specified in the FSAR for ASME Code allowable stresses and design load combinations were followed.

3.3 Mechanical Equipment

The turbine driven auxiliary feedwater pump was selected for review including its valves and valve HV-12 which is located on the discharge line from the pump. The basic design information was supplied to the equipment suppliers in the purchase specifications. The suppliers performed the required evaluations and documented the results in qualification reports which were supplied to Bechtel. The team's review focused on the design interface between the Stress Analysis Group and the equipment vendor for the transmittal of correct nozzle loads and compatibility of the analysis assumptions at the boundary points. Because qualification of mechanical equipment was an open item in the NRC staff's Safety Evaluation Report and would be subject to a later audit, the qualification reports were not reviewed in depth.

The team reviewed the seismic qualification reports for the turbine driven pump and the turbine. Ingersoll-Rand supplied the qualification report for the turbine driven pump, (Reference 3.34). The maximum allowable nozzle loads listed in this report were the same as those used in the piping stress analysis. Ingersoll-Rand had utilized 2.12g in both orthogonal horizontal directions along with a 2g vertical acceleration in their operability evaluation. However, the FSAR commitment and the requirement in Bechtel Specification M-900 (Reference 1.42) specified that 3g horizontal and 2g vertical be used. Mechanical/Nuclear Group personnel stated that they had been evaluating this matter and determined that the pump was acceptable. The team's review of the Ingersoll-Rand report indicated that significant margins existed between the calculated stress and the stress allowables. Therefore, the design should be adequate for the higher acceleration values.

The Terry Corporation supplied the report on turbine qualification (Reference 3.35). There was one outstanding question about the angle iron members that supported an instrumentation panel. For these panel angle supports, Terry Corporation did not perform an unsymmetrical bending analysis of the equal and unequal leg angles. The method used underpredicted the actual stresses present in the angles. The angle supports should be checked using appropriate analytical methods. (Unresolved Item No. 3-7)

The inlet nozzle loads used in the qualification report were the same as the loads used by the Stress Analysis Group for Problem No. 60. The stiffness of the nozzle could not be determined from the review of the report. Therefore, it could not be verified that the assumption of the nozzle as a rigid anchor in the piping analysis was valid. It was noted that dynamic testing results presented on page 52 of the turbine report listed frequencies ranging from 2.5 to 6.7 Hz, indicating that the turbine was not a rigid component. This item should be addressed to determine whether or not there is any effect on the piping analysis. (Unresolved Item No. 3-8)

There was no indication that the Stress Analysis Group reviewed the above vendor design reports and we had some concern about whether the stress analysis assumptions in those reports were being checked for consistency with Bechtel pipe stress analyses. However, since we found no violations of regulatory requirements, this matter is mentioned as a recommended area for licensee consideration. (Observation No. 3-3)

The team reviewed the qualification report for valve HV12 (Reference 3.36) as well as the valve data sheet supplied by Masoneilan, dated 8/19/77 which provided the actual weight of the valve. The weight given on the data sheet was approximately 6% greater than the weight used in the piping analysis (Problem No. 70). When questioned about this difference, Bechtel personnel produced the current revision of isometric drawing M-04AL04 (Reference 3.37), which contained the correct valve weight. They also produced the Bechtel criterion for reanalysis of piping problems due to changes in valve weights. This criterion stated that reanalysis was not required if the valve weight change was less than 17%. This was based on generic calculations performed by the Plant Design Staff. We did not review the documentation supporting the 17% criteria; however, the weight difference for valve HV-12 in Problem No. 70 was not considered significant.

The seismic input that Bechtel had provided for valve qualification consisted of generic envelope spectra for the plant. These spectra enveloped the output accelerations from the piping analysis and were conservative.

As discussed above, our review in this area resulted in two unresolved items and one recommendation for licensee consideration. Based on the limited review of equipment, it appeared that adequate controls existed to ensure basic design inputs such as nozzle allowable loads, seismic inputs and valve weights were properly transmitted between the Stress Analysis Group and the component suppliers.

3.4 Conclusion

On the basis of the sample included in the inspection, the design process appeared to be controlled in the mechanical components area. As discussed in the preceeding sections, weaknesses were identified, the most significant involving guidance concerning design assumptions and standard components. Nevertheless, the inspection sample in this area appeared to indicate adequate control.

4.0 Civil and Structural Engineering

The objective of this portion of the inspection was to evaluate civil and structural engineering design details and practices with emphasis upon control and exchange of information as well as the technical execution of the design. The team reviewed the involvement of Union Electric Company and Nuclear Projects Incorporated and the execution of design by the Bechtel Power Corporation. Areas of review included personnel qualifications, guidance provided, and a number of technical and procedural areas as described below.

4.1 Involvement of Union Electric Company and Nuclear Projects Inc.

The objective of this portion of the inspection was to determine, on the basis of a limited sample of technical items, the manner and depth of involvement of the licensee, Union Electric Company and the SNUPPS Utilities' contractor, Nuclear Projects Inc. (NPI), in the design of the Callaway facility in the civil-structural discipline area.

The Union Electric Company Nuclear Engineering Department responsible for the Callaway facility consisted of 26 engineers at the time of the inspection. Two of those engineers were civil-structural. Union Electric personnel indicated that the group had been formed about May of 1976. At that time a supervisory engineer in the civil-structural area and another civil-structural engineer were assigned to the Nuclear Engineering Department. Prior to that time these two engineers had been involved along with a third civil-structural engineer on assignment to the Callaway project from the Union Electric Engineering and Construction Department.

FSAR Section 1.4.1.3 describes the technical qualifications of Union Electric and provides the company philosophy with respect to engineering, design and construction of the nuclear facility. That section states that "UE does not maintain engineering and construction staffs for the design and construction of power plants, but rather engages reputable engineering and construction firms for these purposes. UE has a staff of engineering personnel that directs site investigation activities, guides plant design, implements a quality assurance program, and prepares for construction and operation of the plant." Union Electric Procedure QA-303 (References 4.5 and 4.6), which governs the Union Electric review process, is consistent with the FSAR commitments in this subject area.

The team reviewed the work assignments of the three individuals for the May 1975 time frame when many of the basic decisions in the civil-structural discipline were made. The work was divided between the power block work (Bechtel scope of design) and site (Sverdrup and Parcel scope of design). The site work apparently consumed a significant portion of the time available to the Union Electric personnel. In addition, the supervising civil-structural engineer was responsible for all disciplines with respect to site-related design work.

The function of these Union Electric civil-structural engineers was to provide comments and input to the Company's representative on the SNUPPS Technical Committee for consideration by that Committee for incorporation into the standard plant design. Once a design or engineering decision was reached by the SNUPPS Technical Committee, or the Management Committee if necessary, NPI would provide the direction to Bechtel. Various other committees and groups existed within the SNUPPS concept to provide input, to complete reviews and to give direction to the various management decisions which had to be made, including those related to engineering and design.

We reviewed in excess of 125 letters and meeting summaries and 13 specifications related to Union Electric Company's involvement in the civil structural design (References 4.9, 4.10, and 4.13 to 4.23). Generally they indicated involvement, coordination, and responsiveness to regulatory concerns with work conducted in accordance with Union Electric Company's procedures and FSAR commitments.

We found that Union Electric was involved in the review process of the basic civil-structural design criteria after September 1973 when Specification C-0 (Reference 4.10) was issued by Bechtel for the SNUPPS utilities' approval. The Union Electric review was conducted before Union Electric had a formal procedure to govern such reviews since Union Electric Procedure QA-303 (Reference 4.5) was not issued until March 1974. This appeared to be contrary to Criterion III of Appendix B to 10 CFR 50 which requires such procedures. The team's examination of the items noted by Union Electric during the review process and the resolution of comments did not indicate that improper consideration was given during the review to the pertinent safety issues. Therefore there was no apparent impact on the review work performed or actions taken by Union Electric prior to the issuance of QA-303. It was a procedural matter that had been corrected in March 1974 with issuance of the appropriate procedure. (Finding No. 4-1.)

Currently, the NPI staff includes 13 technical personnel (compared with 8 to 9 at the start of the project). They are organized into project functional areas with the civil-structural area being addressed by two systems engineers under the Technical Director. The only civil-structural engineer involved is the Manager of Technical Services. Earlier (1975-1976) one additional civil engineer was involved. This staffing level appears to be consistent with the NPI role of coordinating and consolidating utility efforts since the utilities provide civil-structural engineering expertise for the review process.

The principal means for the utilities and NPI staff to provide input into the design process is by the Technical Committee's actions. The team reviewed the records related to several sample areas of Technical Committee activity in detail, including meeting minutes.

It appears that all parties were aware, at the outset of the project, of the need to define interfaces among the various groups involved in design, engineering, construction and management. In addition, levels of review and categories of comments for design documents produced by Bechtel had been defined. The team reviewed several letters and minutes from early in the project related to the Technical Committee's review of the basic civil and structural design criteria document. We also found that the Technical Committee had been fairly active in the early phases of the project when many of the basic design decisions were being made. The Committee averaged one day per week in session from June 1973 to June 1974. We noted and examined the following items that involved the Technical Committee in the civil-structural area for selected time frames:

1973

1. Bechtel - Sverdrup and Parcel interface
2. Review of Civil-Structural Design Criteria, C-0
3. Plant layout planning

Early 1974

1. Concrete aggregate sources, testing, etc.
2. Reinforcing steel procurement
3. Third level reviews for safety review of selected systems
4. Functioning of the Technical Committee
5. Systems descriptions and SAR consistency and updates
6. Procedures of design review
7. Procedures for bid packages
8. QA requirements on the operation of the Technical Committee

Late 1975

1. Status Report - Bids - Specification C-202; Pipe Hangers and Supports and Miscellaneous Metal
2. Bid recommendation on Specification C-202
3. Development procedure for bidder's lists
4. Civil-structural design review

Early 1976

1. Reactor cavity design
2. Third level reviews
3. Base mat seismic design
4. Bid award for Specification C-202
5. Design reviews

Late 1981

1. Deletion of selected pipe whip restraints

Late 1982

1. Retrofit of specifications and drawing revisions
2. Disposition of field reports
3. Installation tolerances for surface mounted plates
4. Intermediate design change packages
5. Walkdown of piping systems
6. Nonstandardization - Startup Field Reports, Field Change Requests and Nonconformance Reports
7. Hanger status
8. Penetration closures

The team also reviewed a number of items related to efforts of the Construction Review Group to evaluate the consideration of items such as constructability, cost, schedule and sequence. A brief line item summary of the subjects noted and examined for selected time frames is provided below.

1976

1. Comments on Specifications C-101, 103 and 131
2. Schedule and concrete placement in the auxiliary building
3. Field Change Requests - Site interfaces and communications
4. Concrete specification
5. Field Change Requests and Nonconformance Reports and waivers
6. Structural steel bolting
7. Construction details and blockouts
8. Blockout reinforcing steel spacing
9. Resolution of comments on Specification C-103
10. Construction Review Group's recommendation for field run pipe
11. Pipe whip restraints
12. Technical Committee review levels
13. Construction joint at containment-auxiliary building wall intersections.

1977

1. Concrete problems
2. Reinforcing detailing problems/errors
3. Component support boundaries
4. Wall reinforcing steel erection
5. Construction Review Group Charter and Management Committee Action
6. Nonconformance Reports on minor concrete deviations
7. Design drawings vs. American Concrete Institute Standard 318 and resulting conflicts
8. Reinforcing steel placing tolerances
9. Construction Review Group meetings
10. Procedures for Field Change Requests and Construction Variance Requests
11. Reinforcing steel interferences
12. Auxiliary building reinforcing steel

The team did not review the activities of other groups, such as the Management Committee and the Quality Assurance Committee.

Additional inspection was performed of the NPI involvement in the design and engineering effort by selective review of specifications in the civil-structural discipline. This was conducted in the same manner as for Union Electric Company by selecting distinct specifications and the related correspondence. The areas inspected included the documents reviewed at Union Electric. In addition, two other specifications and related correspondence files were reviewed (References 4.17 and 4.18).

It appeared that most of the independent technical input in the civil-structural area had originated with the utilities. The coordination and consolidation function performed by NPI was evident. NPI had set an excellent example from a quality assurance standpoint on items related to the civil-structural design criteria in diligently pressing for resolution of issues.

Based on the information reviewed, it appears that the relevant commitments in FSAR Section 3.8.4 have been correctly translated into specific project design documents such as specifications, drawings and procedures. The basic civil-structural design criteria document (Reference 4.10), which contained the civil-structural design criteria for the facility, is consistent with the commitments contained in the FSAR. This document appears to have been adequately reviewed, controlled and maintained. The individual design subjects and criteria commitments were developed into technical specifications addressing the acquisition of materials, the fabrication of assemblies and the erection of various portions of the civil-structural items. These documents have also been subjected to a review process which was controlled and the documents have been maintained.

Our review indicated that the transmittal of information between the various groups involved in civil-structural design and engineering process was good. Coordination meetings and effective communications contributed to this good level of design interface. Where problems seemed to develop there had been timely recognition of them by engineering and project management through the controls that had been instituted before and during the project. Resources were directed to the problems until a solution was prescribed, implemented and monitored for the desired results.

4.2 Personnel and Guidance

This section describes our review of staffing and guidance information in the civil-structural area.

At Union Electric Company, the supervising civil-structural engineer had 30 years experience in civil engineering with the company and had been working on the Callaway project as a supervising engineer since 1973. The other civil engineer had 8 years experience in civil engineering with the company and had been assigned to the Callaway project since 1976. Both had BS degrees in civil engineering, were registered professional engineers and had received additional company training in quality assurance in connection with their Callaway assignments.

At NPI, the civil engineer that remained on the project had 30 years professional experience, mostly related to nuclear plant design, following receipt of a BS degree in civil engineering. He had also received an MS degree in nuclear engineering and a law degree and was a registered professional engineer. This individual was originally involved with the SNUPPS project as the licensing engineer and was the Manager of Technical Services at the time of our inspection.

The training and experience records for a civil-structural engineer who was employed by NPI from June 1975 to May 1976 could not be located. This was contrary to Criterion XVII of Appendix B to 10 CFR 50, which requires that records shall also include data such as qualifications of personnel. We found no adverse effects on the design from this specific item, which was a record keeping error. (Finding 4-2)

At Bechtel, a cross-section of 6 civil-structural engineers, ranging from junior to senior levels, representing working design engineers as well as supervisors, was selected as being representative of the civil-structural engineers that had worked on the project over time. Their qualifications were summarized as shown on Table 4-1. Additionally, all had received training while at Bechtel, including project related quality assurance training.

TABLE 4-1

BECHTEL PERSONNEL QUALIFICATION SAMPLE

Engineer Number	1	2	3	4	5	6
Function	Designer	Designer	Group Leader	Special Problems	Group Leader	Group Supervisor
Degrees	BSCE	BSCE	BSAE MSCE PhDCE	Technical Institute Graduate	BSCE	BSCE MSCE
Registration		EIT	EIT	PE	PE	PE
Years of Experience						
a. Total Professional	1.5	27	5	24	12.5	12
b. Nuclear Plant Construction						2
c. Nuclear Plant Design	1.5	8	5	7	8.5	7.5
d. SNUPPS Project	1.5	5	5	6	8.5	6.5

The team reviewed the records of the project related training required by Bechtel procedures for individuals working on various aspects of the project for the civil-structural group. The requirements related to training and indoctrination were addressed in Bechtel Procedure EDP 5.34 (Reference 4.52). The Bechtel project quality engineering group had also implemented supplemental procedures. Basically the group supervisor was responsible for defining which specific procedures were necessary for a given individual to read and understand. A log was maintained identifying the individual records of these required reviews. As new assignments or functions were detailed to individual engineers the group supervisor was responsible for reviewing the individual's training and indoctrination record to ascertain whether the individual must receive training on additional procedures.

For revised procedures the project quality engineer, who was responsible for the procedures, issued a memorandum to project group supervisors noting the substance of the changes. The individual group supervisors then determined how they would pass that information to the individuals within their group.

Our review of the project's execution of training and indoctrination of project procedures and instructions for the civil-structural group indicated that it was consistent with the Bechtel procedures. Interviews and contacts with the various individual engineers in the civil-structural group during the design inspection led us to conclude that the individual engineers generally knew the procedures and followed them.

The results of our review of design details in the civil-structural area are described in the following sections.

4.3 Auxiliary Building and Floor Response Spectra

The objective of this portion of the inspection was to examine the adequacy and coordination of analysis, design, and the resulting floor response spectra for the auxiliary building which housed the auxiliary feedwater system. We also examined the as-built structure.

The auxiliary building was designed with both exterior and interior concrete walls to transfer lateral shear force from seismic loads and steel columns to transfer only vertical loads. The capacities of concrete walls were mostly governed by, and designed for, missiles and were later checked for seismic capability. The team checked a sample of design calculations for the auxiliary building and found them correct and adequately documented. Two engineers who were involved in the design were interviewed and both had a good understanding of the overall design concept of the auxiliary building and were able to relate the construction drawings to design calculations quickly. Based on these spot checks of the design calculations and drawings, and interviews, it appeared that the overall design of the auxiliary building had been properly executed.

Our review of seismic analysis was somewhat hampered because the seismic model of the auxiliary building was a part of an integrated power block structures model which was quite complicated and could not be fully evaluated within the time frame of our inspection. Nevertheless, it appeared to us that the geometry of the auxiliary building had been properly represented in the mathematical model.

Some problems were found in the dissemination and coordination of updated floor response spectra.

We found that seismic analysis calculations on the auxiliary building had been given final approval by the civil group supervisor in March 1982, but had not been sent for microfilming at the time of our inspection in December 1982. This violated Bechtel procedure EDPI 4.37-01, Section 4.2, which required that all calculations completed or revised during the month be submitted for microfilming by the 15th day of the following month (Reference 4.39). This was a procedural matter that had no apparent effect on the design. (Finding No. 4-3)

Floor response spectra are not only used as design loads for civil structures, but also are used as basic input loads for other engineering disciplines, such as piping, mechanical, and electrical equipment. Bechtel had calculated revised floor response spectra using actual as-built conditions for the auxiliary building. Some of the revised spectra exceeded the original spectra that had been used in design, by significant amounts in some cases. The calculations had been completed and checked in August 1981. During our inspection, in December 1982, the effects of these revised spectra had not yet been accounted for in the design. Revised spectra had not yet been sent to the other discipline groups, such as mechanical and electrical, to evaluate the effects of the greater seismic loads upon systems and components.

It was appropriate, in these circumstances, for the Civil-Structural Group to examine means by which the spectra might be reduced before providing the revised seismic inputs to other groups in order to minimize the impact. Judging from the amount of exceedance, however, it appeared that some revised floor response spectra would have to be sent to other groups eventually. The team was concerned about the amount of time taken to achieve a resolution of this matter. The time scale of 16 months without yet achieving a final resolution did not appear consistent with efficient design and project management needs.

A memorandum in May 1982 (Reference 4.127) indicated that the Civil Group had discussed the situation to some degree with other groups. However, the matter had not yet been resolved and new spectra had not been entered in the central file system which was the controlled system for obtaining current response spectra. Our interviews indicated that personnel in other groups were not generally aware of the item. Accordingly, the delay introduced a likelihood that someone might base new work on the older spectra and such work might eventually have to be corrected or justified when the matter was resolved. However, the concern in this regard was not a finding or an open item. No adverse effect on the final design was expected because the issue was recognized, was being worked on and would not have been overlooked.

Accordingly, this delay in dissemination of design input information is mentioned as an area recommended for licensee consideration with respect to efficiency and project management needs. (Observation No. 4-1)

The team examined essential shear walls that transferred lateral loads in the plant. The walls were constructed consistent with the drawings which themselves reflected the design conditions and no voids or significant cracks were found.

The team identified a questionable assumption concerning typical electrical raceway supports in the electrical penetration room and the lower cable spreading room. A typical support consisted of a vertical square structural steel tube section connected (at the floor) to a base plate by two welded angles on opposite sides of the tube. Both the angles and the welds were designed for horizontal shear forces but not for bending moments because the baseplate attachment was assumed to act as a hinge in the mathematical model. This assumption corresponded to a normal civil-structural design practice for a typical hinged connection between a beam and a column. However, in this installation the tube was butted against the baseplate in contrast to the normal practice of providing a gap to allow rotation between the beam and column. Thus the installation had a degree of fixity and would attract some moment under seismic loading rather than acting purely as a hinge. Accordingly, the welds and angles should be evaluated in terms of the actual fixity of the attachment to determine whether or not adequate strength exists. (Unresolved Item No. 4-1).

4.4 Generic Embedded Plate Program

The objective of this portion of the inspection was to review samples of specific design calculations and engineering work concerning embedded plates to ascertain whether or not:

1. design commitments were being met,
2. design controls were effective, and
3. proper information flow and interfacing were evident.

A major discipline interface occurred in the design of the SNUPPS plants generally in the area of the boundaries between structural support plates and supported elements. The defined interfaces which occurred on this project were between the Civil-Structural Group and Plant Design Group (mechanical items), between the Civil-Structural Group and the Electrical Group and between the Civil-Structural Group and the Instrumentation and Control Group. This section of the report represents the review of a sample of the interfacing between two distinct design disciplines. Specifically the review of the generic embedded plate program instituted by Bechtel for this project is discussed. Specific use of the methodology and details for a given support are addressed in Section 4.5.

FSAR Section 3.8.4.6.4 defines relevant general commitments for embedded base plates. Loads and load combinations were defined in Section 3.8.4.3 and the design and analysis procedures were defined in Section 3.2.4.4 as conventional analytical methods of standard engineering practice and computer methods as defined in Appendix 3.8A. The basic materials were identified in Section 3.8.4.6.4 as well as erection, examination and quality control aspects. The design commitments provided in the FSAR were properly reflected in Bechtel Specifications C-0, C-121 and C-131 (References 4.10, 4.17 and 4.18). Drawings allowed the use of surface mounted plates or chipped and grouted embed plates instead of embedded plates placed prior to the casting of the concrete elements. Owner approval was required to exercise these options. Details of the options were provided on approved drawings. Use of the substitution was to be documented and traceability of the plate and bolt materials maintained. Other variations to these had also been developed which consisted of through bolting for plates as well as grouted bolts. These alternates had also been detailed on approved drawings. The need for alternates to embedded plates arose from several reasons: (1) development of locations and/or loads for specific plates lagged concrete placement, and (2) changes made from the original design.

Further commitments for base plate design and engineering had been made in the SNUPPS reply to an NRC Bulletin 79-02 (Reference 4.110). It was noted that the design efforts and programs in this area had been well underway before the bulletin had been issued.

Analyses for the embedded plates were completed using the computer programs ANSYS and BSAP as described in FSAR Sections 3.8.A.1.9 and 3.8.A.1.10 and Appendix 3.8.A. The models used to consider the various embedded plate configurations included the flexibility of the plate, the flexibility of the anchorage device (tension) and the concrete (compression), and the loading interactions as well as the geometrical parameters. Based on the analyses, a series of design aids in the form of nomographs had been developed for use on the project to allow sizing or checking of a specific plate assembly for a given set of conditions. If multi-directional loading was involved, it was necessary to utilize one of a series of interaction formulas which were also analytically developed for use on the project along with empirically derived constants. The use of these design aids also considered construction tolerances by performing analyses for the worst location of the attachment within the middle third of the plate. The definition of the middle third used in the analytical work had been reflected in the design documents in several cases. If the geometry and conditions were not such that the attachment could be made within the middle third then the constructor filed a middle third deviation report which must be resolved by Bechtel. This disposition required an engineering review and determination of acceptability based on the specific geometry and loading for that case. The controls for dimensions of such items as attachments, bolt holes and edge distance surface mounted plates were provided as notes on approved drawings. The control of those attachments outside the middle third was also addressed in Bechtel Procedure EDPI 4.62-01 (Reference 4.47). We reviewed Revision 13 to this procedure with respect to Middle Third Deviation Notices and found it to be consistent with the design assumptions and that it had been used correctly.

We conducted specific checks of several individual calculational packages which formed the basis of the design aids for embedded plates. They were:

1. Calculation 03-53.4-F, "Capacities of Embedded Plate Type EP912A" (Reference 4.54)

2. Calculation 03-107-F, "Formulation of Load Capacity Coefficients of Embedded and Replacement Plates" (Reference 4.55)

3. Calculation 03-109-F, "Load Nomographs for Embedded and Replacement Plates" (Reference 4.56)

We reviewed these calculations to verify that the assumptions, boundary conditions and input data and analyses were correct. The model used in the computer based analysis for Plate Type EP 512A reflected the geometry and material properties for the actual structure and input data appeared to be properly and accurately prepared.

Several of the Bechtel procedures were reviewed in part during this effort since they directly provided controls and guidance for the design process in this area. They were:

1. EDPI 4.25-01, Design Interface Control (Reference 4.36)
2. EDPI 4.37-01, Design Calculations (Reference 4.39)
3. EDPI 4.46-01, Project Engineering Drawings (Reference 4.41)

The project procedure on design interface control (EDPI 4.25-01, Section 4.0) appeared somewhat general. The requirements for defining interfaces are contained in Regulatory Guide 1.64 (Reference 4.126) and ANSI N45.2.11 (Reference 4.125) to which the licensee had committed in FSAR Section 17.1.2. The procedure addressed interfaces among Project Engineering, Project Construction, speciality groups and other Bechtel divisions and companies. However, there was no precise definition or prescribed procedure for design interface between subunits within the project such as the Stress Analysis Group and the Civil Group. Subunit interfaces were addressed by the following statement: "The interface responsibilities are well understood through existing organizational agreements and established practice."

These agreements and practices varied in formality, precision and the degree of personnel awareness. For the most part, our reviews indicated that interfaces among discipline groups were understood. However, the following items are examples of problems:

1. Zone of influence drawings not being prepared, contrary to the memorandum that defined interfaces and responsibilities for high energy line break analyses (Finding 2-4 in Section 2.4)
2. Failure of discipline groups to exchange information or take action needed to meet pipe support stiffness requirements (Finding 3-8 and Unresolved Items 3-3 and 3-6 in Section 3.2.3)
3. Failure of a standard support location tolerance provided by the Stress Analysis Group to reflect the Civil Group's needs regarding load path (Unresolved Item 4.2 in Section 4.5)

Accordingly, in our judgment, the general statement (in EDPI 4.25-01) that subunit interfaces were well understood through existing agreements and established practices was not uniformly borne out in practice. We conclude that this is contrary to the licensing commitments discussed above. The licensee should employ more formal and precise methods or training to enhance the effectiveness of subunit interface control. (Finding No. 4-4)

As discussed above, a weakness was identified in the definition of internal interface controls. This finding and the associated examples applied to the project in general. However, as discussed in this and other sections, for the most part our reviews indicated that internal interfaces were understood.

With respect to embedded plates, based on our review and interviews, we concluded that adequate procedures generally existed to control the transmittal of design related information. Calculations we reviewed in this area reflected correct input and were current with other design documents being utilized for design and construction. The designs and analyses had been conducted in accordance with the appropriate procedures. Assumptions were judged to be valid.

4.5 Pipe Supports, Hangers and Restraints

The objective of this portion of the inspection was to determine, for a samp'_ of hangers, piping supports and restraints selected by our inspection team's mechanical systems, components, and piping engineers, whether or not:

1. the licensee's design commitments contained in the FSAR and other relevant documents had been met,

2. correct design information had been coordinated and complete interfaces made through a rational design process,

3. design engineers had sufficient training experience and guidance to complete the necessary design work, and

4. the completed design was adequate.

Pipe Hanger 0-AL04-C009/135(Q) supporting the turbine driven auxiliary feedwater pump discharge pipe, was designed by the pipe support group It consisted of a double sway strut vee assembly hung from the bottom flange of a structural steel beam which formed part of the structural building frame supporting a concrete slab floor. The attachment of this hanger assembly to the flange was through field welds. The team found no discrepancies related to this hanger. The review is described below to illustrate the nature of the coordination necessary in such designs.

A review of documents indicated that Revision 4 of the hanger drawing M-06AL04 (Reference 4.97) had been coordinated with the Civil Group as a markup working print prior to issuance by the Pipe Support Group. The markup contained the location of the needed welded attachments to the structural steel as well as the revised forces and displacements at the centerline of the pipe. Also included was information clearly defining the orientation of the pipe forces and displacements. The coordinated markup also contained a reference to the correct and current civil drawing associated with the structural steel framing to which the hanger was attached.

Action by the Civil Group was documented only on the markup work print which carried a civil coordination stamp with the date and initials of the individual reviewing for the Civil Group noted. Discussion within the Civil Group regarding their normal actions on such an item indicated that a check would be made that there was in fact a structural steel beam at the location defined in the drawing. Bechtel procedure EDPI 4.46-01 (Reference 4.41) generally described the coordination, review and approval process. The requirements for documentation are contained in ANSI N45.2.11 (Reference 4.125) to which the licensee committed in FSAR Section 17.1.2. From discussions with personnel in both the Civil and Pipe Support Groups it appeared that the process defined in the Bechtel procedure had been followed. The procedure required no records related to internal coordination of drawings and comments thereon once the drawing had been approved and released by the project engineer. Coordinating prints could be destroyed, although they were generally being saved by the originating group for those instances examined by the team. Without the Pipe Support Group saving the marked up working print, the Civil Group has no record of the actions on base plate selection. This item is noted as an area recommended for licensee consideration. (Observation No. 4-2)

The resolution of the above item may be related to Finding No. 4-6.

The question of the load's effect on the structural steel in this case did not require unique consideration since the maximum pipe force was 3.1 kips and the pipe loads were not in an area with heavy piping concentrations. The civil-structural design criteria, specifically address the manner in which piping dead loads are to be treated as follows:

"For permanently attached small equipment, piping, conduits, and cable trays, a minimum of 50 psf shall be added where appropriate. In the event structural design must precede the availability of piping loads, a concentrated load of 20 kips shall be applied in the above areas or in other areas of concentrated piping (in lieu of the actual piping loads) to maximize moments and shears."

The structural loads resulting from pipe reactions during normal operating or shutdown conditions, based on the most critical transient or steady state conditons, were addressed in the civil-structural design criteria and were consistent with the FSAR. In this case no specific values for live load were defined with the apparent assumption that the prescribed dead load values were sufficient for design. Based on inspection of the actual pipe loads provided by the Pipe Support Group to the Civil Group we determined that the loads represented a conservative combination of all piping loads at the support point, including dead load, normal operating pipe reactions and seismic loads. Since the loading combination elements in each of the combinations which must be considered had identical load factors in all cases, it was in fact not necessary to specifically separate the two load effects.

For this instance, the prescribed allowance for a 50 psf uniform dead load and the 20 kip concentrated load application was considered by the designer to be sufficient to encompass the imposed loads from the hanger. Based on the dates of erection of structural steel in this area and the date of Rev. 0 of this specific hanger drawing no specific loads would have been available at the time of the basic structural steel design.

Based on the above facts we concluded that the correct design information had been transferred from the Pipe Support Group to the Civil Group and that appropriate action had been taken by the Civil Group. The design commitments in the FSAR had been correctly transferred into the civil-structural design criteria document. Considering the loads used in design of the basic structural steel framing and the magnitude of the actual loads for this hanger and observation that no other significant loads were currently supported by the beam we concluded that the civil structural design was adequate for the hanger assembly. It should also be noted that additional margins besides that resulting from the magnitude of the load existed since all loads were considered for resistance capacity at allowable stress levels whereas the criteria would allow for increased stresses of 50 and 60 percent under the working stress methods for certain load combinations.

Other hangers, supports and restraints were examined during the inspection based on the selections made by the mechanical engineers from the inspection team. This group of piping support hardware (along with hanger 1-AL01-C009/135Q discussed at the beginning of this section) included interfaces and design input to the Civil Group for standard pipe struts, spring hangers, support frames, stanchion type anchors and isolation restraints. Some were supported by structural steel building frames and others by embedded plates in concrete walls. Two pieces of pipe support hardware designed by the Civil Group were also included among these. The following is a list of the other support hardware and related interfaces examined during the inspection.

Hangers 0-AL01-H001/135Q and 0-AL01-R005/135Q represented a combination spring hanger and support frame with the hanger suspended from the frame. This combination supported the turbine driven auxiliary feedwater pump suction piping. The support was found by field inspection to have been installed outside the middle third of the embedded plate and therefore was required to be checked. No middle third deviation notice (MTDN) had been prepared for this as-built condition. However, the licensee's representatives indicated final acceptance had not been completed for this assembly. Based on our field measurements the Bechtel Civil Group in Gaithersburg performed an evaluation for the as-built conditions utilizing the project's interaction equations and found more than adequate margin with respect to allowable stress levels for the support plates.

Hanger 0-FB01-A002/135Q represented a stanchion type pipe anchor designed to be welded to a pair of embedded plates and to resist pipe collapse loads. It was located on the steam supply piping from the auxiliary boiler to the turbine for the turbine driven auxiliary feedwater pump. Based on early criteria set for this project, a load greater than 15 kips placed the anchor design responsibility with the Civil Group. We found that loadings had been revised on 10/14/81. Because of this change the issued drawing, M-06FB01 (Reference 4.108), was undergoing a change to reflect the new loads. At the time of the inspection the Civil Group had completed the design of the necessary additional increases in the stanchion's cross-section based on calculations (Reference 4.59) approved on 9/29/82. The drawing had been revised but had not yet been processed and issued.

Our field inspection indicated that the load transfer path used in the design calculations did not reflect actual conditions (References 4.59 and 4.108). The stanchion had been mislocated by about 4 inches. Since the piping design group allowed a 6 inch tolerance for this situation, the licensee's representatives at the site indicated that they would consider the installation satisfactory. However, in this case, such a tolerance was not consistent with the design load path that had been used by the Civil Group for design. The design calculations had assumed that the stanchion would be centered over and connected to two embedded plates which would share the load. The 4 inch mislocation had placed the stanchion on one plate only. In our judgment this condition would likely not have been detected in subsequent system walkdowns. This specific condition, however, turned out to be adequate. During our inspection, Bechtel personnel revised the calculations for this design to address the as-built condition and found adequate load carrying capacity in the single plate (Reference 4.59). However, in the team's judgment, further evaluation should be conducted to determine whether or not there are other similar instances where the standard Hanger Group tolerance does not match the Civil Group's load path. (Unresolved Item No. 4-2).

Hanger 0-AL03-C010/135Q and 0-AL03-C011/135Q were two of five identical support frames designed by the Pipe Support Group which were field welded to embedded plates, Type EP 912B, provided by the Civil Group. They support the discharge piping from the motor driven auxiliary feedwater pump (Pump B). The worst case selected for the support frame design was based on Hanger 0-AL02-C009/135Q.

Interfacing between groups in design indicated good information flow. The team checked loads, selected by the Pipe Support Group as representing the worst case for the supports, against the embedded plate design. We utilized the interaction curves (Reference 4.56) to check the adequacy of the plates which had been selected and found them to have substantial margin.

Isolation restraint FC02 consisted of a series of plane frames which geometrically formed a space frame whose purpose was to serve as eight pairs of restraints at a tee pipe intersection on the steam supply line to the auxiliary feedwater pump turbine. This structure was designed by the Civil Group with interaction between the Civil Group and the Pipe Support Group for loads and stiffnesses. The design calculations for this restraint (Reference 4.58) had been performed and checked in November 1982, but were still undergoing review for approval. The detail drawing had been used for fabrication in January 1982 as Revision 0 (Reference 4.93) and was issued for construction in November 1982 as Revison 2 (Reference 4.93) before the calculations discussed above were performed. We questioned what design calculations had existed in order for the drawing to have been released for fabrication or construction. A set of calculations that had not gained final approval had existed in the group. They had been overtaken by field conditions in the form of interferences. These field problems had been detailed in drawing change notices which were subsequently considered when the final calculation was made. These actions were contrary to Bechtel procedures EDPI 4.37-01 and EDPI 4.46-01 (References 4.39 and 4.41) which required approved calculations prior to release of drawings for construction. This item did not have any apparent adverse effect on the final design product. It is one of two examples of release of design information prior to approval of calculations. Finding 6-4 provides a discussion of the other example. (Finding No. 4-5)

We did not review the calculation package of 54 sheets in detail. We noted that interfacing information between the Civil and the Pipe Support/ Pipe Stress Groups did occur and the calculation package appeared to contain the neccesary information.

Support 2-AL01-A002/125Q was a stanchion type anchor for which a field change request had been prepared because of a 2" differential between the design height and the as-built condition. The initial request was processed through the Pipe Support Group and then coordinated with the Civil Group which evaluated the embedded plate design (EP 912B) and elected to add stiffness to the plate-stanchion connection. The team requested a check of the original plate's selection as no documentation was maintained for each individual plate selection. Based on this current evaluation it was concluded by Bechtel that, although an initial check indicated over-stressing, further analysis demonstrated the plate as originally detailed would have been adequate. It was assumed that when an engineer evaluated the information on the Field Change Request he stopped with the initial check and elected to added the stiffeners. Based on the current evaluation the anchor is adequate for the design loads.

We found that, in general, no specific design calculations existed for embedded plates to document the basis for their selection and placement on design drawings designating the type of plate for use at a given location. In some cases the selection of a specific plate could be completed by the use of one of a series of nomographs but in many cases the selection was based on the results of calculations using the appropriate interaction equation. The lack of documented analyses for each specific plate was contrary to EDPI 4.37-01 (Reference 4.39) which required that design calculations be made to provide the basis of drawings used to construct the facility. However, the team was still able to conclude that a controlled process for these selections had been in effect. (Finding No. 4-6)

In summary, there existed excellent evidence of the interface action between the plant design groups (Stress Analysis Group and Pipe Support Group) and the Civil Group on the examples reviewed. There appeared to be good coordination of the necessary information from one group to another. Examples of the analysis completed by one group being translated into input for the other group existed.

While it was possible to check the selection of a specific type of embedded plate in accordance with the standard techniques, documentation did not exist to ascertain how the actual selection had been made. Nevertheless, in our opinion, based on the sample examined and discussions with the personnel involved, there was a consistent process for designing supports and restraints in the Civil Group including the embedded plates. Only one instance was identified where there was a question of why the original designer had selected a particular type of plate. The original selection was apparently a judgment call, as it was unlikely that the refined analysis which was performed during our inspection was in fact performed originally to support the selection. However, the more refined analysis did support the original design, validating the judgment been made by the original designer.

Overall, there was evidence that when an interface problem was identified, management had taken corrective action and the inspector was able to see how the coordination process had improved although the written procedures might not in every case reflect the actual functioning process as a requirement.

4.6 Control of FSAR and Design Changes

The objective of this portion of the inspection was to examine whether licensing commitments were being met and maintained as changes and deficiencies arose as well as to evaluate the flow of information and the design control process. The team reviewed a sample of procedures to evaluate their adequacy, coverage of the design process and implementation. The procedures reviewed were:

EDPI 4.22-01, Preparation and Control of SAR (Reference 4.34)

EDPI 4.23-01, SAR Change Control (Reference 4.35)

EDPI 4.47-01, Drawing Change Notice (DCN) (Reference 4.42)

EDPI 4.60, Processing Corrective Action Reports (CAR) (Reference 4.45)

EDPI 4.61-01, Nonconformance Reports (NCR) (Reference 4.46)

EDPI 4.62-01, Field Change Request, Construction Variance Request and Middle Third Deviation Notice (FCR, CVR, MTDN) (Reference 4.47)

EDPI 4.65-01, Design Deficiency Processing (Reference 4.48)

No items within this group of procedures were identified as being questionable nor were any specific omissions of necessary procedural controls identified. The similarity of the flow path for information and actions in the NCR, FCR and MTDN process presented a decided advantage in that each type of tracking control did not require that different actions be taken on the part of project individuals. In the cases where the Bechtel Site Liaison Group had authority for preliminary disposition under certain defined conditions, all such actions were reviewed by the Gaithersburg Office before becoming final. During the conduct of this inspection the use of these procedures by design and engineering personnel was observed as well as the results of using the procedures. Several specific examples some of which directly related to the civil-structural engineering aspects are provided below.

We reviewed Drawing C-0003 (Reference 4.60) and DCN's which had been issued against it. This specific drawing contained many important references and notes since it contained most of the structural steel and concrete related general notes for the project. DCN No. C-0003(Q)-8-5 (Reference 4.111) was reviewed to see if EDPI 4.47-01 had been followed. We found the DCN form had been properly completed. During our inspection four DCN's dating from 8/23/82 to 11/8/82 were reviewed. (References 4.112 to 4.115) We found no deficiencies related to meeting commitments or controlling the design process relative to DCN's.

During inspection activities at the Callaway site several FCR's (References 4.116 to 4.119) were selected from the FCR log which was maintained within the Bechtel site liaison engineer's organization. Four FCR's were reviewed to ascertain what types of changes were being requested by the constructor, the reason for the changes and the disposition of the requests. Action was taken on the FCR's during the last half of October 1982 and the first half of November 1982. Three of the four involved missing or interferring embedded plates for supporting electrical or mechanical items and the fourth involved interferences and tolerance problems on elastic shock absorption material and pipe supports. Three of the four cases had been initially resolved by the Bechtel Site Liaison Group. We noted that in all three cases of disposition in the field by Bechtel site liaison engineering, the FCR contained a notation of persons in project engineering at Bechtel Gaithersburg who had discussed the item in coordination with the field liaison effort and the date this had occurred. This appeared to be an excellent way of documenting the coordination effort regarding the consultation between the field and project engineering at Bechtel Gaithersburg although the procedures did not require it. The completed FCR would then be routed to the Gaithersburg Office for review and final approval as required by procedures.

During the team inspection at the site it was noted that the exterior wall penetration at Elevation 1991'-0" in the auxiliary building for the suction line to the auxiliary feedwater pumps from the condensate storage tank was not as detailed on Drawings C-0C1931, C-0029, and C-0019, (References 4.89, 4.69 and 4.67). No information such as an FCR or DCN apparently addressed this change. The licensee should address the acceptability of the actual installation. (Unresolved Item No. 4-3)

During the team's inspection at the site on 11/11/82 it was noted that a number of voids and surface defects existed in certain areas of the walls of Area #5 of the auxiliary building between elevations 2000' and 2026'. Some of these defects were significant enough to require engineering approval of the repair methods. Upon the team's return to the Callaway site during the period 12/6/82 - 12/8/82, it was found that repairs had been made in most of these areas.

Certain portions of these defects were tracked to an NCR (Reference 4.120), which was originated on 7/27/82 on concrete repairs in seven rooms. Concrete was placed in this area in the 1977-1978 time frame with one of the specific placements involved being made on 7/12/77. The cause noted on the NCR and the action to prevent recurrence states: "Craft error; Construction notified of this NCR; No further Daniel action necessary." It was noted within the descriptive text of the NCR that the "voids/honeycombs, after chipping, require prior approval per Bechtel Specification C-103, Section 15.2 before repairing." Other observed defects were repairable without approval. Daniel's proposed corrective action was to use non-shrink grout, stating that it should satisfy design requirements. However, several of the defects Daniel had identified as requiring repair were required under Section 15.3.2.b.4 to be repaired using replacement concrete. Because of the timing of the repair, Daniel had proposed using non-shrink grout, citing economic considerations and physical location. Bechtel subsequently approved the use of non-shrink grout. The best repair method in the opinion of the team was replacement concrete, but the grouted repair was determined to be acceptable. This is an instance in which the engineering personnel were not promptly made aware of the field construction problem so that the best solution could be obtained. Nevertheless, the team considered the approved repair methods adequate.

The Bechtel specification C-103 states that "imperfections in formed concrete requiring repair shall be repaired as soon as practicable after removal of forms and shall be completed without delay, except in cases where approval is required." Concrete in Placement 2C135W01 was made on 7/12/77 and the deficiencies noted by an NCR on 7/27/82. This appeared to be contrary to the specification. (Finding No. 4-7)

The delay in initiating the NCR meant that the information was not available in a timely manner for trending and analyses conducted by the construction quality group. Resolution of the above finding should address the significance and extent of such delays as well as whether the proper quality control measures were in place during the concrete placement in this particular area (area 5 of the Auxiliary Building).

In addition to the previously mentioned NCR, four other NCR's (References 4.121 to 4.124) were reviewed based on a selection of examples from the NCR log maintained by the Bechtel Site Liaison Group. All were generated in the last half of 1982. One involved a pipe whip restraint member being located out of tolerance and three related to damaged reinforcing steel as a result of coring or drilling in reinforced concrete walls. All four of these cases were resolved by the Bechtel site liaison engineering group in coordination with the project engineering office of Bechtel in Gaithersburg. The personnel involved in the coordination and the date of the contact were noted on the NCR. The team's review of the resolution of these items and of the controls in effect resulted in no concerns.

The procedure controlling the disposition of MTDN's (middle third deviation notices) which is contained in Section 5.0 of EDPI 4.62-01 (Reference 4.47) was reviewed. We determined the controls to be adequate. As a result of the large number of MTDN's to be processed, the Bechtel site liaison engineering group forwards all of them to Bechtel project engineering in Gaithersburg for review. The team's observation and review of this effort by the Civil-Structural Group in Gaithersburg is included in Section 4.5.

In summary, the single finding in this area concerned failure to document a construction deficiency rather than weakness in the process for controlling design documents. Based on the review of documents, interviews and observations the team concluded that the design commitments were being met and there was adequate control over the design process.

4.7 Bechtel Site Liaison Engineering

The objective of this portion of the inspection was to review the involvement by the Bechtel Site Liaison Engineering Group for the civil-structural discipline in the design process as related to:

1. the interface between the Site Liaison Group and the constructor,
2. the actions taken by the Site Liaison Group, and
3. the interface with the Civil-Structural Group in project engineering in Gaithersburg.

The entire Site Liaison Group was under the direction of the lead site liaison engineer and the four engineers reported to the civil-structural leader. This group was one of the five discipline groups that make up the site liaison engineering. The groups were organized by discipline and function parallel to the project engineering activities in the Gaithersburg office. The team noted that nearly all of the civil-structural personnel had design experience in the project engineering design functions on the SNUPPS project or others, so that they had a good working knowledge of the design process and the general considerations made for a particular item with respect to assumptions, simplifications, analysis, design, fabrication and construction.

The following are the principal tasks of the Site Liaison Group:

1. Maintain field engineering log for all NCR's, FCR's and MTDN's.
2. Review submittals from the constructor to determine if disposition can be made in the field or must be forwarded to project engineering. Guidelines of what can be dispositioned in the field are provided in the governing procedure/instruction.
3. Disposition those items meeting the criteria for field disposition and indicate any drawings needing revision.
4. Forward completed items to the constructor and distribute copies to groups such as project engineering.

The team concluded, on the basis of field observations, that the Site Liaison Group in the civil-structural discipline was performing in accordance with the procedures and that the procedures were adequate to control the group's efforts.

4.8 As-Built Programs for Reinforced Concrete and Structural Steel

The objective of this portion of the inspection was to ascertain:

1. How the final loads resulting from the location of and addition of pipe supports, electrical cable trays and ventilating systems not specifically considered in the original design were checked, and

2. How the deficiencies found to be acceptable on an individual basis by engineering would be integrated into an overall as-built review to assess the acceptability of the as-built structures in the civil-structural discipline.

The Civil-Structural Group for the project had prepared two documents, known as civil design guidelines, for the purpose of reviewing and assessing final as-built structural adequacy. CDG-1 addressed the structural steel framing system (Reference 4.11) and CDG-2 addressed the reinforced concrete structural elements (Reference 4.12). At the time of the inspection the concrete program had not started and the structural steel program was just beginning.

For those steel structures or portions of structures which were framed with structural steel the guidelines prescribed that a sample of 60 beam-type elements in each of the five powerblock structures would be randomly selected for review and evaluation. Several levels of analysis would be conducted if warranted on each beam element reviewed. The first level analysis made very conservative assumptions and provided a simple check procedure. If a particular beam element using this approach was found to be over-stressed then a more refined set of assumptions was used. If overstressing remained, there were provisions for physical modifications to the beam element. This could result in such actions as adding cover plates or stiffeners. Provisions in the procedures addressed non-composite and composite design and considered moments and forces in three directions. The team noted that, if either of the first two level of reviews resulted in acceptance, significant margins would exist in the design.

We recommend that consideration be given to selecting the sample on some basis other than randomly and that more than the scale model, or composite drawings for unmodeled areas, should be used to identify the additional loading points. After the above have been studied and a tentative selection of the sample made, a field walkdown should be performed to ascertain whether other elements are more heavily loaded or loaded in a manner not considered. We would also recommend that during a field walkdown all structural steel columns should be checked to verify that no loadings from attachments introduce moments into the columns as the columns were designed on the basis of only vertical loads. These recommendations are neither findings nor unresolved items but recommendations for licensee consideration as the program is implemented. (Observation No. 4-3)

For the reinforced concrete structures or portions of structures the elements would be reviewed by reviewing each fabrication drawing and calculations made on a "worst case" basis to address the effects of cut reinforcing steel. The elements would also be reviewed for the effects of load concentrations from closely spaced pipe supports, cable tray and duct supports. This guideline was in the development process and was released as Rev. 0 during our inspection. Our review of the draft, which was undergoing internal Bechtel technical review, resulted in a significant comment regarding the load combinations which would be considered in the as-built worst case studies. As the Bechtel review evolved and the document was revised and issued it was apparent that the internal Bechtel review had identified the same item. The guidelines were revised to reflect the loads and loading combinations specified in the FSAR and the civil-structural design criteria for the project.

A control system had been set up so that each piece of reinforcing steel cut in the field during coring of concrete for penetrations or drilling of concrete for anchor bolts would be documented. This information was transferred to the specific fabrication drawing which detailed the location and the cut reinforcing. These as-built drawings were being assembled by the Civil-Structural Group as they were transferred in from the field in preparation for the as-built review.

The review would use these marked up detail drawings, the original calculations and the analyses for the various defined "worst case" situations until all cut reinforcing steel had been checked for its particular effect on the structure as well as cummulative effects of other cut reinforcing or additional loads. The guidelines allowed for the use of simplifying assumptions when a very conservative analysis was made. Other more refined analyses could be performed when the overly conservative analyses indicated the criteria were exceeded. We had no specific comments on the guidelines which reflected a good method of assessing the as-built conditions of loading and reinforcing steel.

The effort on the part of Bechtel to analyze for as-built conditions reflected a good program for assuring that reported field conditions which modified loading and load resistance parts were studied for their individual and cummulative effects. We noted that this program can be no better in addressing as-built conditions than the field input data. Efforts by Region III NRC inspectors had previously identified problems in the field with the accuracy of the field data regarding cut reinforcing steel. We would recommend that care be taken in conducting this program to assure that the field data have been made accurate. This is neither a finding nor an unresolved item from our inspection but a recommendation for licensee consideration. The appropriate findings have been made previously in an NRC Region III inspection report, Report No. 50-483/82-09. (Observation No. 4-4)

4.9 Conclusion

Based on the results of this integrated design inspection relative to selected portions of the auxiliary feedwater system and other features reviewed in the civil-structural discipline, we concluded that the design and engineering aspects were controlled and the design function was being completed in conformance with the commitments of the FSAR. Areas for improvement have been identified as well as some findings but, as discussed in the preceeding sections, an evaluation of the design and engineering process for the sample areas we reviewed in the civil-structural area indicates that the project is under control from the standpoint of design and engineering.

It is our opinion that for the numbers of personnel involved in this project in the civil-structural area for Union Electric and NPI, the control of the design and engineering effort by Bechtel has been effective. This appears to have been possible because of the good capability and execution by the Bechtel Civil-Structural Group assembled for the SNUPPS project. In this regard, it appeared that the SNUPPS concept, which integrated the staffs of several utilities into the review and control process of criteria and design documents, played an important role.

5.0 Electrical Power

The objectives of this portion of the inspection were to evaluate the electrical power portion of the design with respect to standards, guides, criteria, assumptions and calculational methods with emphasis on the handling and control of interface information. Usually, the electrical power aspects of the design did not consist of separate work packages for the auxiliary feedwater system. For instance, the voltage drop calculations dealing with the station distribution systems include the auxiliary feedwater system as well as other systems. Accordingly, the team's review included a range of design features, technical issues and information systems that often related to other plant systems.

5.1 Auxiliary Feedwater Components

The objective of this portion of the inspection was to determine the adequacy and consistency of basic design documents.

The team reviewed the auxiliary feedwater system description, the motor driven pump circuit breaker, the motor driven pump and valve logic, the motor driven pump discharge valve operator schematic, and pump motive power and cable routing. The recently revised system description was an accurate source of guidelines for the system design. The logic diagram prepared by the Control Systems Group for the motor driven pump operation was found to be correctly transferred into the circuit breaker schematic diagram by the Electrical Group. The team checked the control and motive power to the redundant motor driven pumps and the turbine control system for the turbine driven pump and the design was found to follow appropriate criteria for separation, adequacy and redundancy. In general, we found this area to be in good order with reference to criteria, standards and information interfaces.

5.2 Class 1E Motor Control Centers

The team reviewed the design files for a typical Motor Control Center (MCC). The objectives of this review were to:

1. Evaluate how equipment electrical data was transmitted to and used by the electrical group, and
2. Evaluate the design calculations and selection and application of MCC components

MCC load data were transmitted between engineering disciplines in the manner prescribed by Bechtel Procedure EDPI 5.16-01 (Reference 5.58). Electrical loads for assignment to the motor control centers were obtained from review of the supplier's electrical equipment data sheets and entered into a computerized data base. A software routine prepared by the Electrical Group used the information stored in the data base to generate a load summary for each MCC. Inspection of the load summary printout allowed monitoring of the loading as a function of bus capacity. The software usage procedures were documented in a users manual. It thus appeared that the MCC loads were being monitored in an adequate manner.

In accordance with the SNUPPS electrical design criteria the MCCs generally had the following ratings: 480V, 600A, 25,000 A RMS symmetrical short circuit current bracing. The configurations used standard factory components. In each motor starter cubicle power was fed from the bus work to a molded case circuit breaker, then to a motor starter and then to the motor branch circuit. Where circuits entered the containment structure, current limiting fuses were to be applied in order to meet the NRC staff's Regulatory guidance for additional protection of the penetration assemblies.

The interrupting ratings of a typical molded case branch circuit breaker were 14,000 A RMS symmetrical. The vendor (Gould) had provided Bechtel with a copy of a form letter from one of its subsidiaries (Rowan Controls) which summarized the results of a short circuit test conducted on a MCC of similar configuration to the SNUPPS design and indicated a maximum let through current for the circuit breaker duty to be approximately 10,000 A. We had no further questions about the breaker application.

We found that the capability of motor controllers to withstand fault currents had not been addressed or assured in the design process. The best information available during our inspection was from the Gould environmental qualification report which indicated that the controllers could withstand 5000 A fault currents with a limited degree of damage. However, the potential fault current in this application was 10,000 A or more. This appeared to be contrary to Bechtel Design Criteria Document E-0 (Reference 1.7) which stated that "short-circuit protection of combination motor starters will be provided by circuit breakers ...." The calculations reviewed were intended to be typical for all Class 1E MCC assemblies controlling loads of up to 50 horsepower. Thus, the oversight applied to essentially all Class 1E motor control centers. (Finding No. 5-1)

In summary, our review in this area indicated one finding concerning the fault current capabilities of motor controllers. This represented an instance of improper detailed design. In other aspects, the samples reviewed indicated controlled transmittal and use of data.

5.3 Equipment Qualification Reports

The team reviewed three equipment qualification reports to evaluate the methods used to review and process the data.

In response to NRC guidance contained in NUREG-0588 (Reference 5.78), Bechtel had been reviewing and compiling qualification reports on all Class 1E electrical equipment for about 1 year. The electrical group had established a subgroup of specialists who compared qualification reports submitted by the suppliers of electrical equipment with checklists prepared in accordance with the requirements of NUREG-0588. Unresolved items on the checklist were transmitted to the equipment supplier and resolved before the report was finalized. When this process was completed the overall results would be submitted for NRC review.

All reports, including any that might have been previously reviewed and approved, were to be reviewed in this manner. For a sample the team selected one report that was being reviewed for the first time by the specialists group and two reports that had previously been approved but had not yet been reviewed by the specialists group.

In the first category, the team examined the Bechtel review of the environmental qualification report for the motor driven discharge valve actuator (Reference 5.41). The generic checklist being used was comprehensive and this review appeared to be proceeding well.

In the second category, the team reviewed the seismic qualification report for Motor Control Centers (Reference 5.42) which had been approved by Bechtel in June 1978. The report referred to the required response spectra that had been provided to the vendor (Gould) as an attachment to Bechtel Specification E-018 (Reference 5.79). The supplier performed seismic capability testing and the report indicated that the test response spectra enveloped the required response spectra for all SNUPPS sites. We found two revised spectra (U.E. Site Ultimate Heat Sink Cooling Tower, Mass Point 1) which had higher peaks than the required response spectra that had been provided to the vendor. These revised spectra had been forwarded from the Civil Group to the Electrical Group in a memorandum dated September 1, 1978 (Reference 5.38) with a request that their impact on equipment qualification be evaluated. However, no indication could be found that the Electrical Group had evaluated their effect on motor control center qualification. During our inspection, Bechtel personnel evaluated the revised spectra and found them to be less severe than the test response spectra that the vendor had used to qualify the motor control centers and, therefore, this specific oversight had no adverse effect on the design. The same revised spectra had been sent to General Electric, the supplier of the only other equipment affected at that particular location, within 2 months after receipt from the Civil Group. However, we found no systematic tracking in place in the electrical group to assure that such revised spectra were addressed. (Finding No. 5-2)

Generally, the Civil Group notified other groups of revised spectra but did not receive responses or track the completion of required actions. As indicated above, we found a problem with this area in the Electrical Group. We did not check in other groups to determine whether or not the problem might apply more widely. Accordingly, this question should also be addressed in resolving the above finding.

Also in the second category, we reviewed the environmental qualification report for Motor Control Centers (Reference 5.57). This report had been resubmitted six times and the latest revision had been approved by Bechtel in May 1981. The short circuit tests of the motor control center and of the components were selected for review. This report summarized test results for an MCC which had a configuration different from that specified for use on the SNUPPS project. The tests had been conducted with current limiting fuses. The SNUPPS application used non-current limiting circuit breakers instead of current limiting fuses. It appeared that this discrepancy had not been noted during Bechtel's review of the report. Because the test conditions were not representative of the application conditions, the approved report did not provide assurance that the motor control centers were qualified for the short circuit conditions that could be encountered on the SNUPPS project. (Finding No. 5-3)

The two findings concerning reports that had been previously approved appeared to indicate that there had been a weakness in the review and approval of environmental qualification reports. However, a program was in place to review all reports, including rereview of any that had been approved earlier in the project, in preparation for submittals to the NRC required by recent regulatory guidance. Since the rereview program was already in place, the overall program appeared to be adequate at the time of our inspection.

5.4 Cable Sizing and Voltage Drop

The design methods for selecting cable sizes were reviewed to evaluate the methods and assumptions used.

The team reviewed cables for the auxiliary feedwater pumps (Cables 15NB0205 and 15NB0105). The cable sizing calculations considered the feeder load characteristics, with derating factors applied to account for such factors as ambient temperatures, raceway and penetration characteristics. Separate calculations were made regarding minimum cable size selection and voltage drop requirements for various systems. The parameters derived from these calculations were imposed on the final cable selection. In general, feeder cables had been sized to withstand a fault current equal to the feeder circuit breaker rating for a period of 7 cycles without causing an insulation temperature rise that exceeded the manufacturer's recommendations. We found the methods of sizing feeder cables for both Class 1E and nonsafety related equipment technically adequate.

A review was made of the methodology used in making the voltage drop calculations. Calculation B-3 (Reference 5.80) had been completed and approved. This calculation did not reflect the Callaway Plant configuration, nor did it reflect the configuration of any SNUPPS plant. It was intended to establish an envelope which considered the worst conditions of all of the SNUPPS plant sites simultaneously. Thus, it was conservative with respect to predicting voltage drops at Callaway, assuring the selection of adequate cable sizes.

We found no problems in this area.

5.5 Battery Ventilation

A review was made of the hydrogen generation rates and HVAC system design to verify the assumptions that justified application of nonexplosion proof electrical equipment within the battery room environment. This review also examined the transfer of design information between the Electrical Group and the Mechanical Group.

The Electrical Group sized the battery banks, then provided this information to the Mechanical Group. Hydrogen generation rates for the worst case and nominal operating conditions were obtained from the battery vendor. Under worst case conditions the hydrogen concentrations were determined not to produce a hazardous environment. In addition, hydrogen concentration monitors had been installed with remote readouts to monitor the battery room environments.

In this area it appeared that the design assumptions were valid and the information regarding design parameters was properly transmitted and documented.

5.6 Circuit Breaker Study

An examination was made of the methods that had been used to resolve circuit breaker failures which had occurred in the 13.8 kV distribution systems at the Callaway Site, the Wolf Creek site and a fossil fueled plant. The purpose of this review was to evaluate the effectiveness of the participants' organizations in achieving resolution to such a problem.

Upon recognition of the problem NPI had assumed an active leadership role in assembling a technical team, resolving minor organizational conflicts, identifying the failure modes, and developing a technical resolution. Each of the organizations involved had transmitted information, and documented their actions, in accordance with the project documentation control procedures established for the SNUPPS project administration. Two circuit breaker problems had been identified - a manufacturing defect, and application of a breaker in a circuit whose transient response parameters exceeded the breaker's capabilities. Following the identification of each problem, an investigation had been made of similar breakers in the Class 1E distribution systems to determine if a generic failure mode existed. The manufacturing defect had been resolved by a vendor recall. The transient response parameter problem had been resolved by the addition of capacitor banks. This delayed the rise rate of transient voltages to fit within the circuit breakers' operating capabilities.

A paper had been prepared for publication to inform the technical community of the pitfalls encountered in this particular circuit breaker application, to recommend analysis of the transient recovery voltage (TRV) phenomenon when designing an air circuit breaker installation, and to suggest minimum TRV criteria which the equipment vendor must meet. In general, the participating organizations appeared to function well in their respective roles on the technical team. The failure modes had been identified and corrected and no similar vulnerabilities had been found elsewhere in the 13.8 kV systems. The resolutions appeared adequate in that the circuit breakers should be capable of interrupting faults in the modified system.

Although surge capacitors had been added to slow the voltage rise so that the breaker could interrupt a fault current, the ultimate voltage peak on the primary side of the breaker could still be high. The capability of system components to withstand this voltage peak had not been considered or assured. Consideration of such switching voltage transients was recommended as normal design practice in IEEE Std 399 (Reference 5.81) and in

IEEE Std 141 (Reference 5.82). However, based on power plant design experience, we found no nuclear safety implications and no regulatory basis indicating that such consideration was required. Accordingly, we had no further questions in this area. This is mentioned as an item recommended for licensee consideration. (Observation No. 5-1)

Generally, we found that the circuit breaker operating problems had been effectively addressed.

5.7 Relay Coordination

The team reviewed the electrical relay coordination for the 13.8 kV feeders from the power block (Bechtel design scope) to the site distribution system (Sverdrup and Parcel design scope) in order to examine the methods for passing information between these two organizations.

Design criteria had been issued by Bechtel to S&P through the appropriate information channels. The S&P power distribution designs had been transmitted to Bechtel, but were not being reviewed since they were outside the Bechtel design scope. Those items that were required to be considered in the Bechtel power system design, such as relay settings for the four site power feeder breakers, had been transmitted to Bechtel from S&P via Union Electric and NPI. Bechtel then incorporated the recommended settings in the relay coordination studies to assure coordination with the upstream breakers.

We found no problems in this area.

5.8 Change and Deviation Documents

Some key documents that affect and/or relate to design are Field Change Requests (FCR), Drawing Change Notices (DCN), Requests for Clarification of Information (RCI), Non-Conformance Report (NCR) and Supplier Deviation Disposition Requests (SDDR). The team checked a sample FCR in the area of cable routing that required a cable to be deleted after being pulled. This particular cable could not be physically pulled out because it was at the bottom of the tray. Accordingly, Bechtel had reviewed the changes and issued a DCN, changing the design to reflect the actual condition.

When changes required an FSAR or system design concept review or change, then design/drawing review notices (DRN) were issued and sent to the Chief Electrical Engineer for review. The documents were listed in the Electrical Group's design control checklist for the followup.

We checked SDDR's for two different items requiring changes to the auxiliary shutdown panel specification. The specification had correctly implemented the changes.

One NCR raised a question. The auxiliary feedwater pump turbine trip and throttle valve had been removed and returned to the vendor for replacement. The NCR (Reference 5.83) indicated that the valve had originally not been specified as safety grade and that the vendor had erred in shipping an unqualified valve. Other documents were reviewed (Reference 5.84 and 5.90) but the team was unable to develop a clear picture during the inspection. Because it appeared that there might be a generic problem with the valve, the team asked NPI personnel to investigate further. After the inspection, NPI personnel informed us of the following results:

(1) The valve had always been correctly specified to be safety grade.

(2) The pump vendor had requested and received permission to ship the pump prior to completing environmental qualification of the valve actuator. The matter had been documented by exchanges of correspondence. The open item regarding qualification of the valve actuator had been tracked on a SDDR.

(3) Eventually, it had been decided to replace the valve actuator with one of a different (qualified) model rather than qualifying the original model. The valve had been returned for this purpose.

The team found this response adequate.

In general, the samples reviewed in this area indicated a controlled process.

5.9 Test Procedures

The team reviewed test procedures for a sample (13.8 kV switchgear) at the job site. Union Electric has developed a system of generic test procedures to perform tests in Union Electric plants before start-up tests are carried out. After the completion and release of a system by the constructor (Daniel) the Union Electric staff performs the generic test and writes data sheets (Startup Field Reports). These data sheets are transmitted to Bechtel along with any observed deficiency in the drawing or design. These data sheets are logged against the drawings and the items are closed out when the drawings are changed.

With respect to startup tests, Bechtel submits start-up procedures to the utility on each system. Bechtel also writes procedures for hydrostatic test, energization and flushing that are used by the constructors and the utilities. Bechtel written start-up (acceptance) test procedures are re-written by the utility and assigned a new document number. This is the final test procedure which is used by the utility for the start-up/pre-operational testing.

No problems were found in this area.

5.10 Tracking NRC Generic Communictions

Implementation of NRC bulletins, circulars and information notices in the design and installation process was examined by the team at Union Electric, Bechtel and NPI to assess the control and tracking systems. At Union Electric the Nuclear Group tracked actions in implementing these documents. As a sample, the team checked the followup and response for NRC Bulletins 82-02, 79-25 and 81-02 (References 5.85, 5.86, and 5.87). At NPI, such documents were logged and co-ordinated with Bechtel for review and response to the NRC. The Manager, Nuclear Safety was responsible for final response to NRC. At Bechtel, the discipline groups received the documents for review. The Licensing Group logged the documents and followed up with the discipline group for action. The team found the licensing group records with respect to NRC bulletins, circulars and information notices were up-to-date back to 1978 (which is as far as the team checked). In general, we found no problems in this area and actions on the sample bulletins were contolled.

5.11 Auxiliary Shutdown Panel

In September 1981 design changes were decided upon concerning postulating a control room fire, transferring of control to the auxiliary shutdown panel and isolating one train of required instrumentation and control from the control room. The SNUPPS design provided isolation of the B auxiliary feedwater train, which included one motor operated pump and the turbine driven pump. The auxiliary shutdown panel was purchased from Harlow and the isolation feature (process cabinets and transfer switch arrangements) were to be provided by Westinghouse for reactor control and instrumentation and by Foxboro for Bechtel designed balance of plant control and instrumentation. The racks were to be delivered to the SNUPPS sites in the middle of 1983.

We reviewed the design documents and purchase orders at both Bechtel and Westinghouse. The design was not yet complete. The control room fire hazard analysis had been submitted to the NRC staff and was under review. In addition, Bechtel, NPI and Westinghouse were completing their design modifications to achieve cold shutdown using only Class 1E equipment. These design modifications, when completed, might include additional changes to the Auxiliary Shutdown Panel (ASP).

The design features to achieve and maintain a safe shutdown condition (cold shutdown) within the guidelines of the NRC staff's Regulatory Guide 1.139 (Reference 5.88) and Branch Technical Position RSB 5-1 were reviewed by Bechtel and Westinghouse. Because the original standard safe shutdown design basis for Westinghouse reactors had been hot standby, the auxiliary shutdown panel features were initially considered to be sufficient. However, in response to the above regulatory guidance, an extensive review had been performed by Bechtel, NPI and Westinghouse. The correspondence which we reviewed indicated an ongoing design activity since 1977. Bechtel identified various modifications (10 basic changes) with utility and Westinghouse agreement. The Branch Technical Position indicates that all equipment for achieving the cold shutdown should be Class 1E and should be usable from outside the control room. This had been evaluated by Bechtel, NPI, and Westinghouse and a package had been submitted to the NRC for review. Operator actions are required and four operators are to be dispatched in case of control room fire to initiate various safety actions inside and outside the control room. NRC review of these procedures was in progress at the time of the inspection.

From the review, it appeared that the project designers understood the NRC requirements and were working to comply with them.

5.12 Storage of Class IE Equipment

The team reviewed the on-site storage of class IE equipment to determine compliance with ANSI Standard N45.2.2 (Reference 5.89). We checked various environmental control and protective features provided in the storage area. Level B storage is maintained at 72°F. Overhead smoke detectors and water sprinkler mesh are provided throughout the storage area. Weekly inspection of water pressure and temperature records is required by Daniel procedures. The records for Level A storage area air conditioning systems, fire protection systems and temperature are inspected and checked 4 times in a week. Automatically initiated Halon Systems are employed as fire extinguishers. Smoke detectors, provided in this area, automatically shut the doors and actuate the Halon system. A sign-in and sign-out procedure is used to control access to this area. The team also reviewed the Daniel warehouse procedures and material control functions. These procedures contained material receiving, storage and handling instructions. A Material Receiving Report was written by Daniel and the Overage, Storage or Deferral (OSD Sheet) was signed by Bechtel Site Liaison. The equipment or material was stored in specified level of storage with the OSD tag signed by the Quality Control Organization.

The site storage and handling of class IE material appeared to follow the ANSI Standard.

5.13 Conclusion

In the electrical power area our review included a range of design features, technical issues and information systems related to various plant systems along with the Auxiliary Feedwater System. In general, we found the handling and control of interface information among Bechtel, NPI, Union Electric and equipment suppliers to be controlled. In most cases, the Union Electric and the other SNUPPS utilities (through NPI) had considerable involvement in the design and procurement process. Bechtel, as the architect-engineer, had implemented procedures to provide reasonable assurance of the quality of the design and procurement activities. These procedures were generally followed and interface information was controlled.

Findings 5-1 and 5-3 concerned improper application of motor controllers and an oversight in review of the qualification report for the same controllers. Finding 5-2 concerned the handling of revised seismic response spectra. However, most of the information reviewed was adequate and consistent and our review did not indicate significant breakdowns in the design process or control of interface information.

6. Instrumentation and Control

The objective of this portion of the inspection was to review the instrumentation and control (I&C) aspects of the auxiliary feedwater (AFW) system design. In general, the I&C aspects of the design did not consist of separate work packages for the AFW system. For example, purchase specifications for control valves, flow orifice elements and control panels included equipment for several plant systems. However, the team's detailed review was devoted to the AFW system with specific emphasis placed upon the control of design interface information. Selected samples of field installation and the reactor vendor's design input were also reviewed.

6.1 Design Information

This section summarizes basic information reviewed concerning the flow of design information.

The team conducted a review at Union Electric Company and at Nuclear Projects Inc. (NPI) to determine the Union Electric and NPI involvement in the design process. All utility comments (from Union Electric and other project participants) relating to the design are coordinated through the NPI office and a utility committee process is used to determine which comments will be forwarded to Bechtel for incorporation into the design. The design documents that required NPI and/or utility review and comment prior to Bechtel issue were identified early in the design process and comment categories were established to indicate to Bechtel which comments were required to be incorporated into the design. Bechtel is responsible to assure that the initial issue of all required documents are routed through NPI for review and that all comments received are resolved in accordance with established procedures prior to document issue. Revisions to design documents after the initial issue do not require an NPI review prior to issue, but the revisions are distributed to NPI for informational purposes concurrent with the document issue. Review and comments by NPI and the utilities are not intended to take the place of the required independent design reviews, but are more in the nature of a broad overview of the design and a operability/maintainability review.

The review of design products is described in the following sections.

6.2 Auxiliary Feedwater System Design

The objective of this portion of the inspection was to evaluate the adequacy and control of a sample of detailed design information.

The team reviewed the applicable Final Safety Analysis Report (FSAR) sections that described the design and operational requirements of the auxiliary feedwater system in order to establish the base instrumentation and control design requirements. The motor driven pump B, the turbine driven pump discharge valve (AL-HV12), the automatic switchover of the suction supply, and the system discharge flow elements were selected for a detailed design review to assure that applicable design inputs were incorporated in the instrumentation and control design and that the design interface requirements were properly considered. The results of these reviews are discussed below.

The team reviewed the motor driven pump B control logics, schematic diagram, vendor submittals and the initiating signals for automatic start of the motor driven pumps. Bechtel was reviewing vendor submittals in accordance with established procedures and the process appeared to be controlled.

One discrepancy was noted in that Logic Diagrams, 02AL05, 02AL06, and 02AL07, (References 6.50, 6.51, and 6.52) had not been submitted by Bechtel to NPI for review prior to initial issuance. This was a violation of section 4.2.1 of Bechtel procedure EDPI 4.41-01 (Reference 6.53). Although a procedural violation did occur, the nature of this item was such that we did not consider it indicative of any systematic weakness in the control of design information and it had no adverse effect on design. (Finding No. 6-1)

During our review of Logic Diagram J.02AL01 (Reference 6.25), it was noted that the logic diagram was incorrect. The logic diagram indicated that the pump would start given a <u>coincidence</u> of several signals whereas FSAR section 10.4.9.2.3 and the schematic diagram (Reference 6.24) correctly indicated that the pump would start given <u>any</u> of the signals. This error should have been detected in the design review of the schematic diagram. However, the actual equipment design, as represented by the schematic diagram was correct and consistent with the FSAR. Although we found no similar control logic errors in the AFW system, the sample reviewed was not large enough to make a firm determination as to whether this was a systematic error which might indicate some weakness in the design process for development and use of control logic diagrams. This should be addressed in resolving the item. During our inspection, the control logic diagram was corrected while being revised to enter fire protection changes. (Finding No. 6-2)

The team reviewed the turbine driven auxiliary feedwater pump discharge valve (AL-HV12) purchase specification, control logic, emergency operation requirements, incorporation of design basis, and the interface with the supplier in the area of seismic testing and the required Bechtel review of certain vendor document submittals. The purchase specification included the applicable design basis and established requirements for vendor document submittals to provide assurance that the specification requirements were implemented by the supplier. The Bechtel design process required an engineering review and approval of the vendor submitted documents and, within the scope of this inspection, these requirements were being implemented in this area. The purchase specification also included requirements for seismic and environmental qualification of the control valves and the specification/procedural requirements were being implemented in this area. It was noted that during the initial seismic testing of these air operated valves, certain modifications to the valve design were required to assure proper function during seismic events. The areas noted were additional bracing and support for the lower limit switch and a change to a bolted bonnet design. These design changes were selected for checking at the site where it was found that the changes had been implemented for the installed valves.

The team's review of the control logic indicated that remote flow control and isolation from the control room and from the auxiliary shutdown panel was provided as described in the FSAR.

We noted a discrepancy during our review of the emergency backup nitrogen accumulator system which provided a safety grade backup nitrogen supply for operation of the pump discharge valves upon loss of the non-safety grade normal air supply. Single check valves had been provided to prevent bleeding pressure from the safety grade accumulator in the event of a pressure loss in the non safety grade control air system (Reference 6.47) instead of double check valves as described in FSAR Section 9.3.1.2.2. However, it did not appear that there was any regulatory requirement for double check valves because the system requirements could be met even with the loss of one accumulator system. This was one of three examples of failure to meet FSAR commitments. Findings 2-1 and 2-7 provide discussions of the other examples. (Finding 6-3)

The team reviewed the design of the automatic feature for switchover from the normal (non safety grade) condensate storage tank supply to the emergency (safety grade) service water supply. This switchover would occur upon detection of low suction pressure at the common suction line for all three pumps. The team attempted to review the pressure setpoint for this switchover, but it was found that the design process had not been completed to the point of providing a required setpoint. This setpoint was to be provided by the instrumentation and control design group at a later date. Our review of the area indicated that the applicable design bases were being implemented as described in the FSAR.

The team examined the process by which actuation setpoints were determined at Bechtel and at Union Electric. Setpoint determination was a multipart process consisting of assessment of physical system requirements, measurement uncertainty and construction variability. Bechtel Procedure J1GEN (Reference 6.54) for determination of safety related setpoints was reviewed along with several setpoint calculations. No setpoints had been determined at the time of the inspection. The preliminary calculations appeared to be satisfactory.

The team reviewed the calculations and the purchase specification for the sizing and purchase of the AFW system discharge flow elements. These elements were designed for both flow indication and automatic flow control of the motor driven AFW pump discharge valves. Bechtel had developed a computer program for the sizing of flow elements and this program was used for the calculation/sizing of the AFW flow elements. This program had been verified and approved as required.

A discrepancy was noted in that Calculation J-435 (Reference 6.41) had not been checked (computer input check) and approved prior to issuing the purchase specification as required by section 3.4 of Bechtel procedure EDPI 4.37-01 (Reference 1.16). Although a procedure violation had occurred, a review of the latest calculations indicated that the flow elements identified in the purchase specification were correct and the discrepancy noted had no apparent effect on the final design. This was one of two examples of releasing design information prior to approval of calculations. Finding 4-4 provides a discussion of the other example. (Finding No. 6-4)

As discussed above, four findings resulted from the inspection in this area. Two (6-1 and 6-4) involved procedural violations and two (6-2 and 6-3) involved errors. None of these individual items was found to have an adverse effect on design or to indicate a systematic weakness. In other respects, the design information we reviewed was adequate and consistent, indicating that the significant design bases were being considered and correctly implemented.

6.3 Auxiliary Feedwater System Installation

The team conducted a system installation review at the Callaway site with the results as discussed below.

The team examined the turbine driven pump discharge valve to assure that the design modifications identified during seismic testing had been completed. The lower limit, switch bracing and the bolted bonnet design were implemented on the installed valve at the site.

The team reviewed the layout of the AFW system controls on the main control board and on the remote shutdown panel. It was noted during this review that the remote shutdown panel was to be modified due to the recent design changes to incorporate the logic for control room isolation for fire protection purposes. This design change was in process and modifications were to be completed at a later date.

The installation review at the site did not reveal any discrepancies and within the area reviewed, the installed system implemented the design.

6.4 Westinghouse Information

This area of review included a review of the initiating logic for the auxiliary feedwater system from Westinghouse designed systems (e.g., Safety Injection Actuation and Lo-Lo Steam Generator Level Actuation). Westinghouse had provided for the necessary initiating signals as described in the FSAR. We noted that a recent logic change had been made to close the main feedwater isolation valves from a lo-lo steam generator level signal on any one steam generator. This had been a project specific change for SNUPPS that was required because of a Bechtel design change that relocated the main feedwater check valves downstream of the auxiliary feedwater system injection point. Bechtel had made this design decision in order to mitigate water hammer effects under certain transient/accident conditions. The Westinghouse standard design recommendation called for the main feedwater check valves to be upstream of the auxiliary feedwater injection. The system implications of this change had been correctly recognized and appropriate changes made to the initiating logic. Westinghouse personnel stated that they were not aware of any other project that had addressed the main feedwater system water hammer effects by placing the check valve downstream of the auxiliary feedwater tie in. Although Westinghouse normal design scope did not include the main feedwater piping analysis, Westinghouse had issued a "Technical Bulletin" in 1979 to inform operating reactor customers of the need to evaluate water hammer effects upon fast closure of the main feedwater check valve during certain transient/accident conditions. Westinghouse had also informed the SNUPPS construction project by a memorandum in 1979. Documentation was not available during this inspection to show that Westinghouse had transmitted this information to other construction projects. Although this area of review revealed no discrepancies, the discussion on water hammer effects is provided for informational purposes and for potential NRC inspection followup at Westinghouse to determine which construction projects were issued the technical bulletin information. (Observation No. 6-1)

6.5 Pre-Operational Testing Program

The team reviewed the auxiliary feedwater preoperational testing program at Bechtel. The following start-up test procedures were reviewed:

(1) "Auxiliary Feedwater Turbine-Driven Pump and Valve Pre-Operational Test S-03AL02";
(2) "Auxiliary Feedwater Motor-Driven Pump and Valve Pre-Operational Test S-03AL01"; and
(3) "Auxiliary Turbine Pre-Operational Test S-04FL01".

These test procedures were used by the Union Electric start-up group as the core of the actual tests to be run in the field. At Union Electric the team reviewed the start-up testing schedule and test agenda, particularly the test sequence and event timing since some tests are interdependent and others depend on construction scheduling and loop turnover. We concluded that the procedures were thorough and complete, the test schedule was well coordinated with construction events, and adequate time was allocated for preliminary preparations and systems checkout.

6.6 Conclusion

The four findings from our inspection in this area did not indicate adverse effects on the actual design or systematic weaknesses. In general, the information reviewed was adequate and consistent, indicating a controlled design process.

7.0 Reference Material

7.1 General

7.1.1 - Background Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
1.1	NPI letter	SLNRC 81-39, letter to NRC (Denton) reviewing AFS vs. SRP, Action Plan Items, staff questions, etc.		6/3/81
1.2	NPI letter	SLNRC 81-44, letter to NRC (Denton) on AFS reliability analysis		6/8/81
1.3	Organization Charts	Charts for NPI, Bechtel, and Union Electric		
1.4	Magazine Article	Article in Nuclear Engineering International, "SNUPPS- the Multiple Utility Standardization Project," by N. A. Petrick		11/75
1.5	Bechtel Design Criteria	10466-A-000, "Architectural Design Criteria for SNUPPS"	3	8/11/80
1.6	Bechtel Design Criteria	10466-C-0, "Civil and Structural Design Criteria for SNUPPS"	10	6/9/82
1.7	Bechtel Design Criteria	10466-E-0, "Electrical Design Criteria for SNUPPS"	11	6/25/81
1.8	Bechtel Design Criteria	10466-J-000, "Control Systems Design Criteria for SNUPPS"	9	9/30/80
1.9	Bechtel Design Criteria	10466-M-000, "Mechanical/Nuclear Design Criteria for SNUPPS"	6	8/30/77
1.10	Bechtel Procedure	Project Engineering Procedures Manual Index for Job 10466	52	
1.11	Bechtel Procedure	Engineering Department Project Instruction (EDPI) 4.1-01, "Design Criteria"	5	5/12/80

Ref. No.	Document Type	Description/Title	Rev.	Date
1.12	Bechtel Procedure	EDPI 4.22-01, "Preparation and Control of SAR"	7	5/8/81
1.13	Bechtel Procedure	EDPI 4.23-01, "SAR Change Control"	9	8/25/80
1.14	Bechtel Procedure	EDPI 4.25-01, "Design Interface Control"	1	5/9/78
1.15	Bechtel Procedure	EDPI 4.34-01, "Off Project Design Review"	4	1/15/79
1.16	Bechtel Procedure	EDPI 4.37-01, "Design Calculations"	8	1/19/81
1.17	Bechtel Procedure	EDPI 4.46-01, "Project Engineering Drawings"	17	7/30/82
1.18	Bechtel Procedure	EDPI 4.47-01, "Drawing Change Notice"	12	9/18/81
1.19	Bechtel Procedure	EDPI 4.49-01, "Project Specifications"	11	9/18/81
1.20	Bechtel Procedure	EDPI 4.61-01, "Nonconformance Reports"	14	7/30/82
1.21	Bechtel Procedure	EDPI 4.62-01, "Field Change Request, Construction Variance Request and Middle Third Deviation Notice"	13	7/30/82
1.22	Bechtel Procedure	EDPI 5.30-01, "Project Release Procedure and Document Release Log"	2	12/10/79
1.23	Bechtel Drawing	MS-1, "Piping Class Summary for the SNUPPS"	14	12/29/81
1.24	Bechtel Specification	10466-M-204(Q), "Field Fabrication and Installation of Piping and Pipe Supports to ASME Section III"	33	7/20/82

Ref. No.	Document Type	Description/Title	Rev.	Date
1.25	Bechtel Specification	10466-M-216(Q), "Fabrication of Non-Catalog Pipe Supports"	16	5/12/81
1.26	Bechtel Specification	10466-M-217(Q), "Design Specification for Pipe Supports to ASME Section III, Subsection NF	6	2/26/80
1.27	Westinghouse Specification	SG 689, Steam Systems Design Manual, Subsection 7 AFS	2	8/73
1.28	Bechtel Drawing	M-00AL(Q), "AFS Description SNUPPS"	3	12/15/77
1.29	Bechtel Drawing	M-02AL01(Q), "Piping and Instrumentation Diagram AFS"	11	9/21/82
1.30	Bechtel Drawing	M-03AL01(Q), "Piping Isometric Auxiliary Feedwater Pumps Suction Piping"	9	
1.31	Bechtel Drawing	M-03AL02(Q), "Piping Isometric Motor Driven Auxiliary Feedwater Pump 'A' Discharge Piping"	10	
1.32	Bechtel Drawing	M-03AL03(Q), "Piping Isometric Motor Driven Auxiliary Feedwater Pump 'B' Discharge Piping"	8	
1.33	Bechtel Drawing	M-03AL04(Q), "Piping Isometric Turbine Driven Auxiliary Feedwater Pump Discharge Piping"	7	
1.34	Bechtel Drawing	M-03AL05(Q), "Piping Isometric Auxiliary Feedwater Pumps Recirculation Piping	9	
1.35	NPI Letter	SLNRC 81-010, "SNUPPS AFS Meeting"		2/19/81
1.36	Bechtel Letter	BLSE 9344, "Response to Action Items Resulting from 2/12/81 meeting with NRC"		4/3/81

Ref. No.	Document Type	Description/Title	Rev.	Date
1.37	PSAR Extract	SNUPPS Project QA Programs for Design and Construction	4	12/81
1.38	NPI Procedure	SNUPPS Staff Administrative Control Procedures Manual	58	10/1/82
1.39	Bechtel Specification	E-012.2(Q), "Technical Specification for Purchase of Large Induction Motors 250 Hp and Larger for SNUPPS"	2	3/18/77
1.40	Bechtel Specification	E-091(Q), "Technical Specification for Seismic Qualification of Class IE Equipment for SNUPPS"	4	5/25/76
1.41	Bechtel Specification	M-021(Q), "Design Specification for Auxiliary Feedwater Pumps and Turbine Drive for SNUPPS"	13	5/28/81
1.42	Bechtel Specification	M-900(Q), "Technical Specification for Qualification of Seismic Category 1 Mechanical Systems and Equipment for SNUPPS"	2	7/9/76
1.43	Bechtel Specification	J-820(Q), "Technical Specification for Seismic Qualification Requirements for Class IE Control and Instrumentation Devices for SNUPPS"	1	5/27/75
1.44	Bechtel Specification	J-601(Q), "Design Specification for Nuclear Service Control Valves for SNUPPS"	13	10/17/80
1.45	Bechtel Specification	E-025(Q), "Technical Specification for Valve Electric Motor Actuators for SNUPPS"		
1.46	Bechtel Specification	10466-MS-6, "End Preparation Data"	5	2/3/77

Ref. No.	Document Type	Description/Title	Rev.	Date
1.47	Bechtel Specification	10466-J4-102, "Instructions for Typical Instrument Tagging"	1	11/14/74
1.48	Bechtel Specification	10466-MS-7, "End Transition Detail"	2	2/2/76
1.49	Bechtel Design Criteria	10466-C-04A03S, "Floor Response Spectra for SNUPPS"	0	11/1/76
1.50	Bechtel Design Criteria	10466-C-04A03B, "Floor Response Spectra for SNUPPS"	0	11/1/76
1.51	Bechtel Design Criteria	10466-C-04A04S, "Floor Response Spectra for SNUPPS"	0	11/1/76
1.52	Bechtel Design Criteria	10466-C-04A04B, "Floor Response Spectra for SNUPPS"	0	11/1/76
1.53	Bechtel Drawing	10466-M-[illegible]AL01(Q), "System Flow Diagram AFS"	D	
1.54	Bechtel Photographs	Six Composite Photographs of SNUPPS Model of AFS		
1.55	NUREG	NUREG/CR-2458, "Sandia Comments on SNUPPS AFS Reliability Analyses		
1.56	NRC Paper	SECY 82-352, "Assurance of Quality," page 5 and Enclosure 1, pages 6 and 7		8/10/82
1.57	Magazine Article	Article in Nuclear Engineering International, "A Progress Report on the SNUPPS Nuclear Stations," by N. A. Petrick		9/77
1.58	Magazine Article	Article in Power, "Standardization of Nuclear Plants Offers Better Designs, Faster Construction"		11/77

7.1.2 - Meeting Attendance

Name	Organization	Title	Meeting Attended 11/10/82	11/11/82	11/12/82	11/15/82	11/16/82	11/19/82	12/03/82	12/06/82	12/08/82	12/09/82
D.P. Allison	NRC	Team Leader	X	X	X	X	X	X	X	X	X	X
D.P. Norkin	NRC	Team Member, Mechanical Sys.	X	X	X	X	X	X	X	X	X	X
J.R. Fair	NRC	Team Member, Mechanical Comp.	X	X	X	X	X	X	X	X	X	
D.K. Morton	EG&G	Team Member, Mechanical Comp.	X	X	X	X	X	X	X			
R.E. Shewmaker	NRC	Team Member, Civil/Structural	X	X	X	X	X	X	X	X	X	
J.S. Ma	NRC	Team Member, Civil/Structural				X		X	X	X	X	
I. Ahmed	NRC	Team Member, Electrical Power	X	X	X	X	X	X	X	X	X	X
R.L. Sprague	EG&G	Team Member, Electrical Power	X	X	X	X	X	X			X	X
D.D. Chamberlain	NRC	Team Member, I&C	X	X	X	X	X	X	X		X	X
R.O. Karsch	NRC	Team Member, I&C	X	X	X	X	X	X	X	X	X	X
J. Neisler	NRC	Resident Inspector	X	X						X	X	
G.E. Edison	NRC	Licensing Project Manager	X	X	X							
E.L. Jordan	NRC	Director, DEQA, IE	X									
T.L. Harpster	NRC	Chief, QAB, DEQA, IE					X	X	X			
H.M. Wescott	NRC	RIII Project Inspector									X	
J.E. Konklin	NRC	RIII Project Section Chief									X	
R. Stright	NPI	Licensing Manager						X	X			
S.J. Seiken	NPI	QA Manager	X	X	X	X	X	X	X		X	
N.A. Petrick	NPI	Executive Director	X									
F. Schwoerer	NPI	Technical Director				X						
J.O. Cermak	NPI	Manager, Nuclear Safety				X						
J.H. Riley	NPI	Staff Engineer				X						
D.J. Kle[illegible]	NPI	Staff Engineer				X						
R.P. White	NPI	Nuclear Engineer				X						
W.W. Baldwin	NPI	Administrative Manager				X						
E. Dille	UE	Executive Vice President	X									
D.F. Schnell	UE	VP, Nuclear	X	X	X							
J.F. McLaughlin	UE	Assistant to VP Nuclear	X	X								
D. Capone	UE	Manager, Nuclear Eng.	X	X	X						X	
R.J. Schukai	UE	General Manager, Eng.	X	X	X							
W.H. Weber	UE	Mgr., Nuclear Construction	X	X								
F.D. Field	UE	Manager, QA	X	X	X							
A.C. Passwater	UE	Licensing Manager	X									
N.G. Slayten	UE		X									
W.H. Zvanut	UE	Supervising Engr., Nuclear	X									
W.B. Bobner	UE		X									
T.H. McFarland	UE	Superintendent, Site Liaison	X							X	X	
R.P. Wendling	UE	Supervising Engr., Nuclear	X									
J.E. Kaelin	UE			X								

Name	Organization	Title	Meeting Attended 11/10/82	11/11/82	11/12/82	11/15/82	11/16/82	11/19/82	12/03/82	12/06/82	12/08/82	12/09/82
K.W. Kuechenmeister	UE	Supv. Engr., UE Construction		X						X	X	
D.J. Maxwell	UE	Construction Engineer		X						X	X	
W.H. Mawyer	UE	Consulting Engineer		X						X	X	
R.K. Cothren	UE	Consulting Engineer		X								
F.E. Maddy	UE	Consulting Engineer		X								
W. Steinberg	UE	Construction Engineer								X	X	
J.R. Veatch	UE	Supervising Engineer								X	X	
J.A. McGraw	UE	Supervising Engineer								X	X	
R.L. Powers	UE	Superintendent Site QA								X		
C.J. Plows	UE	Consulting Engineer, Quality									X	
J.V. Laux	UE	Supervising Engineer									X	
D.E. Shafer	UE	Nuclear Engineer, Licensing									X	
C.C. Wagoner	Daniel	Project Manager		X						X		
M.K. Smith	Daniel	Audit Response Coordinator								X		
G.M. Warblin	Daniel	Project Administrator								X	X	
D.C. King	Daniel	Construction Manager								X	X	
W.A. Poppe	Bechtel	Group Leader, Mech/Nuclear		X								
R.C. Boles	Bechtel	Site Liaison Eng (Mech.)		X						X	X	
G.P. Schwartz	Bechtel	Control Sys. Site Liaison		X							X	
J. Kroehler	Bechtel	Proj. QA Manager, SNUPPS					X	X	X			
D.R. Quattrociocchi	Bechtel	Proj. Engineer, SNUPPS					X	X	X			
J.A. Chlapowski	Bechtel	Proj. Engineer, SNUPPS					X		X			
J. Milos	Bechtel	Project Quality Engineer					X	X	X			
J.H. Smith	Bechtel	Project Engineering Manager					X	X	X			
L.F. Rotondo	Bechtel	Project Engineer, Facilities					X	X				
D.C. Kansal	Bechtel	Division QA Manager						X	X			
B.L. Meyers	Bechtel	Project Manager, SNUPPS						X	X			
N.P. Goel	Bechtel	Project Engineer, Mechanical						X	X			
L.E. Ruhland	Bechtel							X				
J.S. Prebula	Bechtel	Group Leader, Mech/Nuclear							X			
R.W. Bradford	Bechtel	Site Lead Liaison Engineer									X	
P.T. McManus	W*	Mgr., Design Assurance Sys. & Quality Engineer										X
J.B. Stearns	W	SNUPPS QA Engineer										X
W.R. Spezialetti	W	Mgr., Plant Licensing										X
D.L. Cecchett	W	License Engineering SNUPPS										X
M.H. Shannon	W	Senior Quality Engineer										X
S.T. Maher	W	Engineer, Nuclear Safety										X

*W - Westinghouse

Name	Organization	Title	Meeting Attended									
			11/10/82	11/11/82	11/12/82	11/15/82	11/16/82	11/19/82	12/03/82	12/06/82	12/08/82	12/09/82
J.S. Schlonski	W	Engineer, Fluid Sys. Design										X
N.I. Beck	W	Engineer, Fluid Sys. Design										X
R.A. Loose	W	Balance of Plants System Design										X
J.W. Swogger	W	SNUPPS Project Engineer										X
P.A. Barilla	W	Engr., Chemical & Waste Process Sys.										X
C.A. Vitalbo	W	Senior Engineer										X
T. Kitchen	W	Process Control Technician										X
J. Cunningham	W	Nuclear Safety Engineer										X
R. Tuley	W	Nuclear Safety Engineer										X

7.2 Mechanical Systems

7.2.1 - Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
2.1	Westinghouse Procedure	SSE-SF-37, Secondary Systems Parameters Required for FSAR Accident Analyses	1	9/81
2.2	Bechtel Internal Memo	File 0332, Mechanical/Nuclear Group Organization and Responsibilities	13	8/25/82
2.3	Bechtel Calculation	AL-21, Motor Drive Auxiliary Feedwater Pumps; Determine Total Head	0	12/1/81
2.4	Bechtel Calculation	AL-20, Turbine Driven Auxiliary Feedwater Pump; Determine Total Head	0	11/20/81
2.5	Westinghouse Specification	SIP/10-1, Section 4-4 Steam System Design Manual (10-1)	3	3/78
2.6	Westinghouse Specification	SIP/10-1, Section 5-4 Steam System Design Manual (10-1)	3	3/78
2.7	Westinghouse Letter	SNP-2256, SNUPPS Projects Steam System Design Manual (10-1)		1/17/79
2.8	Westinghouse Letter	SNP-2342, SNUPPS Projects Areas of Significant Change in Rev. 3 of Steam System Design Manual		3/6/79
2.9	Bechtel Letter	BLWE-1082, Westinghouse PIP Volume 10-1, Steam System Design Manual, Rev. 3		10/2/79
2.10	Westinghouse Letter	SNP-3121, Revised Steam Systems Design Manual		2/5/80
2.11	Bechtel Calculation	AL-26, Aux. Feedwater Pumps; Verify Turbine Driven Pump Performance Throughout the Feedline Break Transient Provided by Westinghouse in SNP 2243	0	12/17/79

Ref. No.	Document Type	Description/Title	Rev.	Date
2.12	Westinghouse Letter	SNP-1857, Impact of New Steam Break Protection System on Design of AFS Relative to Secondary Pipe Rupture		6/8/78
2.13	Bechtel Letter	BLWE-916, AFS Secondary Pipe Rupture Accidents		8/3/78
2.14	Westinghouse Letter	SNP-2243, Auxiliarry Feedwater System		1/10/79
2.15	Bechtel Letter	BLWE-1155, AFS; Pump Runout During Steam Generator Pressure Transients		1/30/80
2.16	Bechtel Letter	BLWE-1345, AFS; Design Information on Delivery Times and Flowrates		12/8/80
2.17	Westinghouse Letter	SNP-1054, AFS; Turbine Driven Pump Flow Rate		1/22/76
2.18	Bechtel Letter	BLWE-380, Feedwater Isolation; Deletion of Check Valve		1/22/76
2.19	Bechtel Calculation	AL-16, AFS; Determine Available NPSH for Aux Feedwater Pumps	0	10/20/81
2.20	Ingersoll-Rand-Curve	10466-M-021-118-01, Characteristic Curve, Motor Driven Pump (AFS)		1/31/78
2.21	Ingersoll-Rand-Curve	10466-M-021-096-01, Characteristic Curve, Turbine Driven Pump (AFS)		10/18/77
2.22	Bechtel Calculation	AL-22, AFS; Revise Flow Diagram Data	0	12/2/81
2.23	Bechtel Drawing	M-01AL01(Q), System Flow Diagram, AFS	D	12/15/77
2.24	Bechtel Drawing	M-01AL01(Q), System Flow Diagram, AFS	E	11/15/82

Ref. No.	Document Type	Description/Title	Rev.	Date
2.25	Westinghouse Letter	SNP-384, Revised Recommended AFS		2/5/75
2.26	Westinghouse Specification	SG-689, Steam Systems Design Manual, III-5 and V-7	2	8/83
2.27	Bechtel Specification	M-OOAL(Q), System Description, AFS	4	11/15/82
2.28	Bechtel Drawing	FSAR Fig. 3.6-1, SH 49, High Energy Pipe Break Isometric Main Steam Supply to Turbine AFP Outside Containment	9	5/82
2.29	Bechtel Calculation	PBFC01, "Pipe Break Analysis"	1	8/31/78
2.30	Bechtel Calculation	PBFC01, Pipe Break Analysis	2	11/10/82
2.31	Bechtel Internal Memo	SNUPPS High Energy Line Break Analyses Task Force Reorganization		8/19/80
2.32	Bechtel Analyses	Break By Break Dynamic Effects Analyses for Main Steam Branch Line to AFS Turbine Driven Pump		Undated
2.33	Bechtel Specification	10466-M-021(Q), Design Spec For Aux FW Pumps and Turbine Drive	13	5/28/81
2.34	Bechtel Calculation	FL-13, Aux Building Area 5 Flooding	0	10/28/82
2.35	Bechtel Calculation	FL-01, Flooding of the Aux Building	0	10/4/82

Ref. No.	Document Type	Description/Title	Rev.	Date
2.36	Bechtel Drawing	M-02AL01(Q), Piping and Instrumentation Drawing Auxiliary Feedwater System	11	9/21/82
2.37	NPI Letter	SLNRC 81-44, Reliability Analysis of the SNUPPS Auxiliary Feedwater System		6/8/81
2.38	NPI Letter	SLNRC 81-010, SNUPPS Auxiliary Feedwater System Meeting		2/19/81
2.39	Bechtel Calculation	GF 175, Miscellaneous Building, HVAC		10/15/75
2.40	Bechtel Calculation	HV 319		3/6/81
2.41	NPI Letter	Letter to NRC Enclosing Page Changes for PSAR		12/9/77
2.42	Bechtel Drawing	MOP 1451, "Drainage System Auxiliary Building	4	7/14/80
2.43	Bechtel Drawing	MOP 1902, "Drainage System Auxiliary Building	4	8/19/77
2.44	NRC SER	NUREG-0830, Safety Evaluation Report Related to the Operation of Callaway Plant, Unit No. 1		10/81
2.45	NRC SER	NUREG-0830 Supplement No. 1, "Safety Evaluation Report Related to the Operation of Callaway Plant Unit No. 1		1/82

7.2.2 - Personnel Interviewed

Name	Title	Organization
J. D. Hurd	Group Supervisor, SNUPPS Mechanical/Nuclear Group	Bechtel
J. S. Prebula	Deputy Group Supervisor, SNUPPS Mechanical/Nuclear Group	Bechtel
K. Miller	Hazards Task Force Coordinator, SNUPPS Mechanical/Nuclear Group	Bechtel
A. Woolard	Engineer, SNUPPS Mechanical/Nuclear Group	Bechtel
W. A. Poppe	Power Conversion Group Leader, SNUPPS Mechanical/Nuclear Group	Bechtel
J. Canale	Engineer, SNUPPS Mechanical/Nuclear Group	Bechtel
B. C. Seam	Facilities/Site Group Leader SNUPPS Mechanical/Nuclear Group	Bechtel
D. L. Herrich	Engineer, SNUPPS Mechanical/Nuclear Group	Bechtel
B. Spezialetti	SNUPPS Licensing Manager	Westinghouse
J. Swogger	Project Engineer, SNUPPS Project	Westinghouse
N. Beck	Engineer	Westinghouse
S. Maher	Engineer	Westinghouse

7.3 Mechanical Components

7.3.1 - Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
3.1	Bechtel Procedure	EDPI 4.37-01, Design Calculations	8	1/9/81
3.2	Bechtel Procedure	EDPI 4.1-01, Design Criteria	5	5/12/80
3.3	Bechtel Specification	10466-M-200(Q), Design Specification for ASME Section III Piping Systems for the Standardized Nuclear Unit Power Plant System (SNUPPS)	5	10/17/80
3.4	Bechtel Design Criteria	BP-TOP-1, Seismic Analysis of Piping Systems	2	1/75
3.5	Bechtel Design Criteria	BP-TOP-1, Seismic Analysis of Piping Systems	3	1/76
3.6	Bechtel Design Criteria	Stress Analysis Newsletter File - Loose Leaf Binder Containing Stress Analysis Newsletters		
3.7	Bechtel Analysis	SNUPPS Stress Analysis Problem No. 60 File	4	10/16/81
3.8	Bechtel Analysis	SNUPPS Stress Analysis Problem No. 44A File	1	6/28/78
3.9	Bechtel Analysis	SNUPPS Stress Analysis Problem No. 70 File	4	3/11/81
3.10	Bechtel Internal Memo	Memo from R. Lee to F. Banes		5/11/82
3.11	Bechtel Internal Memo	Memo from R. Lee to F. Banes		10/15/81
3.12	Bechtel Internal Memo	Memo from I. Shiudansani to B. Shah		6/2/78
3.13	Bechtel Internal Memo	Memo from R. Lee to E. Thomas		11/10/81

Ref. No.	Document Type	Description/Title	Rev.	Date
3.14	Bechtel Internal Memo	Memo from J. Hurd to B. Shah		9/23/82
3.14	Bechtel Internal Memo	Memo from C. Herbst to C. Barbier		6/12/79
3.16	Bechtel Specification	10466-M-217(Q) "Design Specification for Pipe Supports to ASME Section III, Subsection NF for the Standardized Nuclear Unit Power Plant system (SNUPPS)."	6	2/26/80
3.17	Bechtel Design Criteria	Plant Design Hanger Engineering Standards	12	8/20/82
3.18	Bechtel Calculation	Pipe Support Calculation No. AL01-22	2	6/23/78
3.19	Bechtel Calculation	Pipe Support Calculation No. FC01-28	0	1/27/82
3.20	Bechtel Calculation	Pipe Support Calculation No. AL02-34	0	7/8/81
3.21	Bechtel Procedure	Procedure No. TB-011	1	1/4/78
3.22	Bechtel Internal Memo	Memo from I. Shiudasani to E. Thomas		9/7/79
3.23	Bechtel Calculation	Pipe Support Calculation No. AL01-27	2	11/23/82
3.24	Field Change Report	FCR No. 2FC-1191-MH		6/22/82
3.25	Field Change Report	FCR No. 2FC-1284-MH		6/25/82
3.26	Bechtel Computer Program	ME 909		
3.27	Bechtel Computer Program	ME 101 Users Manual	G-1/1	11/16/79

Ref. No.	Document Type	Description/Title	Rev.	Date
3.28	Bechtel Computer Program	ME 210		
3.29	Bechtel Drawing	M-03AB01(Q), Main Steam System Reactor Building and Auxiliary Building - Area 5	12	
3.30	Dravo Drawing	Pc. 2AB01 S032/145	5A	5/2/79
3.31	Dravo Drawing	Pc. 2AB01 S032/145	5	8/5/78
3.32	NRC MEB Position	Interim Technical Position - Functional Capability of Passive Piping Components for ASME Class 2 and 3 Piping Systems		7/19/78
3.33	Bechtel Analysis	SNUPPS Stress Analysis Problem No. 12 File	3	5/4/82
3.34	Ingersoll-Rand Report	EAS-TR-7707-ASR, "Structural Integrity and Operability Analysis of 6HMTA-6 Pump for Bechtel (SNUPPS)"	2	11/15/77
3.35	Terry Corp. Report	GS-2N, "Qualification Report for Ingersoll-Rand-Cameron F-40176-40180"	1	8/18/78
3.36	Masoneilan Report	Seismic Qualification of Masoneilan Control Valves for Bechtel Purchase Order Number 10466-J 601A-1 through -5 Specification Numbers 10466-J-601A and 601B Masoneilan Order Numbers N-00172-176 and N-00198-202 Test Valve Number 803		
3.37	Bechtel Drawing	M-04AL04(Q)	6	9/1/81
3.38	Daniel Procedure	AP-IV-04, "Field Change Requests"	13	10/6/82
3.39	Bechtel Internal Memo	Memo from J. Hurd to B. Shah		9/23/82
3.40	Bechtel Calculation	Pipe Support Calculation AL01-13	2	6/22/78

7.3.2 - Personnel Interviewed

Name	Title	Organization
B. Shah	Plant Design Group Supervisor	Bechtel
L. DiGiacomo	Pipe Support Group Leader	Bechtel
R. Lee	Pipe Stress Group Leader	Bechtel
N. Kalyanam	Engineer Plant Design Staff	Bechtel
I. Shivdasani	Engineer Plant Design Staff	Bechtel
J. Canale	Engineer Mech/Nuclear Group	Bechtel
J. Prebula	Mech/Nuclear Group Leader	Bechtel
B. Lulla	Piping & Valve Group Leader	Bechtel

7.4 Civil and Structural Engineering

7.4.1 - Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
4.1	SNUPPS FSAR	Section 3.7.1(B)-3.7.3(B) Seismic Design	10	9/30/82
4.2	SNUPPS FSAR	Section 3.8.4 Other Category I Structures	10	9/30/82
4.3	SNUPPS FSAR	Figure 13.1-2 UE Organization Chart	5	1982
4.4	Union Electric QA Procedures	Procedure Status Index Sections QS, QA, QE Section QAC Section QP	 - - -	 11/8/82 10/13/82 6/2/82
4.5	Union Electric QA Procedure	QE-303, Design Document Review and Design Interface Control	0	3/25/74
4.6	Union Electric QA Procedure	QE-303, Design Document Review and Design Interface Control	9	10/13/81
4.7	SNUPPS (NPI) Procedure	1.1, SNUPPS/NPI Staff Administrative Control Procedures, Figure 1.1-1: Organization	4	3/1/81
4.8	SNUPPS (NPI) Log	Standard Power Block - SNUPPS Document Release Log, pp. 752-754, 819, 882	-	10/25/82
4.9	Bechtel Criteria	A-0, Architectural Design Criteria for SNUPPS	3	8/11/80
4.10	Bechtel Criteria	C-0, Civil and Structural Design Criteria for SNUPPS	10	6/9/82
4.11	Bechtel Civil Design Guideline	CDG-1, Structural Adequacy Review of Structural Steel Framing for SNUPPS	0	9/29/82

Ref. No.	Document Type	Description/Title	Rev.	Date
4.12	Bechtel Civil Design Guideline	CDG-2, Structural Adequacy Review of Reinforced Concrete Elements for SNUPPS	2	12/6/82
4.13	Bechtel Specification	C-103, Technical Specification for Forming, Placing, Finishing and Curing of Concrete for SNUPPS	0	2/21/75
4.14	Bechtel Specification	C-103, Technical Specification for Forming, Placing, Finishing and Curing of Concrete for SNUPPS	21	9/8/82
4.15	Bechtel Specification	C-103A, Technical Specification for Installation of Concrete Expansion Anchor Bolts for SNUPPS	5	5/27/80
4.16	Bechtel Specification	C-103B, Technical Specification for Core Drilling of Concrete Structures for SNUPPS	0	9/20/78
4.17	Bechtel Specification	C-121, Technical Specification for Furnishing Structural Steel for SNUPPS	13	10/28/80
4.18	Bechtel Specification	C-122, Technical Specification for the Erection of Structural Steel for SNUPPS	11	5/24/79
4.19	Bechtel Specification	C-131, Technical Specification for the Purchase of Miscellaneous Metal for SNUPPS	14	10/25/82
4.20	Bechtel Specification	C-132, Technical Specification for Erecting Miscellaneous Metal for SNUPPS	6	8/31/82
4.21	Bechtel Specification	C-134, Technical Specification for the Purchase of Steel Anchor Bolts for SNUPPS	9	12/4/80
4.22	Bechtel Specification	C-202, Technical Specification for the Purchase of Pipe Whip Restraints and Embedded Supports for SNUPPS	8	10/4/78
4.23	Bechtel Specification	C-202B, Technical Specification for Purchase of Pipe Whip Restraints for SNUPPS	6	10/25/82
4.24	Bechtel Directive	MED-78-01, Manager of Engineering Directive, EDP Manual Applicability Index	15	6/25/82
4.25	Bechtel Manual Index	Project Engineering Procedures Manual Index, SNUPPS pp. 7-12	52	7/30/82
4.26	Bechtel Procedure	EDP-1.1, Introduction to the EDP System	1	3/31/78

Ref. No.	Document Type	Description/Title	Rev.	Date
4.27	Bechtel Procedure	EDP-1.7, Engineering Department Procedures	2	3/31/78
4.28	Bechtel Procedure	EDP-1.8, Engineering Department Procedures Manual	0	1/20/78
4.29	Bechtel Procedure	EDP-1.10, Engineering Department Project Instructions	2	3/31/78
4.30	Bechtel Procedure	EDPI-1.11-01, Project Engineering Procedures Manual	1	1/15/79
4.31	Bechtel Procedure	EDP-1.13, Manager of Engineering Directives	2	3/31/78
4.32	Bechtel Procedure	EDPI-2.13-01, SNUPPS Project Organization	8	12/23/81
4.33	Bechtel Procedure	EDPI-4.1-01, Design Criteria	5	5/12/80
4.34	Bechtel Procedure	EDPI-4.22-01, Preparation and Control of SAR	7	5/8/81
4.35	Bechtel Procedure	EDPI-4.23-01, SAR Change Control	9	8/25/80
4.36	Bechtel Procedure	EDPI-4.25-01, Design Interface Control	1	3/9/78
4.37	Bechtel Procedure	EDPI-4.34-01, Off-Project Design Review	4	1/15/79
4.38	Bechtel Procedure	EDP-4.36, Standard Computer Programs	1	9/26/80
4.39	Bechtel Procedure	EDPI-4.37-01, Design Calculations	8	1/9/81
4.40	Bechtel Procedure	EDPI-4.41-01, Base Design Document Review, Approval, and Release Requirements	1	5/8/78
4.41	Bechtel Procedure	EDPI-4.46-01, Project Engineering Drawings	17	7/30/82
4.42	Bechtel Procedure	EDPI-4.47-01, Drawing Change Notice	12	9/18/81

Ref. No.	Document Type	Description/Title	Rev.	Date
4.43	Bechtel Procedure	EDPI-4.49-01, Project Specifications	11	9/18/81
4.44	Bechtel Procedure	EDPI-4.58-01, Specifying and Reviewing Supplier Engineering and Quality Verification Documentation	4	9/18/81
4.45	Bechtel Procedure	EDP-4.60, Processing Corrective Action Reports	3	5/31/78
4.46	Bechtel Procedure	EPDI-4.61-01, Nonconformance Reports (NCR's)	14	7/30/82
4.47	Bechtel Procedure	EDPI-4.62-01, Field Change Request, Construction Variance Request, and Middle Third Deviation Notice	13	7/30/82
4.48	Bechtel Procedure	EDPI-4.65-01, Design Deficiency Processing	4	9/18/81
4.49	Bechtel Procedure	EDPI 5.1-01, Communications Control	6	1/9/81
4.50	Bechtel Procedure	EDPI 5.7-01, Project Filing System	6	5/12/80
4.51	Bechtel Procedure	EDPI 5.30-01, Project Release Procedure and Document Release Log	2	12/10/79
4.52	Bechtel Procedure	EDP 5.34, Project Quality Program Indoctrination and Training	2	12/8/75
4.53	Bechtel Calculation	Final Calculation 13-08-F, Auxiliary Building Floor Response Spectra	0	8/24/81 Comp. 8/26/81 Ckd. 3/1/82 App.
4.54	Bechtel Calculation	Final Calculation 03-53.4-F, Capacities of Embedded Plate Type EP 912A	0	2/14/79 Comp. 8/17/79 Ckd. 8/17/79 App.
4.55	Bechtel Calculation	Final Calculation 03-107-F, Formulation of Load Capacity Coefficients of Embedded and Replacement Plates	0	7/30/81 Comp. 7/30/81 Ckd. 11/2/82 App.
4.56	Bechtel Calculation	Final Calculation 03-109-F, Load Nomographs for Embedded and Replacement Plates	1	1/29/82 Comp. 1/29/82 Ckd. 2/6/82 App.

Ref. No.	Document Type	Description/Title	Rev.	Date
4.57	Bechtel Calculation	Final Calculation 03-411-F, Isolation Restraint FC-02	0	12/1/81 Comp.
4.58	Bechtel Calculation	Final Calculation 03-411-F, Isolation Restraint FC-02	0	11/17/82 Comp. 11/18/82 Ckd.
4.59	Bechtel Calculation	Final Calculation 03-90.25-F, Pipe Anchor No. 0-FB01-A002/135	1 2	9/29/82 App. 12/14/82 App.
4.60	Bechtel Drawing	C-0003, Structural Steel and Concrete General Notes	26	6/22/82
4.61	Bechtel Drawing	C-0010, Standard Details, Sheet No. 7	7	7/9/80
4.62	Bechtel Drawing	C-0011, Standard Details, Sheet No. 8	13	7/14/81
4.63	Bechtel Drawing	C-0012, Standard Details, Sheet No. 9	13	9/18/80
4.64	Bechtel Drawing	C-0016, Standard Details, Sheet No. 15	11	9/18/80
4.65	Bechtel Drawing	C-0017, Standard Details, Sheet No. 21	11	11/6/78
4.66	Bechtel Drawing	C-0018, Standard Details, Sheet No. 31	9	2/14/78
4.67	Bechtel Drawing	C-0019, Standard Details, Sheet No. 29	14	7/12/82
4.68	Bechtel Drawing	C-0020, Standard Anchor Bolt Details	9	4/9/82
4.69	Bechtel Drawing	C-0029, Standard Details, Sheet No. 33	7	9/8/82
4.70	Bechtel Drawing	C-0030, Standard Details, Sheet No. 35	12	7/12/82
4.71	Bechtel Drawing	C-0033, Standard Anchor Bolts Schedule	12	1/21/82
4.72	Bechtel Drawing	C-0035, Standard Details, Sheet No. 24	15	2/23/81

Ref. No.	Document Type	Description/Title	Rev.	Date
4.73	Bechtel Drawing	C-0037, Standard Details, Sheet No. 34	16	11/12/82
4.74	Bechtel Drawing	C-0C0241, Condenser Storage and Demineralized Water Tanks, Concrete Neat Line and Reinforcing	9	6/22/82
4.75	Bechtel Drawing	C-0408, Cable Tray Supports, Typical Details, Sheet 8	11	10/17/82
4.76	Bechtel Drawing	C-0418, Cable Tray Supports, Typical Details, Sheet 18	9	10/18/82
4.77	Bechtel Drawing	C-0419, Cable Tray Supports, Typical Details, Sheet 19	7	6/14/82
4.78	Bechtel Drawing	C-0C1113, Auxiliary Building Concrete, Plan-Floor El 1974'-0"	6	4/21/80
4.79	Bechtel Drawing	C-0R1151, Auxiliary Building Area 5 Reinforcing, Plan at Elev. 1974', 1989' and 2000'	6	1/29/82
4.80	Bechtel Drawing	C-0C1151, Auxiliary Building Area 5, Concrete Neat Lines, Plan at Elev. 1974', 1989' and 2000'	19	1/12/82
4.81	Bechtel Drawing	C-0C1352, Auxiliary Building Area 5, Concrete Neat Lines, Plan at Elev. 2013'-6", 2026' and 2090'	16	8/24/82
4.82	Bechtel Drawing	C-0S1352, Auxiliary Building, Area 5, Structural Steel Framing Plans, Elev. 1989', 2000', 2013'-6" and 2026'	5	8/3/82
4.83	Bechtel Drawing	C-0C1353, Auxiliary Building, Area 5 Concrete Neat Line, Plan of Embeds, Underside of Slab at Elev. 2026'	8	9/1/82
4.84	Bechtel Drawing	C-0S1452, Auxiliary Building, Area 5, Structural Steel Framing Plans, Elev. 2037'-7-¼", 2042', 2055'-6" and 2090'	5	8/26/82
4.85	Bechtel Drawing	C-0R1905, Auxiliary Building Reinforcing Sections and Details, Sheet 4	6	12/28/80
4.86	Bechtel Drawing	C-0R1906, Auxiliary Building Reinforcing, Sections and Details, Sheet 6	4	3/20/80

Ref. No.	Document Type	Description/Title	Rev.	Date
4.87	Bechtel Drawing	C-OC1924, Auxiliary Building Concrete Neat Lines and Reinforcing, Wall Elevations, Sheet 24	17	7/16/82
4.88	Bechtel Drawing	C-OC1928, Auxiliary Building, Concrete Neat Lines and Reinforcing, Wall Elevations, Sheet 28	10	7/16/82
4.89	Bechtel Drawing	C-OC1931, Auxiliary Building, Concrete Neat Lines and Reinforcing, Wall Elevations, Sheet 6	14	11/1/82
4.90	Bechtel Drawing	C-OC1932, Auxiliary Building, Concrete Neat Lines and Reinforcing, Wall Elevations, Sheet 5	13	7/16/82
4.91	Bechtel Drawing	C-OC1942, Auxiliary Building, Concrete Neat Lines and Reinforcing, Equipment Pads, Sheet 2	5	12/3/79
4.92	Bechtel Drawing	C-OS4481, Turbine Building, Area 8, Structural Steel Framing Plan at Elevation 2035' and 2017'-9"	7	8/14/80
4.93	Bechtel Drawing	C-03FC02, Isolation Restraints, Auxiliary Turbine System, Auxiliary Building	0 1 2	1/26/82 7/22/82 11/5/82
4.94	Bechtel Drawing	M-03AL01, Piping Isometric, Auxiliary Feedwater Pumps, Suction Piping	9	
4.95	Bechtel Drawing	M-03AL04, Piping Isometric, Turbine Driven Auxiliary Feedwater Pump Discharge Piping	7	
4.96	Bechtel Drawing	M-03AL05, Piping Isometric, Auxiliary Feedwater Pumps Recirculation Piping	9	
4.97	Bechtel Drawing	M-06AL04, Hanger No. 0-AL04-C009/135Q	4	6/29/81
4.98	Bechtel Drawing	M-06AL01, Hanger No. 0-AL01-R005/135Q	2	9/21/78
4.99	Bechtel Drawing	M-06AL01, Hanger No. 0-AL01-H001/135Q	3	9/20/78
4.100	Bechtel Drawing	M-06AL03, Hanger No. 0-AL03-C004/135Q	2	9/1/81

Ref. No.	Document Type	Description/Title	Rev.	Date
4.101	Bechtel Drawing	M-06AL03, Hanger No. 0-AL03-C009/135Q	2	9/1/81
4.102	Bechtel Drawing	M-06AL03, Hanger No. 0-AL03-C010/135Q	0	9/1/81
4.103	Bechtel Drawing	Embedded Plate Location Request - Plate No. 14807	0	11/21/81
4.104	Bechtel Drawing	M-06AL03, Hanger No. 0-AL03-C011/135Q	0	9/1/81
4.105	Bechtel Drawing	Embedded Plate Location Request - Plate No. 14808	0	11/21/81
4.106	Bechtel Calculation	Calculation AL03-15, Hanger 0-AL03-C003/135Q	4	6/29/81
4.107	Bechtel Calculation	Calculation AL03-26, Hanger 0-AL03-C010/135Q	0	7/2/81
4.108	Bechtel Drawing	M-06FB01, Anchor No. 0-FB01-A002/135Q	1 2	10/9/79 (in process)
4.109	Bechtel Drawing	M-26AL01, Anchor No. 2AL01-A002/125Q	0	7/20/82
4.110	SNUPPS Letter	SLNRC 79-11, Response to IEB 79-02, Rev. 1		7/5/79
4.111	Bechtel Drawing Change Notice	DCN No. C-0003-8-5		8/10/77
4.112	Bechtel Drawing Change Notice	DCN No. C-0003-26-1		8/23/82
4.113	Bechtel Drawing Change Notice	DCN No. C-0003-26-2		9/2/82
4.114	Bechtel Drawing Change Notice	DCN No. C-0003-26-3		10/18/82

Ref. No.	Document Type	Description/Title	Rev.	Date
4.115	Bechtel Drawing Change Notice	DCN No. C-0003-26-4		11/8/82
4.116	Field Change Request	FCR No. 2FC-1098-C		10/18/82
4.117	Field Change Request	FCR No. 2FC-1110-C		10/18/82
4.118	Field Change Request	FCR No. 2FC-1121-CX		11/5/82
4.119	Field Change Request	FCR No. 2FC-1152-C		11/5/82
4.120	Nonconformance Report	NCR No. 2SN-6306-C		7/27/82
4.121	Nonconformance Report	NCR No. 2SN-6360-CX		8/11/82
4.122	Nonconformance Report	NCR No. 2SN-6594-C		10/29/82
4.123	Nonconformance Report	NCR No. 2SN-6737-C		10/28/82
4.124	Nonconformance Report	NCR No. 2SN-6847-C		11/5/82
4.125	ANSI Standard	ANSI N45.2.11		1974
4.126	NRC Regulatory Guide	RG 1.64	2	June 1976
4.127	Bechtel Internal Memo	R. L. Burris to L. Rotondo on seismic calculations for the as-built power block structures		5/4/82

7.4.2 - Personnel Interviewed

Name	Title	Organization
William H. Zvanut	Supervising Engineer	Union Electric Company
Don B. Stecko	Engineer	Union Electric Company
Ken W. Kuechenmeister	Supervising Engineer/ Construction	Union Electric Company
J. R. Veatch	Supervising Engineer	Union Electric Company
Wayne Steinberg	Construction Engineer	Union Electric Company
Cliff J. Plows	Quality Engineer	Consultant to Union Electric Company
Eugene F. Beckett	Manager, Technical Services	Nuclear Projects, Inc.
Ken Y. Lee	Chief, Civil-Structural Engineer	Bechtel (Gaithersburg)
Eugene W. Thomas	Group Supervisor, Civil-Structural Staff	Bechtel (Gaithersburg)
James A. Ivany	Civil-Structural Group Supervisor	Bechtel (Gaithersburg)
Peter A. Labarta	Civil-Structural Group Leader - Special Problems	Bechtel (Gaithersburg)
Dwight M. Cornell	Civil-Structural Group Leader - Special Problems	Bechtel (Gaithersburg)
Gerald D. Brown	Civil-Structural Group Leader - Auxiliary Building	Bechtel (Gaithersburg)
Robert L. Burris	Civil-Structural Group Leader - Seismic	Bechtel (Gaithersburg)
Larry Nagielski	Civil-Structural Engineer Auxiliary Building	Bechtel (Gaithersburg)
Bhupesh G. Shah	Plant Design Group Supervisor	Bechtel (Gaithersburg)
William A. Poppe	Mechanical-Nuclear Group Leader - Power Conversion	Bechtel (Gaithersburg)
Nick Cherish	Assistant Project Lead Site Liaison Engineer	Bechtel Site Liaison Engineering
Andy S. Wilkin	Lead Civil-Structural Site Liaison Engineer	Bechtel Site Liaison Engineering

7.5 Electrical Power

7.5.1 - Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
5.1	Bechtel Test Procedure	S-04PA01, 13.8KV Systems Pre-Op Test Procedure	1	3/28/80
5.2	Union Electric Test Procedure	CS-04PA01, 13.8KV Systems Pre-Op Test Procedure	0	7/21/82
5.3	Daniel International Procedure	AP-1V/AP.1, 9, Material Control Function/ Warehouse Procedures		5/24/82
5.4	Union Electric Computer Listing	Computer Listing of all IE Bulletins, Circulars and Information Notices with Follow-up Information		11/82
5.5	Union Electric RCI	Request for Clarification of Information		12/8/82
5.6	Bechtel Internal Memo	Memo from J. H. Smith "Procedure for RCI"		11/5/82
5.7	Bechtel Letter	BLWE-810, "Safe Shutdown Design Criteria and NRC Fire Protection Questions"		1/26/78
5.8	Westinghouse Letter	SNP-1722, "Safe Shutdown"		3/15/78
5.9	Westinghouse Letter	SNP-2027, "Safe Shutdown		10/3/78
5.10	Bechtel Letter	BLSE-7110, "Safe Shutdown" Meeting Notes of 4/10/79		4/18/79
5.11	Bechtel Letter	BLWP-514, "Safe Shutdown Modifications"		8/10/79
5.12	Bechtel Letter	BLWE-1061, "Safe Shutdown Modifications		8/20/79
5.13	Bechtel Letter	BLWE-1081, "Order Confirmation for Item 5"		9/27/79
5.14	Westinghouse Internal Memo	CN-9415, Change Control #9415 for Item 5		10/3/79

Ref. No.	Document Type	Description/Title	Rev.	Date
5.15	Westinghouse Letter	SNP-3360, "Drawing Change Notice to Bechtel"		5/21/80
5.16	Bechtel Letter	BLWP-534, Order for "Q" PORVs		1/9/80
5.17	Bechtel Letter	BLWE-1555, List of Outstanding Items		12/8/81
5.18	Westinghouse Drawing	DWG #7250D64 SH. 17 and 18		
5.19	Westinghouse Drawing	DWG #8756D37, SH. 12		
5.20	NPI Letter	SLBE 79-853, Regarding BFD Relays (IE Bulletin 79-25)		11/8/79
5.21	Bechtel Letter	BLSE 79-57, No BFD Relay Used in SNUPPS Design		1/17/80
5.22	NPI Letter	SLBE-887, Failure of Gate Type VV. to Close Against Differential Pressure (IE Bulletin 81-02)		8/25/81
5.23	Bechtel Letter	BLSE-10, 014, Based on Westinghouse Letter SNP(s)-675 Dated 10-27-81 on IE Bulletin 81-02		11/13/81
5.24	NPI Letter	SLT 7-236, File-J-201, Cold Shutdown from Outside the Control Room		11/7/77
5.25	NPI Letter	SLT 81-182, Agreement Between Bechtel, NPI, W on Auxiliary Shutdown Panel, Instrumentation and Control Isolation		11/30/81
5.26	NPI File	02-78-10 Master File, Bulletin and Information Notice List and Follow-up Record		
5.27	Bechtel Standard Form	J-201-2-3, Supplier Deviation Disposition Request (SDDR) for specification change		10/27/79
5.28	Bechtel Standard Form	J-201-2-11, SDDR for specification change		1/22/80
5.29	Bechtel List	Log Book for All SDDRs with Follow-up Record		

Ref. No.	Document Type	Description/Title	Rev.	Date
5.30	Bechtel Letter	BLSE-10849, Checklist Summarizing NUREG-0588 Requirements		8/03/82
5.31	Bechtel Letter	Letter to Anchor/Darling Forwarding Open Items on Qualification of Valve Operators		11/15/82
5.32	Bechtel Standard Form	FCR - Field Change Request		10/27/82
5.33	Bechtel Design Change Notice	DCN #E-OR2421(Q)-13-2 and DWG #E-OR2421(Q) Incorporating FCR of reference 5.32		
5.34	Bechtel Computer Printout	Raceway Schedule E-25000, E-05000, E-25000		11/82
5.35	Bechtel Letter	BLSE-8561, Relay Setting for Site Feeders		3/5/80
5.36	KG&E Letter	KNLS-099, Relay Setting for Site Feeders		10/15/80
5.37	Bechtel Internal Memo	Floor Response Spectra (FRS), ESWS Pump House Wolf Creek Site (KG&E/KCPL)		6/15/79
5.38	Bechtel Internal Memo	FRS, UHS Cooling Tower Callaway Site (U.E.)		9/1/78
5.39	Bechtel Specification	E-025, Valve Actuator Specification, Attachment Specification to M223-0051 (Check and Gate VV. Spec.)		
5.40	Bechtel Letter	BLWE-1560, FILE 10.581, Isolation of Auxiliary Shutdown Panel Instrumentation - Westinghouse Instrumentation		12/28/81
5.41	Limitorque Report	M-223A-0051-01, Environmental Qualification Report on Limitorque Valve Operator		12/10/76
5.42	Gould Report	E-018-0043-04, Seismic Qualification Report for the Motor Control Centers		6/2/78
5.43	Union Electric Letter	E09 #4, Preliminary Report Callaway 13.8 kV Fault		10/26/81
5.44	Union Electric Letter	ULS-3901, Site Feeder Parameters Callaway Plant		12/8/81
5.45	NPI Letter	SL081-211, File 0491.102/E-009		12/9/81

Ref. No.	Document Type	Description/Title	Rev.	Date
5.46	Bechtel Trip Report	Trip Report, W. Heinmiller		12/10/81
5.47	Bechtel Calculation	F2, Sizing of Cable		
5.48	Bechtel Calculation	F3, Cable Derating		
5.49	Bechtel Calculation	F7, Minimum Cable Size for Fault Current Withstand		
5.50	Component Data Book	Okonite Cable Data Book		
5.51	Bechtel Calculation	A7, Fault Current Calculations	0	
5.52	Bechtel Calculation	A3, Fault Current Calculations		
5.53	Bechtel Calculation	B5, Power System Voltage Drops	0	In Process
5.54	Bechtel Calculation	B6, Control System Voltage Drops	A	In Process
5.55	Bechtel Calculation	F9, Fault Current Calculation Motor Control Centers	1	10/22/82
5.56	Bechtel Specification	J-201, Shutdown Panel Specification	7	
5.57	Gould/ Bechtel Qualification Report	CC-323.74-1/#E/018/0189, Gould Qualification Summary Report for Class 1E Equipment	6	5/24/81
5.58	Bechtel Procedure	EDPI-5.16-01, Supplier Document Control	8	
5.59	Bechtel Procedure	EDPI-4.58-01, Vendor Data Review Procedures	4	9/27/81
5.60	Bechtel Test Criteria	E-091.0 (Q), Seismic Testing Criteria	4	5/25/76
5.61	Underwriters Laboratories	UL508, Industrial Control Equipment Magnetic (NLDX2)		

Ref. No.	Document Type	Description/Title	Rev.	Date
5.62	Underwriters Laboratories	General Information From Electrical Construction Materials Directory		5/78
5.63	Bechtel Drawing	E-03AL05A (Q), Auxiliary Feedwater Pump Air Operated Discharge Control	0	7/7/82
5.64	Bechtel Curves	E-01021, Time-Current Characteristic Curves		
5.65	Bechtel Curves	Sheet 5, Time-Current Characteristic Curves	2	
5.66	Bechtel Curves	Sheet 6, Time-Current Characteristic Curves	4	
5.67	Bechtel Curves	Sheet 7, Time-Current Characteristic Curves	5	
5.68	Bechtel Curves	Sheet 8, Time-Current Characteristic Curves	5	
5.69	Bechtel Curves	Sheet 9, Time-Current Characteristic Curves	4	
5.70	Bechtel Curves	Sheet 10, Time-Current Characteristic Curves	4	
5.71	Daniels International Shipping Request	MN21-B03802, Shipping Request		10/22/82
5.72	Bechtel Letter	Bechtel to Daniels (Pam Nelson to Joe Candrel)		9/7/82
5.73	Westinghouse Diagrams	8756037 Sheets 6, 11, 34, SNUPPS Process Control Diagrams	8	10/26/82
5.74	Westinghouse Diagrams	7246D92, Sheet 17, SNUPPS Process Control External	1	
5.75	Westinghouse Diagrams	7246D92 Sheet 3, Wiring Diagrams	10	10/26/82
5.76	Westinghouse Letter	SNP-4981, PIP Transmittal Letter		11/11/82

Ref. No.	Document Type	Description/Title	Rev.	Date
5.77	Westinghouse Status Report	WRM-ADM-210.6, Task Status System	0	7/1/80
5.78	NUREG	NUREG-0588, Interim Staff Position on Environmental Qualification of Safety Related Electrical Equipment		7/31/81
5.79	Bechtel Specification	E-018 for Motor Control Center		
5.80	Bechtel Calculation	B-3, Voltage Drops	1	7/17/81
5.81	IEEE Standard	IEEE Std 399, Recommended Practice for Power System Analysis		
5.82	IEEE Standard	IEEE Std 141, Recommended Practice for Electrical Power Distribution in Industrial Plants		1976
5.83	Union Electric Non-Conformance Report	2SN-6678-M, Auxiliary Feedwater Pump Turbine Trip and Throttle Valve		10/8/82
5.84	Return Material Form	From P. Nelson to J. Candrel, P.O. 10466-M-021-2, Limitorque Trip and Throttle Valves		9/7/82
5.85	NRC Bulletin	82-02		
5.86	NRC Bulletin	79-25		
5.87	NRC Bulletin	81-02		
5.88	Regulatory Guide	1.139, "Design Requirements of the Residual Heat Removal System		
5.89	ANSI Standard	N45.2.2, "Packaging, Shipping, Receiving Storage and Handling of Items for Nuclear Power Plants		1972
5.90	Union Electric Material Shipping Report	MN21 B03802		10/8/82

7.5.2 - Personnel Interviewed

Name	Title	Organization
D. Schnell	Vice President	Union Electric Company
D. Capone	Manager, Nuclear Engineering	Union Electric Company
W. Katterhenry	Power Systems Engineer	Union Electric Company
S. Hillman	I&C Engineer	Union Electric Company
W. Weber	Site Superintendent	Union Electric Company
Al Passwater	Supt. Licensing	Union Electric Company
W. H. Mawyer	Elect. Consultant	Union Electric Company
D. Pruitt	Site Staff	Union Electric Company
K. Kuechenmeister	QA	Union Electric Company
P. Burrello		Westinghouse
C. Vitalbo		Westinghouse
Jim Swogger	Project Engineer, SNUPPS	Westinghouse
Phil Barilla	Shutdown Panel In Charge	Westinghouse
Tim Kitchen	Process Rack In Charge (I&C)	Westinghouse
Phil Marasco	Process Rack In Charge (I&C)	Westinghouse
D. Schwartz	Cable Terminations Engineer	
R. Moreno	Lead EE Liaison	Bechtel Site
P. Schwartz	I&C Systems Engineer	Bechtel Site
D. Quattrociocchi	PE-Electrical/CS	Bechtel Gaithersburg
M. Tantawi	Supervisor-Electrical Group	Bechtel Gaithersburg
W. Heinmiller	Supervisor-Power Systems	Bechtel Gaithersburg
D. Doan	Electrical Engineer	Bechtel Gaithersburg
J. Kohler	Deputy Supervisor-Electrical Group	Bechtel Gaithersburg
J. Hurd	Supervisor-Mechanical Group	Bechtel Gaithersburg
J. Prebula	Deputy Supervisor-Mechanical/ Nuclear Group	Bechtel Gaithersburg
B. Seam	Facilities/Site Group Leader, SNUPPS Mechanical/Nuclear Group	Bechtel Gaithersburg
P. Burris	Civil-Structural Group Leader-Seismic	Bechtel Gaithersburg
A. Hassan	Group Leader Electrical Group	Bechtel Gaithersburg
D. Abel	Engineer	Bechtel Gaithersburg
P. Ward	Licensing	Bechtel Gaithersburg
Marco Hechavarria	Quality Engineer	Bechtel Gaithersburg
Anthony Diperna	Supervisor, Control System	Bechtel Gaithersburg
Stan J. Seiken	Manager, Quality Assurance	NPI
Dr. J. Cermak	Manager, Nuclear Safety	NPI
F.Schwoerer	Technical Director	NPI
M. Fennetau	Sales Engineer	Gould C&S Division

7.6 Instrumentation and Control

7.6.1 Documents

Ref. No.	Document Type	Description/Title	Rev.	Date
6.1	Bechtel Design Specification	10466-J-601A(Q) Design Specification for Nuclear Service Control Valves	13	10/17/80
6.2	FSAR	Section 9.3 Process Auxiliaries	7	9/81
6.3	FSAR	Section 7.4 Systems Required for Safe Shutdown	1	9/80
6.4	Bechtel Vendor Data	10466-J-601A-099-01 HV-12 Control Valve Vendor Data		8/19/77
6.5	IEEE Standard	IEEE STD 323-1974 Qualifying Class IE Equipment for Nuclear Power Generating Stations		1974
6.6	Bechtel Test Plan	10466-J-601A-0102-04 Environmental Qualification Test Plan	C	1/21/80
6.7	Bechtel Test Plan	10466-J-067-05 Seismic Qualification Test Plan	E	3/29/78
6.8	IEEE Standard	IEEE Std 344 Seismic Qualification of Class 1E Equipment		1975
6.9	Bechtel Test Report	10466-J-601A-0148-03 Seismic Qualification Test Report	C	3/3/82
6.10	Bechtel	10466-J-601A-0163-01 Supplementary Seismic Qualification		8/23/82
6.11	Bechtel	10466-J-601A-0158-01 Environmental Test		4/9/82
6.12	Bechtel	10466-SK-J-103(Q) Modifications and Additions to the Instrument Loops	N	3/31/82
6.13	Bechtel Design Criteria	10466-J-000 Control Systems Design Criteria	8	1/26/78
6.14	Bechtel Specification	10466-QA-1 Specification of General Requirements for Supplier QA Programs	4	10/15/75

Ref. No.	Document Type	Description/Title	Rev.	Date
6.15	Westinghouse Specification	V-7 Subsection 7 - Auxiliary Feedwater System	2	8/73
6.16	Bechtel Drawing	M-02AL01(Q) Piping and Instrument Diagram Auxiliary Feedwater System	11	9/21/82
6.17	Bechtel Drawing	10466-J-110-0350-03 Auxiliary Feedwater Flow Control - Turbine Driven AFP to Steam Generator D	3	2/15/79
6.18	Bechtel Drawing	E-03AL05A(Q) Auxiliary Feedwater Pumps, Discharge Control Air Oper. Valves	0	7/7/82
6.19	Bechtel Drawing	10466-J-110-0356-03 Auxiliary Feedwater Flow Control - Motor Driven AFP B to Steam Generator C	3	2/19/79
6.20	Bechtel Drawing	J-02AL01A(Q) Auxiliary Feedwater System Motor Driven Aux Feedwater Pumps	0	11/11/82
6.21	Bechtel Drawing	E-03AL01B(Q) Motor Driven Aux Feedwater Pump B	0	7/7/82
6.22	Bechtel Procedure	EDPI 4.46-01 Project Engineering Drawings	17	5/21/82
6.23	Bechtel Drawing	E-02NF01(Q) Load Shedding and Emergency Load Sequencing Logic	2	12/7/77
6.24	Bechtel Drawing	E-03AL01B(Q) Motor Driven Auxiliary Feedwater Pump B	0	7/7/82
6.25	Bechtel Drawing	J-02AL01(Q) Auxiliary Feedwater System Motor Driven Auxiliary Feedwater Pumps	3	1/27/82
6.26	Bechtel Drawing	J-02FC19(Q) Auxiliary Turbines SGFP Turbines ESFAS Block Control Logic Diagram	0	2/16/82
6.27	Bechtel Drawing	[illegible]FC27(Q) SGFP Turbines A&B Isolation Input To ESFAS	2	5/5/82
6.28	Bechtel Drawing	E-03AL04A(Q) Supply from ESS Service Water System	0	7/7/82
6.29	Bechtel Drawing	E-03AL04B(Q) Supply from ESS Service Water System	0	7/7/82

Ref. No.	Document Type	Description/Title	Rev.	Date
6.30	Bechtel Drawing	E-03AL02A(Q) Motor Operated Valves	0	7/7/82
6.31	Bechtel Drawing	E-03AL02B(Q) Motor Operated Valves	0	7/7/82
6.32	Bechtel Specification	J104(Q) Technical Specification for Engineered Safety Features Actuation System	12	8/11/82
6.33	Bechtel Specification	J110(Q) Major Electronic Instrumentation and Controls Package	5	4/19/82
6.34	Bechtel Specification	J-301(Q) Electronic Pressure and Differential Pressure Transmitters	11	9/30/82
6.35	Bechtel Drawing	J-104-0147-08 LSELS IE Relay Allocation		4/11/78
6.36	Bechtel Drawing	J-104-0042-12 Actuation Outputs - Channel 4		10/26/82
6.37	Bechtel Drawing	J-104-0034-12 Actuation Outputs - Channel 1		8/4/82
6.38	Bechtel Procedure	EDPI-4.37-01 Design Calculations	8	1/7/81
6.39	Bechtel Specification	J-435(Q) Orifice Plates for Nuclear Class 2 and 3 Piping Systems	13	7/15/82
6.40	Bechtel Calculation	ME-223-001 Calculation Verification of Computer Program ME 223 Thin Edge Orifice Plates	0	11/4/80
6.41	Bechtel Calculation	J-435 Calculation Orifice Type Flow Elements	0	11/29/82
6.42	Bechtel Drawing	7250D64 Sheet 15 - SNUPPS Projects Functional Diagram Auxiliary Feedwater Pumps Startup	3	
6.43	Bechtel Drawing	7250D64 Sheet 7	2	
6.44	Bechtel Drawing	7250D64 Sheet 15	4	

Ref. No.	Document Type	Description/Title	Rev.	Date
6.45	Bechtel Drawing	7250D64 Sheet 8	3	
6.46	Bechtel Drawing	7243D59 Sheet 1 Solid State Protection System SNUPPS Projects Interconnection Diagram	7	
6.47	Bechtel Drawing	M-23KA47 Small Piping Isometric N2 Beck-up Gas Supply Auxiliary Building	1	3/10/82
6.48	Technical Bulletin	Technical Bulletin		
6.49	Westinghouse Letter	Westinghouse Letter to SNUPPS		
6.50	Bechtel Logic Diagram	02AL05	0	
6.51	Bechtel Logic Diagram	02AL06	0	
6.52	Bechtel Logic Diagram	02AL07	0	
6.53	Bechtel Procedure	EDPI 4.41-01, "Base Design Document Review, Approval, and Release Requirements	1	
6.54	Bechtel Procedure	JIGEN		
6.55	Union Electric Procedure	QS-14, "Preparation, Review and Document Control of Safety Analysis Reports and Subsequent Changes"	2	9/23/82

7.6.2 Personnel Interviewed

Name	Title	Organization
Tony Diperna	CS Group Supervisor	Bechtel
D. R. Quattrociocchi	Project Engineer	Bechtel
A. Hassan	Electrical Engineer	Bechtel
W. A. Poppe	Group Leader, Mech/Nuclear	Bechtel
G. P. Schwartz	Control Sys. Site Liaison	Bechtel
P. Trimbach		Bechtel
I. Tessier	Startup Testing	Bechtel
B. Vich	Group Leader, Control Sys. Group	Bechtel
D. Grove	Group Leader, Control Sys. Group	Bechtel
J. J. Milos	Project Quality Engineer	Bechtel
R. P. Wendling	Supervising Engineer, Nuclear	Union Electric Company
T. H. McFarland	Superintendent, Site Liaison	Union Electric Company
R. J. Schukai	General Manager, Engineering	Union Electric Company
K. W. Kuechenmeister	Supv. Engr., UE Construction	Union Electric Company
D. MacIsaac	Startup Engineer	Union Electric Company
S. Hogan	QA Engineer	Union Electric Company
D. Brady	Startup Program Coordinator	Union Electric Company
R. Cothren	Consulting Engineer	Union Electric Company
R. Huston	Startup Test Coordinator	Union Electric Company
R. Veatch	Supervising Engineer	Union Electric Company
A. Sassani	Consulting Engineer	Union Electric Company
R. Trimbach	Supervisor, Metrology	Union Electric Company
F. Maddy	Consulting Engineer	Union Electric Company
W. Minerich		Union Electric Company
W. Spezialetti	Manager, Plant Licensing	Westinghouse
J. Swogger	SNUPPS Project Engineer	Westinghouse
P. Barilla	Eng., Chem. & Waste Process Sys.	Westinghouse
N. Beck	Engineer, Fluid System Design	Westinghouse
Steven T. Maher	Systems Engineer	Westinghouse
Frank Thomson	Engineer	Westinghouse
S. J. Seiken	QA Manager	Nuclear Projects, Inc.

7.7 Other Information

7.7.1 - Chronology

10/20/82	Team members began study of background information and preparation of inspection plans.
10/22/82	Team meeting
11/4/82	Team meeting
11/10/82	Entrance meeting at Union Electric Inspection at Union Electric
11/11/82	Entrance meeting at construction site Inspection at construction site
11/12/82	Inspection at Union Electric Exit meeting
11/15/82	Entrance meeting at Nuclear Projects, Inc. Inspection at Nuclear Projects, Inc.
11/16/82	Inspection at Nuclear Projects, Inc. Entrance meeting at Bechtel Power Corporation
11/17/82 to 11/19/82	Inspection at Bechtel Power Corporation Exit meeting (11/19/82)
11/29/82 to 12/3/82	Inspection at Bechtel Power Corporation Exit meeting (12/3/82)
12/6/82 to 12/8/82	Inspection at construction site Exit meeting (12/8/82)
12/9/82	Entrance meeting at Westinghouse Electric Inspection at Westinghouse Electric (some team members at Union Electric)

12/10/82	Inspection at Westinghouse Electric Exit meeting (some team members at Bechtel)
12/13/82 to 12/14/82	Inspection at Bechtel Power Corporation (some team members only)
1/20/82	Team meeting