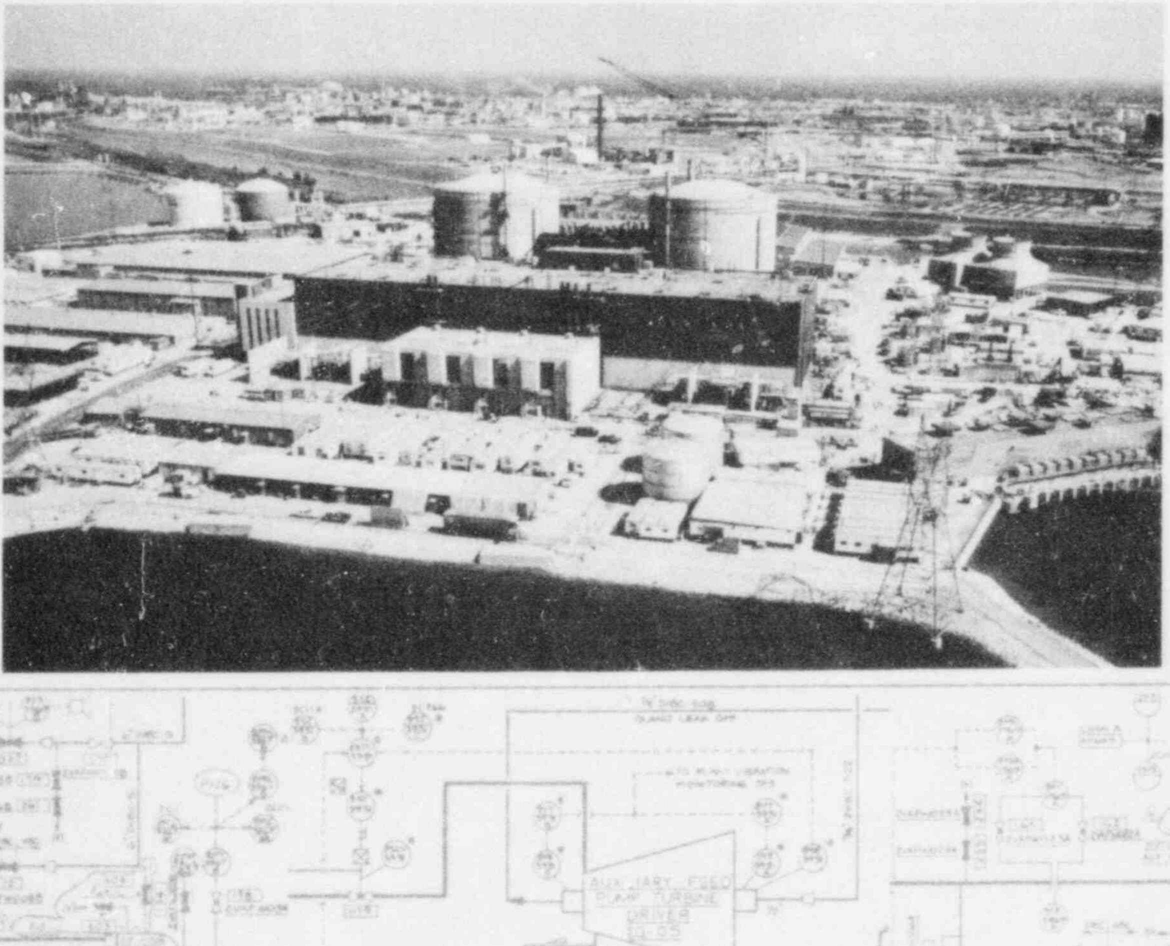
United States Nuclear Regulatory Commission
Docket Numbers 50-329 & 50-330

Midland Independent Design and Construction Verification Program

Auxiliary Feedwater System Performance Requirements



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TERA

June 15, 1984

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Re: Docket Nos. 50-329 OM, OL and 50-330 OM, OL
Midland Nuclear Plant - Units 1 and 2
Independent Design and Construction Verification Program (IDCVP)
Draft Report on the Auxiliary Feedwater System Performance Requirements

Gentlemen:

Attached is our recently completed draft report on the Auxiliary Feedwater (AFW) System Performance Requirements. This report is the first in a series of design verification topical reports that will collectively document the review process and conclusions. As such, design verification activities are ongoing, and this report represents partial fulfillment of the objectives of the IDCVP. A final report will include an integrated assessment which assimilates the specific topical reports into general conclusions.

The scope addressed in this topical report includes elements of the AFW system design specifically related to how the primary functional requirements are met (e.g., system operating limits, hydraulic design, heat removal capability, instrumentation and control, etc.), corresponding to topics listed under section I of the AFW sample review matrix defined in the IDCVP Engineering Program Plan. Similar topical reports will follow, addressing the system performance scope for the standby electric power system and control room HVAC system. System Protection Features and Structures that House the System (sections II and III of the sample review matrices, respectively) will be addressed in two additional topical reports which will cover these aspects for all three systems.

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Based upon our review and independent confirmatory evaluations, we have concluded that for topical areas within the scope of this report, adequate confidence exists that the AFW system will perform its intended safety functions.

As discussed in Section 5.3 of the report, Findings and Observations noted during the course of this review have raised issues which are currently subject to additional verification. While the safety significance of the noted issues has been assessed relative to topics within the scope of this report, the intent of the ongoing verification activities is to determine whether or not these issues have potential broader implications that may affect other design features of the Midland plant. We will report on the results of these investigations in our final report.

The draft report will be finalized upon receipt of Midland project comments. These comments will be appended in unedited form, and all changes to the body of the report will be appropriately identified.

Should you desire further clarification of the bases for our conclusions, we would welcome the opportunity for discussion.

Sincerely,

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SUBJECT

Draft Interim Technical (Topical) Report on the Midland Auxiliary Feedwater (AFW) System Performance Requirements

PURPOSE

This draft report has been prepared within the Independent Design Verification Program (IDVP) of the Midland Independent Design and Construction Verification Program (IDCVP) as partial fulfillment of IDCVP objectives. The report documents the IDVP review process and conclusions related to the adequacy of the design of the auxiliary feedwater (AFW) System Performance Requirements as defined in the Midland IDCVP Engineering Program Plan (PI-3201-009 of the Project Quality Assurance Plan). Upon receipt of CPC and NRC comments to clarify factual information, the draft report will be finalized and will serve as input into the IDCVP integrated assessment and final report preparation.

SOURCES of INFORMATION and REFERENCES

As noted on table, "References/Sources of Information" (Attachment B of PI-3201-001, Rev. 2), of Engineering Evaluations PI-3201-001, -002, -003, -004, -005, -006, -008, -010, -013, -014, -015, -016, -017, -019, -020, -021, -028, -029, -030, -033.

(May Be Continued On A Separate Sheet)

TERA CORPORATION

MIDLAND NUCLEAR PLANT

INDEPENDENT DESIGN AND CONSTRUCTION VERIFICATION PROGRAM

AUXILIARY FEEDWATER SYSTEM PERFORMANCE REQUIREMENTS

June 15, 1984

B-83-465

TERA CORPORATION

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APPENDIX A

NOMENCLATURE

Abbreviation	Term
ac	alternating current
A-E	architect-engineer
AFW system	auxiliary feedwater system
AFWAS	auxiliary feedwater actuation system
ANS	American Nuclear Society
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASP	auxiliary shutdown panel
ATOG	anticipated transient operator guidelines
ATWS	anticipated transients without scram
AWG	American Wire Gage
B&W	Babcock and Wilcox
BOP	balance of plant
CCP	Construction Completion Program
CFR	Code of Federal Regulations
CIO	Construction Implementation Overview
CPC	Consumers Power Company
CRAVS	control room area ventilation system
CR-HVAC	control room heating, ventilating, and air conditioning

NOMENCLATURE
(Cont.)

Abbreviation	Term
CRIS	control room isolation system
dc	direct current
DG	diesel generator
DGB	diesel generator building
ECCAS	emergency core cooling actuation subsystem
ECP	Engineering Control Procedure
EPP	Engineering Program Plan
ESF	engineered safety features
ESFAS	engineered safety features actuation system
FOGG	feed only good generator
FSAR	Final Safety Analysis Report
GDC	General Design Criteria
ICVP	Independent Construction Verification Program
IDCVP	Independent Design and Construction Verification Program
IDVP	Independent Design Verification Program
IE	Office of Inspection and Enforcement, NRC
IEEE	Institute of Electrical and Electronics Engineers
IMAP	Independent Management Appraisal Program
IPCEA	Insulated Power Cable Engineers Association

NOMENCLATURE
(Cont.)

Abbreviation	Term
LTR	Lead Technical Reviewers
MAC	Management Analysis Company
MCAR	Management Correction Action Reports
MCR	main control room
MFW System	main feedwater system
MWe	megawatt electric
MWt	megawatt thermal
NDE	nondestructive examination
NPSH	net positive suction head
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
OCR	Open, Confirmed and Resolved Item Reports
PDS	power distribution system
PI	project instruction
P&ID	piping and instrument diagrams
PIC	principal-in-charge
PQAP	Project Quality Assurance Plan
PRA	probabilistic risk assessment
PWR	pressurized water reactor
QA	quality assurance
QC	quality control
QAP	Quality Assurance Program

NOMENCLATURE
(Cont.)

Abbreviation	Term
QVP	Quality Verification Program
RCP	reactor coolant pump
RCS	reactor coolant system
RG	Regulatory Guide
RPSA	Request for Piping Stress Analysis
SCRE	Safety, Concern, and Reportability Evaluation
SEP system	standby electric power system
S/G	steam generator
SSE	safe shutdown earthquake
SRP	Standard Review Plan
SRT	Senior Review Team
S&W	Stone and Webster Engineering Corporation
TDI	Transamerica Delaval Incorporated

PREAMBLE

This topical report is part of a series of reports that will document the Midland Independent Design and Construction Verification Program (IDCVP) review process and conclusions. Verification activities are ongoing and this report represents partial fulfillment of the objectives of the IDCVP. An integrated assessment will follow which will combine the specific topical report reviews into general conclusions, considering both the specific and potentially broader implications of documented Findings.

TERA Corporation has not reviewed all aspects of the Midland Energy Center design or construction as the approach selected relies upon sampling. The IDCVP methodology has been structured to provide increased confidence that safety-significant deficiencies are detected within the scope of review. Other verification programs provide oversight of essentially all elements of the Midland project completion cycle. Accordingly, the complete set of programs and the NRC regulatory program are collectively directed to verify that the Midland plant has been designed and constructed in conformance with NRC regulations.

1.0 EXECUTIVE SUMMARY

The Auxiliary Feedwater (AFW) System Performance Requirements report is the first of six topical reports that document the Midland Independent Design Verification Program (IDVP). This report describes the review process and results of the review related to AFW System Performance Requirements such as operating limits, hydraulic design, heat removal capability, and instrumentation and control design. Future reports will be issued to address similar System Performance Requirements for two other systems, the standby electric power (SEP) system and the control room heating, ventilating and air conditioning (CR-HVAC) system. Two additional reports will address review topics associated with System Protection Features and Structures Housing the Systems that are generic to all three systems. A final report will provide an integrated assessment of the IDVP results. A subsequent set of reports will address the Midland Independent Construction Verification Program (ICVP).

Bechtel, the architect-engineer for Midland, essentially performed all of the AFW system design; however, an important AFW design interface exists between Bechtel and Babcock & Wilcox (B&W), the nuclear steam supply system (NSSS) vendor. This design interface was reviewed within the IDVP. The IDVP review process followed the requirements set forth in the Project Quality Assurance Plan (PQAP) and Engineering Program Plan (EPP), which had been previously accepted by the NRC staff. This review process sampled the design adequacy using a set of important design topics, each representing typical engineering design areas. Each topic was, in turn, reviewed to levels of detail appropriate for verifying a comprehensive sample of the AFW system design activities.

Design criteria and commitments for the AFW system were systematically reviewed and compiled for all safety-related design activities associated with the AFW system. The IDVP evaluation determined that the AFW system design criteria were occasionally difficult to identify and often required clarification to resolve inconsistencies and to confirm which criteria and commitments govern the design. It was also noted that a comprehensive set of design criteria are not centrally maintained, which may affect proper implementation of criteria;

however, when considered collectively, the AFW design criteria were found to be sufficiently complete and detailed to allow implementation.

The Consolidated Criteria and Commitments List prepared by the IDVP as part of the evaluation described above was used in the evaluation of selected design activities. These evaluations were directed into specific design topics and resulted in identification of design concerns in the form of Open Items, Observations, Confirmed Items, and Findings. Open Items are concerns requiring additional review; Observations are minor discrepancies not constituting design errors but needing correction or further review by the Midland project; Confirmed Items are apparent design errors; and Findings are verified design errors. The IDVP review methodology for the AFW System Performance Requirements and identified review concerns and their resolutions are described in this report for each design topic.

Review results are summarized and evaluated for certain generic implications. The significance of the review results varied considerably, from no review concerns being identified for a large portion of the topics, to one Finding requiring a design change. Except for this one Finding, the IDVP concluded that the AFW system would have met its design objectives without any modifications.

Most of the Confirmed Items resulted from the lack of specific project design criteria documents and discrepancies among project documents. Had the assumptions and design bases for the AFW system been clearly specified, many concerns would not have been identified. Lack of centralized design criteria documents may lead to potential conflicts among project documents because it is not always clear which document is controlling. While the FSAR is often the controlling criteria document or design basis for nuclear plants, it also serves to summarize different and specialized analyses requested by NRC. After multiple amendments, it is sometimes difficult to determine whether an FSAR statement is a design basis for the plant or simply documentation of an analysis to other, often differing, design bases without a specific commitment to implementation.

Lack of documentation for certain analyses, such as the single failure and failure modes and effects analyses, also affected the IDVP review. No design errors were found as a result of the IDVP confirmatory analysis, which indicated that the process used by the Midland project produced acceptable results, although more documentation would have been desirable.

A number of the Observations resulted from minor errors identified in calculations. While these did not affect the actual design, some were obvious enough that they should have been found and corrected in the engineering review and checking process.

The three Findings identified have different levels of significance. A Finding associated with the lack of dc-backed power for certain relays (F-012) was clearly the most significant because the AFW system would not have performed its safety function for the station blackout event had the error not been identified and corrected by either the IDVP review process or plant preoperational testing. The cause of this error may relate to how evolving regulatory criteria are adopted and implemented by the Midland project. A second Finding required an FSAR revision to accurately reflect the AFW system design basis (F-018) but was less significant than F-012 since it did not affect the ability of the AFW system to perform its safety function. The Finding also raised a generic concern regarding the adequacy of implementation of the balance-of-plant (BOP) interface criteria. The third Finding (F-043) had no safety significance because it was subsequently determined that a design error did not, in fact, exist.

Based upon the IDCVP evaluation of all Observations, Confirmed Items and Findings for generic implications, several general concerns were identified which will be considered further in ongoing IDCVP activities and in a subsequent report. Specifically, the lack of centralized design criteria documents, the implementation of criteria for BOP interface with the nuclear steam supply system, implementation of evolving regulatory requirements, and the nature and extent of calculational errors are being evaluated to determine whether these items could result in safety-significant deficiencies.

Verification activities for the other IDVP systems and review topics have been augmented to address these concerns to assure that no safety-significant design deficiencies remain undetected. A subsequent IDVP report will address the evaluation of these general concerns.

After consideration of the corrective action taken by CPC in response to the noted Findings, it is concluded that the AFW system performance design requirements as defined by the scope of this report have been met. The noted design error associated with operation during a blackout event may have been found during system testing, although this could not be verified by the IDCVP project team.

2.0 INTRODUCTION

2.1 BACKGROUND AND SCOPE

TERA Corporation is managing and implementing the Midland Independent Design and Construction Verification Program (IDCVP). On May 3, 1983, the NRC approved the selection of TERA and TERA's Engineering Program Plan (EPP) for evaluating the auxiliary feedwater (AFW) system.

On July 22, 1983, the NRC issued a letter approving TERA's IDCVP Project Quality Assurance Plan (PQAP) and EPP for two other systems, the standby electric power (SEP) and the control room HVAC (CR-HVAC). A summary of the IDCVP including the EPP and PQAP are presented in Appendix A.

Figure 2-1 shows the interrelationship between the design and construction process and corresponding categories of review within the IDCVP scope. When these categories of review are combined with a listing of design/construction topics, a matrix is formed which is utilized to provide direction for the IDCVP. The design review matrix is divided into three major divisions: System Performance Requirements, System Protection Features, and Structures that House the System.

The scope of this report addresses the system performance requirements for the AFW system. System Performance Requirements include elements of the design specifically related to how the primary functional requirements such as system operating limits, hydraulic design, heat removal capability, and instrumentation and control are met.

A key element in the conduct of the AFW system evaluation is the Independent Design Verification Program (IDVP) sample review matrix. The development of the matrix and the scope addressed by this report are presented in Section 3.0. The interface between the IDVP for the AFW system and the Independent Construction Verification Program (ICVP) is also discussed in Section 3.0.

INTER-RELATIONSHIP BETWEEN THE MIDLAND DESIGN AND CONSTRUCTION PROCESS AND THE MIDLAND IDCV PROGRAM

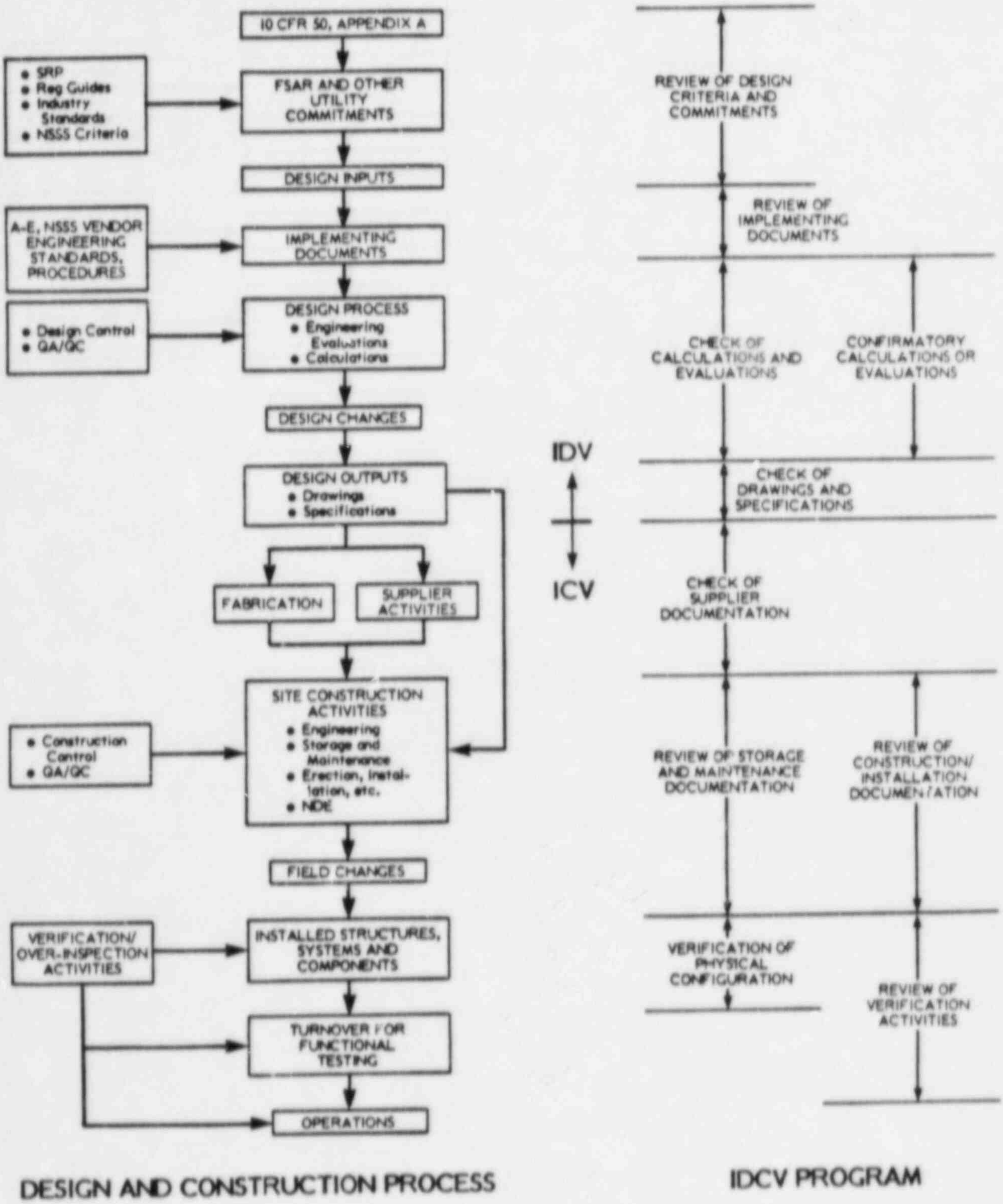

FIGURE 2-1

This draft report on the AFW System Performance Requirements is the first in a series of topical reports, which are intended to summarize important elements of the IDCVP evaluation process and conclusions. Two future reports are comparable to this report in that they will address the system performance requirements of the SEP and CR-HVAC systems.

Three other reports are also planned. A report on System Protection Features will address the engineering evaluations, studies, and other activities which affect the AFW, SEP and CR-HVAC systems and which are typically interdisciplinary in nature. Topics such as Fire Protection, Environmental Qualification, Technical Specifications, and Systems Interaction will be addressed in the System Protection Features report for the three selected systems.

A report on Structures Housing the Systems will address the civil/structural aspects of the design. Topics such as Concrete and Steel Design, Seismic Design and Foundations will be addressed in this report for the three selected systems.

The last report in the IDVP will provide an integrated assessment of the five previously identified topical reports and include development of summary conclusions.

This report has been transmitted to the IDCVP Service List providing an opportunity for Consumers Power Company (CPC), NRC, and the public to review its contents. The report will be finalized upon receipt of CPC comments, which will be appended in unedited form as Appendix B. CPC's review and comments are intended to verify and clarify facts and source data. Any changes to the body of the report resulting from CPC clarification of facts and source data will be identified in the margins of the final report.

2.2 DESIGN VERIFICATION METHODOLOGY

2.2.1 REVIEW OF DESIGN CHAIN

The normal course of a nuclear plant design project begins with the identification of fundamental performance requirements and the specification of design criteria. These design criteria are then further developed and refined as commitments are made during the licensing process. Documents that translate these criteria and commitments into final design documents are termed implementing documents in this report. As the design process continues, calculations are performed and eventually design outputs, such as drawings and specifications, are produced. The IDVP sampled design products associated with each of these stages. After the design outputs are sufficiently complete, construction, fabrication and installation activities begin, using design outputs as the basis for proceeding. The construction process is reviewed by the ICVP portion of the IDCVP which verifies the quality of the physical plant. Figure 2-1 presents the IDCVP process in graphic form and compares it with the overall design chain. As may be seen in this figure, the IDCVP parallels the design and construction activities. Thus, the design process can be related to the IDCVP process, which in turn is related to the review matrices (Figures A-2 through A-10 of Appendix A). These representations have been simplified in that the iterative nature of design and construction is not explicitly presented in the diagram. The activities shown for the independent design and construction verification program relate to the scope of verification shown in the IDCVP sample review matrices.

2.2.2 DESIGN ORGANIZATIONS AND INTERFACES

The three principal organizations involved in design of the Midland project are:

- o Consumers Power Company (CPC)
- o Bechtel Associates Professional Corporation (Bechtel)
- o Babcock & Wilcox Company (B&W).

CPC is the owner of the plant and primarily functions during the design and construction of the plant as overall manager of the project, including review and approval of primary design and construction activities of Bechtel, B&W, and other major contractors. Bechtel is the architect/engineer/constructor for the project and as such performs the vast majority of the design and construction activities, most generally those associated with the balance-of-plant (BOP) scope. B&W, as nuclear steam supply system (NSSS) vendor, is responsible for the supply and fabrication of the reactor, steam generators, and reactor coolant system including pumps and certain other components. Additionally, B&W identified the criteria to which the BOP (i.e., all systems, components and structures other than that within the NSSS scope) must be designed to adequately interface with the NSSS. All three principal organizations have additional subcontractors and consultants who have responsibility for smaller portions of the project. For example, CPC has used the services of companies such as Pickard, Lowe, and Garrick, NUTECH, NUS, and M. Jones to perform certain engineering evaluations and studies. A subsequent report will address the use of service contractors in more detail.

The major organizational interfaces which affected AFW system design were between Bechtel and B&W and between CPC and Bechtel. The scope of the design and construction verification programs has been structured primarily to review the end products of the design process. Consequently, the scope did not specifically focus on an investigation of the processes by which interfaces between design organizations were controlled; however, the effectiveness of these interfaces was tested by the IDVP review. For example, the IDVP reviews whether the outputs of the transmitting organization are properly received and interpreted by the receiving organization. In the process of performing the IDVP end product reviews, if a potential breakdown is identified, appropriate interfaces are examined in greater detail. Of particular note, the IDVP included a review of criteria supplied by B&W. Upon performing that review, it became necessary to review the Bechtel/B&W interface further to ensure that appropriate design criteria were identified and properly used in the design process. A subsequent report will address the B&W/Bechtel interface in more detail.

The CPC/Bechtel interface primarily consisted of reviews of Bechtel design proposals by CPC where several design alternatives were available. Bechtel typically presented those options to CPC together with its recommendations. In the case of the AFW system, CPC also utilized the services of Pickard, Lowe and Garrick to perform a reliability evaluation of the AFW system.

The primary basis for the interface between Bechtel and B&W for the AFW system was through the B&W BOP criteria document. This document specified the necessary parameters that the Bechtel design for the AFW system must meet in order to be compatible with the NSSS. As such, this document provided the basic ground rules for system design and functions as an important input to the design verification. The evolution of the design criteria presented in this document requires special review because the criteria were being finalized and verified after much of the system had been designed, fabricated, and installed. It is noted that this finalization/verification process is also continuing in other interface areas. The AFW situation is therefore typical of the B&W/Bechtel interface and deserves attention to ensure that the IDVP and ICVP appropriately consider ongoing activities. A subsequent report which considers the B&W/Bechtel interface in more detail will also address the adequacy of the implementation of B&W BOP criteria.

2.2.3 OVERVIEW OF REVIEW PROCESS

2.2.3.1 SEQUENCE OF REVIEW

The review process began with a data collection phase. Meetings were held at the Midland site, at the CPC offices in Jackson, Michigan, and at the Bechtel offices in Ann Arbor, Michigan, to obtain documents from the files and to interview selected personnel to determine the design-related information applicable to the AFW system. The IDCVP chronology from inception is documented in IDCVP monthly status reports, which are distributed to the service list. Subsequent visits to Ann Arbor were made in order to review additional data, review documents which were too voluminous to warrant reproduction, and to obtain information pertinent to the disposition of identified issues. Using the data thus obtained, the IDCVP project team identified design criteria and commitments and performed reviews of calculations and evaluations. The need for confirmatory calculations or evaluations was identified as denoted in Figure A-2 and documented in accordance with instructions in the PQAP. When items requiring further review were identified, Open Items were prepared in accordance with the PQAP. The documentation method for Confirmed Items, Findings, and Resolutions is summarized in Appendix A to this report and is also presented in detail in the PQAP. Confirmed Items are apparent errors in the design and Findings are verified errors in the design. Observations are minor discrepancies which do not constitute design errors, but which the IDVP recommends for correction or further review by CPC or Bechtel. Confirmed Items and Findings and their resolutions are documented in the IDCVP monthly status reports.

Confirmed Items were discussed at publicly noticed meetings with CPC, Bechtel, and the NRC. B&W also attended several meetings. Although these meetings were open to the public, members of the public attended none of the meetings. Confirmed Items generally resulted in the identification of the need for additional information which was reviewed and a subsequent determination made of whether or not the Confirmed Item should be Closed, Resolved or converted into a Finding. Findings remain open until a satisfactory resolution plan is developed. A formal response by CPC is required for all Findings, which generally resulted in changes to either key project documentation (such as the FSAR) or physical changes. At a time that the IDVP is satisfied with the Project's disposition of the Finding, a Finding Resolution Report is prepared. Findings associated with the scope of review for this report are discussed in Section 5.0. The evaluation of Confirmed Items is documented in the IDCVP monthly status reports.

2.2.3.2 APPROACH TO VERIFICATION

The sample review matrix for the AFW system consists of five categories of review, which are discussed in detail in Appendix A. The application of these categories of review to the AFW system is discussed below.

Review of Design Criteria and Commitments

All of the design areas listed in the matrix were reviewed for design criteria and commitments. The principal sources of criteria and commitments are the FSAR, 10 CFR 50, and the B&W BOP criteria document. These documents, related correspondence, and other subtier documentation were reviewed and criteria and commitments applicable to the AFW system were extracted, listed on topical checklists, and later compiled by the IDVP into a Consolidated Criteria and Commitments List. The Consolidated Criteria and Commitments List is presented in Appendix C to this report. The identified criteria included quality assurance criteria such as Regulatory Guides 1.28 and 1.64. No overall AFW system design criteria document exists other than the FSAR.

Review of Implementing Documents

For the purposes of this report, the primary implementing documents were the piping and instrument diagrams (P&IDs), the flow diagram, and electrical logic diagrams. These implementing documents were reviewed against the previously evaluated design criteria and commitments. Additionally, where appropriate, the implementing documents were checked for internal consistency and for consistency between the documents. Although the IDVP is not intended as a process (QA) review, the reviews of implementing documents, calculations, etc., made note of quality assurance discrepancies such as a lack of approval signatures.

Check of Calculations and Evaluations

Selected Midland project calculations and evaluations were reviewed using the design criteria, commitments, and implementing documents as standards against which the calculations were verified; e.g., a calculation would be reviewed for consistency with the design criteria. Calculational inputs, which were obtained from implementing documents, and calculational outputs, which appear on implementing documents, were checked to verify that such information was appropriately transferred. Other calculation review considerations include those identified in N45.2.11.

Confirmatory Calculations and Evaluations

In some cases, it was decided to prepare confirmatory calculations or evaluations. The purpose of performing such calculations or evaluations was to provide an independent method for verifying the appropriateness of the results of calculations and evaluations performed in the design process. Two types of confirmatory calculations and evaluations were used in the IDVP. The first type was the situation where an area was pre-selected for a "blind" calculation or evaluation for which the person performing the confirmatory calculation or evaluation selected the calculational method of evaluation, certain input data, and assumptions that he considered appropriate without prior knowledge of the project's approach. The second type was a situation where the project's approach required in-depth verification based upon initial review results. In the latter case, the calculation was repeated by the IDVP using those aspects of the project approach considered acceptable. The conclusions reached in performing the confirmatory analyses were then compared against the results obtained in the original design calculations and evaluations.

Confirmatory calculations were prepared to determine the required heat removal capability for the AFW system and the volume of water required to remove that quantity of heat. Additionally, a calculation was performed in the process of reviewing the system overpressure protection provisions and a confirmatory single failure/failure modes and effects evaluation was developed. All of these calculations and evaluations were performed for the purpose of additional verification. Blind calculations for the AFW system review were selected to be performed for topics outside the scope of this report and will be discussed in a subsequent report.

Check of Drawings and Specifications

Selected drawings and specifications were reviewed in verifying aspects of AFW system performance requirements. Drawings included piping isometrics, electrical schematics, electrical single-line diagrams, equipment arrangements, and cable routing diagrams. The primary purchase specifications for the AFW pumps and drivers and the level control valves were reviewed. The design specification for the AFW pumps required by Section III of the American Society of Mechanical Engineers (ASME) code was reviewed. Other Bechtel specifications, such as the piping class sheets, were also reviewed. Vendor submittals such as outline arrangement drawings, pump test curves, and operating manuals were also reviewed. The drawings and specifications were compared against each other to determine the consistency of these documents. They were also reviewed against design criteria, implementing documents, and calculations, as appropriate, to evaluate the implementation of the outputs of those steps in the design process for the purchased components.

3.0 AUXILIARY FEEDWATER SYSTEM SELECTION AND DESCRIPTION

3.1 SELECTION OF AUXILIARY FEEDWATER (AFW) SYSTEM

This section describes the selection of the AFW system for the Independent Design Verification Program (IDVP). The first criterion used for system selection was the system's importance to safety. The AFW system is an important system in that it performs an essential heat removal function under a variety of conditions including expected operational transients and emergency conditions. Probabilistic risk studies frequently indicate that AFW systems have a high degree of importance to the overall safety of a nuclear power plant.

The inclusion of design and construction interfaces was also an important consideration in system selection. For the AFW system, an important design interface occurs between the reactor vendor, Babcock & Wilcox (B&W), and the architect-engineer, Bechtel. The reactor vendor normally will impose interface requirements on AFW systems to which the architect-engineer (A-E) must respond. In contrast to emergency core cooling systems, which are largely within the scope of the reactor vendor, AFW systems involve the establishment of criteria by the reactor vendor and implementation by the A-E. Because of this interface, the residual heat removal function performed by the AFW system is a unique situation in the design of nuclear power plants. The construction interface considerations in the selection of the AFW system will be discussed in a separate report on the Independent Construction Verification Program (ICVP).

Also important to the selection of systems for inclusion in the IDVP was the ability to extrapolate results. The IDVP is based upon sampling of a limited number of systems and then extrapolating the results to the remaining systems. Thus, it is important that the systems selected contain attributes which are appropriate for extrapolation. The AFW system, which is a safety-related system, has a number of characteristics which enhance the ability to extrapolate results. First, as noted above, this system examines the interface between the A-E and the reactor vendor. Second, the system has both normal and emergency uses. This allows consideration of factors such as the interface between safety-related and nonsafety-related portions of systems and operational considerations. Third, the AFW system has a complex control system which provides a test of the design of such subsystems. Other factors concerning the ability to extrapolate results include the fact that the AFW system has both water and steam portions, provides a test of the interface between the power distribution system and powered components, includes portions of the system inside and outside containment, and has both ac and dc powered components. Furthermore, the AFW has design criteria which are common to all safety-related systems and has been subject to evolving design requirements. The engineering disciplines used in the design of the AFW system represent a broad spectrum of those used in the design of a nuclear plant. All of these factors enhance the ability to extrapolate results and, accordingly, were important considerations in the selection of the AFW system.

Previous experience has shown that the AFW systems have had a number of operating problems and have features which present design and construction challenges to the nuclear industry as a whole. For example, B&W has changed the design of the AFW discharge header at the steam generator due to problems at operating plants. The Midland plant incorporates this change. Other historic problems with AFW systems have included the potential overpressurization of suction lines (which occurred at an operating plant and which Bechtel concluded could affect the Midland plant), and previous Midland plant problems meeting with the station blackout criteria. Furthermore, the unavailability of the AFW system played a role in the Three Mile Island accident. On a more general level, the AFW system includes equipment and design considerations that have resulted in problems both for the industry and the Midland project. Therefore, this prior experience provided a basis for selection of the AFW system.

The final system selection criterion was the ability to test the as-built installation. Substantially all of the major components for the Midland AFW system are currently installed. While all piping connections have not yet been completed, the installation of the pumps, valves, and most piping is completed.

Using the above criteria and considerations, the AFW system was determined by the IDVP to be an appropriate system for inclusion in the IDVP.

3.2 AFW SYSTEM INTERFACE WITH OTHER ASPECTS OF THE IDCVP

The AFW system shares interfaces with the two other systems in the IDVP. The standby electric power (SEP) system provides the ac and dc power required to operate AFW components and to allow control of the system. The SEP also supplies essential power to the control room HVAC (CR-HVAC) system. Nearly all of the AFW system is located in the auxiliary building as is the control room, the CR-HVAC, and portions of the SEP system. Thus, the AFW system shares interfaces with both of the other systems within the IDVP.

The existence of these interfaces improved the effectiveness of the IDVP by allowing the review to consider the design interfaces between systems and structures more directly than would have been the case had certain other systems been selected. In the sample selection process for the other two systems, due consideration was made of review areas that would be adequately covered in the AFW system review. In such cases the review was limited to a confirmation of the applicability of the AFW review to the other systems. This allowed concentration on those topics that were unique and those topics for which the AFW review indicated the need for a larger or more focused sample.

Two major segments in the interface between the IDVP and ICVP which affect the AFW system evaluation are the component interface and construction/installation interface. The component interface was constructed so that design verification activities at the component level (e.g., reviews of specifications, environmental qualification, and seismic qualification) made use of the same sample of components which are used in the construction verification program. This approach creates a common thread between the two programs such that the IDCVP can determine the adequacies of interfaces in the design/construction process of a component from conception through testing for service.

The construction/installation interface provided a method that allowed verification of identity, dimensional verification, inspection, and testing in the field to be fed back into the IDVP. For example, dimensions taken in the field were used in the performance of an independent confirmatory piping analysis by the IDVP. In this manner, the Independent Design and Construction Verification Program (IDCVP) has the ability to directly verify the significance of potential as-built differences in design.

3.3 AFW SYSTEM DESCRIPTION

The AFW system provides several functions for the Midland Plant. The most significant of these is the supply of water to the steam generators during periods when normal feedwater is unavailable. Typical transients which require the use of the AFW system include loss of offsite power and load rejection events. The AFW system also is used for normal startup and shutdown of the plant. Additionally, the AFW system functions as the sole means of cooling the plant during a postulated station blackout condition as discussed below. Because of this variety of functions, the AFW system has both redundant and diverse features, and a large number of specific operating conditions or modes must be accounted for in the design of the system. Figure 3-1 is a simplified flow diagram for the system.

The flow diagram presents the major piping, pumps, water supplies, and major valves associated with the system. For purposes of clarity in presentation most check valves, manual gate valves, and other miscellaneous valves have been deleted from the diagram. Valve positions for various modes of operation are presented in Table 3-1. The AFW system consists of two auxiliary feedwater pumps. One pump (identified as 2P-05A) is a motor-driven pump. The other pump (identified as 2P-05B) is a turbine-driven pump. Except for the driver, these pumps are essentially identical. The AFW system has the capability of taking suction from a number of sources. A seismic Category I essential water supply is provided by the service water system. During startup and shutdown, the preferred source of water is from the deaerator storage tank. For expected

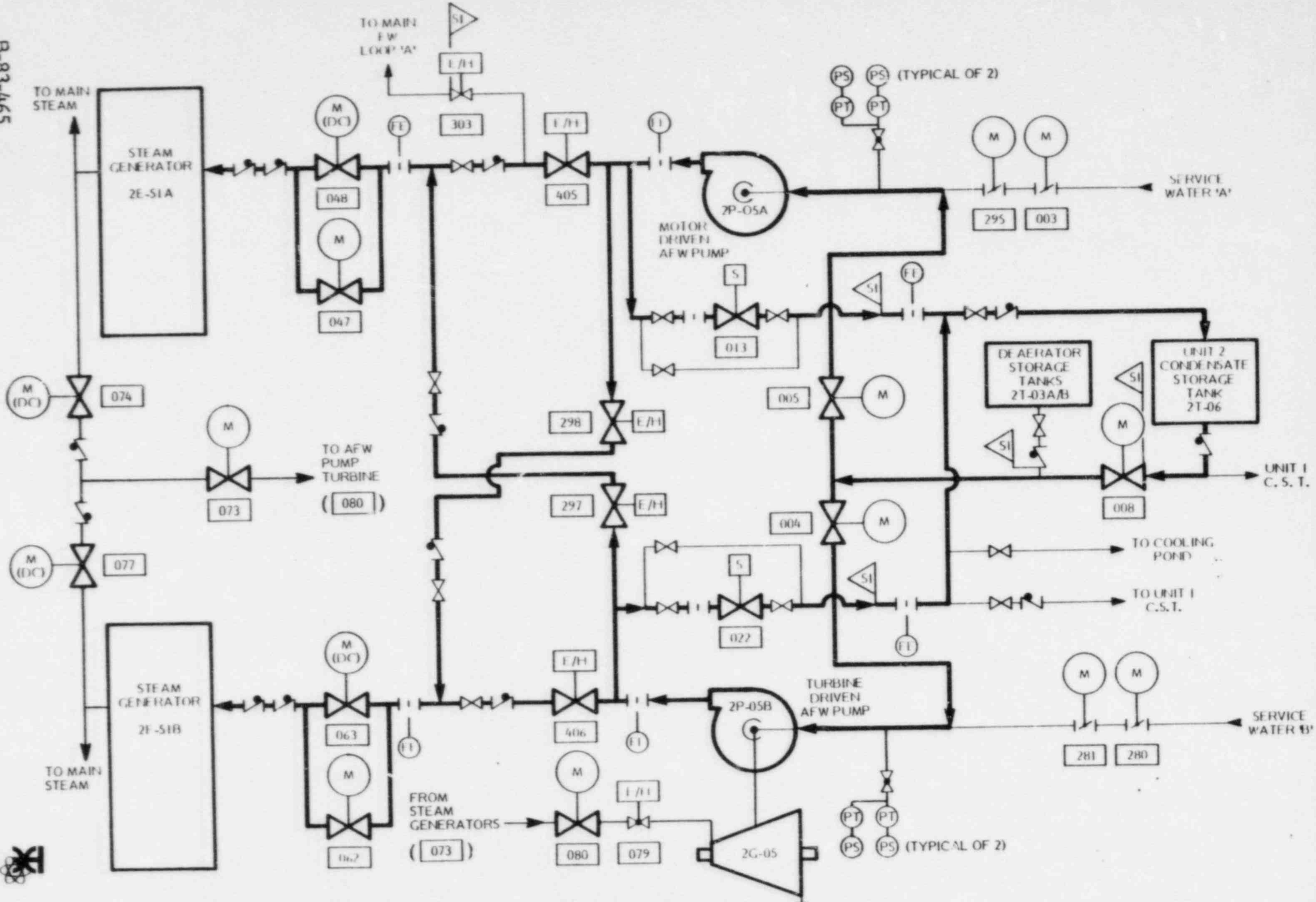

FIGURE 3-1

SIMPLIFIED AUXILIARY FEEDWATER FLOW DIAGRAM

TABLE 3-1

MIDLAND UNIT 2
AUXILIARY FEEDWATER SYSTEM
VALVE POSITION TABLE

		Operating Mode				
Valve No.	CPC Valve No.	Startup[1]	Shutdown[2]	Emerg.[3] (Fm CST)	Emerg.[4] (Fm Svc. Water)	Station[5] Blackout (Fm CST)
003	2MO3993A1	C	C	C	O	C
004	2MO3968B	O	O	O	C	O
005	2MO3968A	O	O	O	C	O
008	2MO3956	O	O	O	O	O
013	2SV3969A	C	C	O/C*	O/C*	C
022	2SV3969B	C	C	O/C*	O/C*	C
047	2MO3970B	C	C	O	O	C
048	2MO3965A	C	C	O	O	O
062	2MO3970A	C	C	O	O	C
063	2MO3965B	C	C	O	O	O
073	2MO3226	O	O	O	O	O
074	2MO3277A	C	C	O	O	O
077	2MO3277B	C	C	O	O	O
079	2SCV3931	C	C	M	M	M
080	2MO3931	O	O	O	O	O
280	2MO3993B1	C	C	C	O	C
281	2MO3993B2	C	C	C	O	C
295	2MO3993A2	C	C	C	O	C
297	2LV3975B2	C	C	C	C	M
298	2LV3975A2	C	C	C	C	C
303	2XV3989	O	O	C	C	C
405	2LV3975A1	M	M	M	M	C
406	2LV3975B1	C	C	M	M	M

O = open; C = closed; M = modulating

* O/C = open or closed depending on flow demand to steam generator.

Operating Mode Descriptions:

1 Motor-driven pump supplying both steam generators via main feedwater/auxiliary feedwater (MFW/AFW) cross-connect from deaerator storage tanks.

2 Same as 2

3 AFW actuation system (AFWAS): Both pumps running -- suction from condenstate storage tank - feed both steam generators

4 AFWAS: Both pumps running -- suction from service water -- feed both steam generators

5 AFWAS: Loss of all site power -- turbine-driven pump only -- suction from the condensate storage tank (CST) -- feed both steam generators.

transients and station blackout, the preferred water supply is from the condensate storage tank. The service water system is used as a backup only if water from the condensate storage tank is not available. The early design of the AFW system provided for suction from the condenser hotwell. This design feature is being disabled because of insufficient available net positive suction head (NPSH). This change has no affect upon the safety-related aspects of the design.

The motor-driven pump is powered from an essential ac bus, which is supplied by offsite power as well as a diesel-generator.

The AFW pump turbine drive receives its power from a main steamline branch which brings high pressure steam to the turbine. Exhaust from the auxiliary pump turbine is vented to the atmosphere. The discharge of the AFW pumps contains level control valves which are intended to control both the level and rate of level change in the steam generator. Four of these valves are provided in order to assure that either pump may feed either steam generator assuming a single failure. An AFW line is provided to each steam generator. Each line has a branch outside contcinment and each branch has a motor-operated isolation valve in it. One of these isolation valves is ac-powered and the other is dc-powered. This arrangement is used to ensure valve operability in the station blackout condition. Inside containment the auxiliary feedwater line is connected to an external ring header on the steam generator, which distributes water directly into the steam generator through penetrations in the shell. This system has provision for testing and is configured to minimize the chance for water hammer. The major piping in the AFW system is 6-, 8-, and 10-inch nominal diameter pipe. Safety-related pressure retaining components are classed as American Society of Mechanical Engineers (ASME) Section III, Class 2 or Class 3, depending upon where it is located in the system. The piping material is ASME SA 106 grade B for safety-related ("Q") piping. Other piping is designed in accordance with the Power Piping Code, B31.1; however, some B31.1 piping has been seismically analyzed when necessary for considerations such as systems interaction.

In the startup mode or shutdown mode, the AFW system takes suction from the deaerator storage tank. Normally, the motor-driven pump is used for startup and either the motor-driven or turbine-driven pump may be used for shutdown. In most cases, the motor-driven pump would be used. During transients when water from the deaerator is not available, the preferred source of water is the condensate storage tank. The condensate storage tank and the line connecting it to the AFW system are not seismic Category I. As a result, a Category I backup source of water is provided from the service water system. In the event of low pressure in the AFW pump suction lines in conjunction with an AFW actuation signal, motor-operated valves in the supply line from the condensate storage tank (e.g., valve 004) are closed and valves connecting the AFW system to the service water system are opened (e.g., valves 280 and 281).

The valves isolating the condensate storage tank line from the rest of the AFW system (e.g., valve 008) are Category I. In the event of a tornado or earthquake which is postulated to cause the loss of the water supply from condensate storage, the service water system provides the needed water source for the AFW system. During transients which cause the loss of normal feedwater, the AFW system preferentially takes suction from the condensate storage tank. When that supply is not available the service water system provides the AFW water source. In either case operation of the AFW system is essentially identical. The logic associated with the automatic transfer to service water is such that an AFW actuation system (AFWAS) signal must be present with the low suction pressure condition in order for the transfer to be accomplished.

The AFW system incorporates a system to control steam generator water level when the AFW system is in operation. The level control system must meet the single failure criterion, operate during the blackout event, and function under a variety of AFW operating modes (e.g., two AFW pumps feeding two steam generators, one AFW pump feeding two steam generators, two AFW pumps feeding one steam generator, etc.). Additionally, the level control system must control steam generator water level (at different levels) for both the forced circulation and natural circulation modes. Because of overcooling considerations, the steam generator rate of fill between the forced and natural circulation modes is controlled. As a result of these considerations, the level control system is fairly complex and received extensive review by the IDVP.

Because of the need for the AFW to supply water only to intact steam generators for postulated pipe breaks, it is necessary that the AFW system be capable of detecting whether a steam generator is "good." The Midland plant uses a feed only good generator (FOGG) system to ensure that AFW flow is provided only to the intact steam generator. The FOGG system must operate in conjunction with the level control system and be capable of functioning for various assumed accidents in conjunction with a single failure. The FOGG system operates using the differential pressure between the steam generators as an input. The higher pressure steam generator is assumed by the FOGG logic to be the "good" generator when a differential pressure between the steam generator exceeds a specified limit.

A special operating mode of the AFW system is the station blackout condition. Under this scenario it is assumed that normal offsite ac power is lost, the main turbine is tripped, and normal onsite power is lost. Furthermore, it is assumed that the plant diesels fail to operate so that no ac power is available. Under this condition only dc power, ac power through inverters from dc power sources, and steam power is available. Because decay heat must be removed from the reactor core, the AFW system must be capable of functioning using only these power sources. In this case the turbine-driven pump is available and the condensate storage tank must provide the necessary water because the service water system does not operate under the assumed blackout condition. In this mode, the turbine-driven pump supplies water to both steam generators, and valves 406 and 297 perform the level control function. For the station blackout case, no other failures are assumed to occur.

Consumers Power Company (CPC) has committed to adding a third AFW pump. Because design of that modification has not progressed to the point where sufficient documentation is available for review, this evaluation only considers the current two-pump design. The third pump, which will only function during startup and shutdown and will not have safety-related functions, is intended to improve AFW system reliability by being available when one of the other pumps is out of service.

Physically, AFW system components are primarily located at the 584 ft elevation in the auxiliary building. The AFW motor-driven and turbine-driven pumps are each located in separate rooms at this elevation. Much of the piping and three of the four-level control valves are located in areas immediately outside of these rooms. From this location AFW piping passes through a penetration area into the containment and rises to its discharge into the steam generator at approximately elevation 656 ft. The service water pumps are located in the service water pump structure and the condensate storage tank is located outdoors.

Shortly before completion of this report, CPC announced that it was considering completion of only Unit 2 at Midland. This decision will affect certain aspects of the the design, but will not directly affect the AFW system as defined in the IDVP Engineering Program Plan. The service water system shown in Figure 3-1 is shared by both units; however, its review has not been included in the IDCVP.

3.4 AFW SAMPLE SELECTION

3.4.1 BASES FOR SAMPLE SELECTION MATRIX

The system selection criteria discussed in Section 3.1 of this report also guided the selection of specific structures, components, or commodities to be reviewed within each area of the IDVP, as well as the depth of the review in deciding the number and types of design documents sampled. In general, the selection was based on engineering judgment. The bases for these judgements are documented in IDVP engineering evaluations. The sample selected for review appropriately considers information resulting from previous reviews of the AFW system and the project design processes. In order to make use of this information a review was made of 10 CFR 50.55e reports filed by CPC, Safety Concern and Reportability Evaluation (SCRE) reports, Management Corrective Action Reports (MCAR), and NRC documentation such as inspection reports and IE bulletins. Areas experiencing repeated problems within the industry or specifically on the Midland project, areas previously receiving less intensive reviews than other areas, and areas where Findings were identified were all candidates for increased sampling of documentation or components. Of particular relevance was a MCAR concerning the failure to properly power components from battery-backed power sources. This led to a potential inability of the AFW system to respond to the blackout event, which is a design requirement for the system. This concern led to specific considerations within the development of the sample review matrix for the AFW system. The sample of design documents selected are considered to be sufficiently broad to present a representative sample of the AFW system.

3.4.2 MODIFICATION OF SAMPLE REVIEW MATRIX

In the course of performing the engineering evaluations and review the design of the AFW system, several changes were made to the matrix. As shown in Figure A-2 of Appendix A, the initial sample review matrix for the AFW was modified in the following respects: Topic 1.2-1, Accident Analysis Considerations, was modified to add a review of implementing documents as well as a review of design criteria and commitments. This modification was determined to be necessary because of the interrelationship between design criteria and implementing documents with respect to this topic. Topic 1.3-1, Single Failure, was modified to include a confirmatory evaluation performed by the IDVP. This addition was due to the lack of a formalized and documented single-failure evaluation for the AFW system. As is the case with some other design organizations, Bechtel procedures for Midland are such that single-failure evaluations are performed on an ongoing project basis as opposed to a clearly identified single-failure evaluation with detailed documentation. Similarly, Topic 1.23-1, Failure Modes and Effects, was added to account for a similar lack of documentation available for ready review. The Failure Modes and Effects review consisted of a review of criteria and commitments, a review of implementing documents, and a confirmatory evaluation.

Topic 1.8-1, Overpressure Protection, was expanded from a design criteria and commitments review to a more detailed review for two reasons. First, apparent discrepancies were found in some of the documentation concerning overpressure protection. These are discussed in Section 4.0 of this report. Second, MCAR 55 was issued as a result of operating experience at a nuclear power plant. This experience indicated the potential for overpressuring the suction line of an AFW system. Bechtel determined that a similar event could occur at the Midland plant, and consequently the IDVP expanded its review to determine the considerations and resolution being applied by Bechtel and CPC to this MCAR. In Topic 1.10-1, System Hydraulic Design, and Topic 1.11-1, System Heat Removal Capability, confirmatory calculations were performed due to apparent discrepancies in key parameters. These confirmatory calculations are discussed below. Topic 1.16-1, Electrical Characteristics, added reviews of implementing documents and checks of calculations in order to ensure an adequate review. For Topics 1.19-1, Control Systems, and Topic 1.20-1, Actuation Systems, a check of drawings and specifications was added to ensure proper consideration of important aspects of the control systems associated with the AFW system.

An important use of the sample review matrix was to focus the review effort. The sample review matrix allowed IDVP reviewers to concentrate their reviews in a logical and consistent manner. The comprehensive review of criteria and commitments ensures that these fundamental bases for the system design are adequately reviewed. Based upon the results of that review a more focused sample could be selected for implementing documents and calculations. Finally, those documents in turn aided in the selection of drawings and specifications for review. As discussed above, the sample review matrix was expanded as the review progressed depending upon the results of the reviews.

3.4.3 DETAILED COMPONENT MATRICES

Using the sample selection criteria discussed in Appendix A, and the design criteria and commitments which were identified, a sample of components was selected for the review. These components represent an important interface between the IDVP and the ICVP because a common sample was sought to track the influence of the full project completion cycle on specific components. Where calculations and implementing documents needed to be selected from a number of potential candidates, those calculations, evaluations, and implementing documents associated with equipment on the detailed component review matrices were preferentially selected. However, in some cases the judgment of the reviewer indicated that other calculations evaluations or implementing documents would be more appropriate given the objectives of the IDVP.

4.0 AUXILIARY FEEDWATER SYSTEM PERFORMANCE REVIEW

The sample review matrix (Figure A-2 of Appendix A) was used to define the scope of the Auxiliary Feedwater (AFW) System Performance Review. All of the topics shown on that matrix are included in this report except for the following:

Topic	Description
1.4-1	Technical Specifications
1.14-1	Preservice Testing/Capability for Operational Testing
1.21-1	NDE Commitments
1.22-1	Materials Selection

All of these topics, as well as the System Protection Features topics shown in Section II of Figure A-3 (Appendix A) and the corresponding topics for the other Independent Design and Construction Verification Program (IDCVP) systems, will be covered in a subsequent report, Review of Protection Features and Related Topics.

Except for the four topics discussed above, this report section contains summaries of the review scopes shown in Figure A-2 for all of the System Performance topics.

This section is organized into two major subsections: Subsection 4.1 which describes the evaluation of the design criteria applicable to AFW system performance, and Subsection 4.2 which describes the evaluation of the review scopes for those topics on the matrix requiring review activities in addition to the evaluation of criteria. The criteria evaluation subsection discusses AFW system design criteria for all topics. The review topic evaluation subsection is organized based upon specific topics or groups of related topics.

4.1 REVIEW OF CRITERIA AND COMMITMENTS

The review of criteria and commitments applies to all topics in the AFW system performance requirements evaluation. The method of review, described in more detail in Appendix A, is to determine applicable design criteria by reviewing source documents and then evaluating the design criteria against pre-established acceptance criteria. Principal source documents included the balance-of-plant (BOP) interface criteria document prepared by Babcock & Wilcox (B&W) for the AFW system, the FSAR, and NRC regulations. Other sources of criteria included codes and standards referenced by the FSAR and other project documents, NRC regulatory guides and branch technical positions, and other similar documents either referenced in project documents or otherwise known to the members of the IDCVP review team.

Because no central source existed for these criteria (except for the FSAR), a Consolidated Criteria and Commitments List was prepared. This list is included as Appendix C to this report. The Consolidated Criteria and Commitments List provided a mechanism for ensuring that a consistent set of criteria was used by all team members in the performance of the Independent Design Verification Program (IDVP). The IDVP used the Consolidated Criteria and Commitments List to determine the criteria applicable to each specific review topic. The Consolidated Criteria and Commitments List also allowed the identification of potentially conflicting or erroneous criteria and commitments.

4.1.1 CURRENT CRITERIA

Requirements for AFW systems have evolved in the course of the development of commercial nuclear power plants. Because the AFW system has both safety-related and nonsafety-related functions, the design criteria typically includes criteria which have safety significance and criteria which are significant only from a normal operational point of view. Over the period during which the Midland plant was designed, the requirements for AFW systems have increased, particularly in the area of safety-related requirements.

The general design criteria contained in 10 CFR 50, Appendix A, apply to the AFW system in that Criterion 34 covers residual heat removal, which is the primary safety function of the AFW system. This criterion is very general and states that the system shall transfer fission product decay heat and other residual heat from the reactor core at a rate such that acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded. Furthermore, it states that suitable redundancy in components, interconnections, etc., are to be provided to ensure that the safety function can be accomplished assuming a single failure and power from either onsite or offsite sources.

The requirements for the AFW system have been further defined in industry standards such as ANSI/ANS-51.1-1983 (Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants) and ANSI/ANS-51.10-1979 (Auxiliary Feedwater System for Pressurized Water Reactors). These two industry standards were published well after the basic design for the Midland AFW system was complete. The NRC has not formally referenced these standards in regulatory guides or similar NRC documentation, and Consumers Power Company (CPC) has not committed to implementation of these standards. As a result, the fundamental criteria against which the AFW system was reviewed were the General Design Criteria (10 CFR 50, Appendix A) as supplemented and clarified by regulatory guides and standards referenced in the Midland FSAR. The IDVP reviewed the above-referenced criteria and standards, as well as other documents such as the Standard Review Plans and Branch Technical Positions, to establish benchmarks for evaluating the completeness and adequacy of the criteria and commitments for the Midland AFW system.

4.1.2 CONSOLIDATED CRITERIA AND COMMITMENTS LIST

Since the criteria and commitments applicable to the AFW system were not compiled in one document but were found in the FSAR, interface documents supplied by B&W, and NRC regulations, it was determined that a consolidated list of criteria would enhance the review process. This need was recognized because of the overlapping, redundant, and potentially inconsistent criteria and commitments which could be found in these various documents. The Consolidated Criteria and Commitments List was developed by reviewing appropriate sources of criteria and commitments, extracting applicable criteria and commitments, and determining the review topics to which the criteria and commitments apply. The Consolidated Criteria and Commitments List was then used by the IDVP reviewers to ensure consistency in the reviews with respect to the applicable criteria for the AFW system. Furthermore, the Consolidated Criteria and Commitments List was used to identify the existence of potentially deficient, inconsistent, or inadequate criteria. The engineering evaluations performed for the AFW system used the Consolidated Criteria and Commitments List.

4.1.3 EVALUATION

For each engineering evaluation involving a review of criteria and commitments, acceptance criteria were developed for evaluation of the design criteria. The acceptance criteria were developed by IDCVP team members using requirements contained in the Project Quality Assurance Plan (PQAP) and their judgement. The applicable acceptance criteria are documented in each engineering evaluation.

For the review of criteria and commitments, the following general acceptance criteria were used:

- o Consistency of criteria and commitments (i.e., whether the set of criteria and commitments are internally consistent)
- o Completeness of criteria and commitments (i.e., whether the set of criteria and commitments addresses all necessary design areas)
- o Adequacy of detail in criteria and commitments (i.e., whether adequate information is provided to allow implementation).

These acceptance criteria are applicable to all of the review topics.

Additional specific acceptance criteria were developed as necessary to fully evaluate the Consolidated Criteria and Commitments List. Examples of the specific acceptance criteria include:

- o The assumptions used for determining the decay heat which the AFW system must remove should be specified
- o The parameters for determining AFW flow requirements should be provided
- o Criteria for system interfaces should be identified or be capable of being determined.

Using the acceptance criteria and the consolidated criteria and commitments list, the review proceeded in accordance with the PQAP.

The review resulted in the identification of criteria and commitments which were either potentially inconsistent or ambiguous. For example, the FSAR states that the license power level is 2452 MWt, but that "ultimate" power (2552 MWt) is used for accident analyses (with an additional 2% margin for instrument error when conservative to do so). Thus, a potential inconsistency existed regarding the power level upon which the AFW system sizing should be based. Other inconsistencies concerned the water temperature for the AFW system and the method of calculating the plant's decay heat.

The inconsistencies and questions concerning criteria and commitments were identified in the Open, Confirmed, and Resolved (OCRs) Item Reports which were distributed to CPC, the NRC, and the public in accordance with IDCVP procedures. Additional information was obtained and all of the OCRs specifically applicable to the scope of this report were dispositioned. The Consolidated Criteria and Commitments List was amended and annotated to document the disposition of these OCRs. In some cases the OCRs originated because of statements made in the FSAR which were ambiguous as to whether a statement of commitment or design basis was being made, as opposed to a discussion of an evaluation performed to respond to a specific question or concern. Furthermore, parameters which may be conservative in some cases may be considered nonconservative if they were to be used in different circumstances. The IDVP considered these situations in reaching its conclusions regarding the adequacy of the criteria and commitments for the AFW system.

As a result of the review of criteria and commitments and the disposition of OCRs, the IDCVP determined that certain review topics required the application of review scopes in addition to the criteria review initially specified in the review matrix and that certain aspects of the review required additional attention in the reviews of the other systems.

When the sample review matrix was initially developed, the certain topics were limited to reviews of criteria and commitments; however, the IDCVP project team determined that further reviews were necessary. In accordance with the PQAP, the review matrix was modified through the addition of implementing document reviews, checks of calculations, and reviews of drawings as appropriate.

The design areas in which this expansion took place were as follows:

Topic No.	Design Area
1.2-1	Accident Analysis Considerations
1.8-1	Overpressure Protection
1.16-1	Electrical Characteristics
1.23-1	Failure Modes and Effects

Additionally, the IDCVP determined that in the performance of the reviews of the other systems, further consideration should be given to the following matters:

- o The method and extent of the implementation of criteria provided by B&W to CPC (in balance-of-plant (BOP) criteria documents) requires further consideration by the IDVP.
- o The significance of the lack of centralized design criteria and the impact of this situation on the design. The IDVP notes that a programmatic review of Midland performed by Management Analysis Company (MAC) also indicated a

concern in this area in its Construction Project Evaluation report of January 31, 1983 (Rev. 1, March 2, 1983).

- o The timeliness and effectiveness of the Midland project's adoption of newer criteria.

These aspects will be discussed in subsequent IDCVP reports.

For the review topics discussed in this report the IDCVP project team has concluded that:

- o The criteria and commitments are consistent
- o The criteria and commitments are complete
- o The criteria and commitments are sufficiently detailed to allow implementation.

These conclusions were reached after due consideration was given to revised FSAR sections and responses to OCRs.

The Consolidated Criteria and Commitments List (Appendix C) is considered by the IDCVP to represent a set of criteria which, if properly implemented with due consideration of interfacing systems, structures, and components, will result in an AFW system which meets performance requirements and NRC regulations. The implementation of these criteria were reviewed in accordance with the sample review matrix by the IDCVP, and the results are discussed in Subsection 4.2 of this report.

4.2 REVIEW TOPIC EVALUATIONS

This report subsection discusses those topics for which reviews were performed, in addition to the criteria and commitment reviews discussed in Subsection 4.1. For convenience of presentation, related review topics are discussed in the following paragraphs and are identified by the topic numbers shown in Figure A-2. This subsection is divided into further topics covering the systems, mechanical, and electrical (including instrumentation and control) aspects of the design of the AFW system.

The systems evaluation discusses those topics which are related to the general system performance requirements and which implement the most general functional requirements of the system, such as system operating limits and applicability of the single-failure criterion. The mechanical evaluation discusses topics associated with the mechanical design aspects of the system. Included are topics such as component functional requirements, system hydraulic design, and water supplies. The electrical, instrumentation, and control evaluation discusses all electrical, instrumentation, and control related topics including electrical characteristics and protective devices/settings.

4.2.1 SYSTEMS EVALUATION

4.2.1.1 SYSTEM OPERATING LIMITS -- TOPIC 1.1-1

The purpose of the system operating limits evaluation was to determine the range of operating parameters in which the AFW system must operate. The review considered whether appropriate limits were specified for parameters such as pressure, temperature, and flow. This review was accomplished through a review of implementing documents and a check of calculations.

Because of the interfaces which exist between it and other systems, important design considerations for the AFW system include the parameters in the interfacing systems since these systems may control the parameters applicable to the AFW system. That is, parameters such as pressure or temperature directly associated with the AFW system may have a narrower allowable range than parameters associated with interfacing systems. The evaluation of the parameters associated with the AFW system was made by comparing them against the parameters associated with the interfacing systems and the applicable design criteria.

The review consisted of an implementing document review and a check of calculations in addition to the criteria and commitments review.

The system operating limits review compared B&W-specified parameters related to the AFW system against Bechtel design parameters as provided in documents such as the AFW flow diagram and related calculations as well as the FSAR. It was determined that the Bechtel design parameters provided a wider range than that specified by B&W. This is generally conservative, but consideration must be given to the specific use to which the parameter is being put. For example, the pressure at the AFW suction varies depending upon the water source for the system operating mode. Thus, in reviewing overpressure calculations, it is appropriate to use the highest pressure. On the other hand, when reviewing net positive suction head (NPSH) calculations, it is appropriate to use the lowest pressure. The evaluation performed for the system operating limits review topic determined the range of parameters applicable to the AFW system. Tables 4-1 through 4-5 identify the range of parameters applicable to the AFW system. The evaluation of this topic was conducted by reviewing AFW system documents and criteria for interfacing systems. For example, the range of service water temperature stated in the noted AFW calculation was compared to service water information contained in the FSAR.

The review also considered whether appropriate ranges of operating modes were used in the design process. Bechtel makes use of a flow diagram with supporting calculations in its design process. Such flow diagrams contain valuable information about operating modes. In addition, the "Input to RPSA" calculations (which are used to provide input to piping stress analysis) also consider the system's operating modes.

The system operating limits review determined the ranges applicable to each of the primary AFW design parameters. The specific value of each parameter depends upon how the value is to be used and the assumptions appropriate for that use. Thus, the reviews conducted for other review topics had to consider whether the parameter values were correctly chosen for the situation being evaluated and whether those values were within the ranges determined in conducting the review of this topic.

No OCRs were identified for this review topic.

TABLE 4-1

AFW AND WATER SUPPLIES UNDER VARIOUS OPERATING MODES

Operating Modes	Water Sources			
	Condensate Storage	Deaerator Storage	Service Water	Condenser Hotwell*
Standby	X			N/A
Startup	X	X^P		N/A
Shutdown	X	X^P		N/A
Emergency	X^P		X	N/A
Blackout	X			N/A

* This water source has been disabled.

P Preferred water source.

TABLE 4-2

AFW WATER SUPPLY TEMPERATURES

Water Source	Temperature (°F) Minimum	Maximum	Data Source*
Condensate Storage	40	135**	FM-4117-28(Q)
Deaerator Storage	32	295	FM-4117-28(Q)
Service Water	32	108	FM-4117-28(Q)

* FM designation indicates a Bechtel calculation number.

** Based upon interception of condenser hotwell reject water. Expected maximum temperature in condensate storage tank is 90°.

TABLE 4-3

AFW WATER SUPPLY PRESSURES

Water Source	Pressure (psig) Minimum	Maximum	Data Source*
Condensate Storage	s	34.8	FM-4117-16(Q), -21(Q), -28(Q)
Deaerator Storage	s	120	FM-4117-16(Q), -21(Q), -28(Q)
Service Water	22.4	112	FM-4117-16(Q), -21(Q), -28(Q)

* FM designation indicates a Bechtel calculation number.

s = static head; varies with tank level.

TABLE 4-4

AFW SUCTION PRESSURE PARAMETERS

	Pressure	Data Source*
AFW NPSH Required	10 ft (4.33 psi)	Pump Test Curve**
Low suction pressure transfer set point	14.0 psig	FM-4117-21(Q)
Service water pump shutoff head	89.6 psig	FM-4117-28(Q)

* FM designation indicates a Bechtel calculation number.

** Pump Test Curve No. 35225.

TABLE 4-5

PRESSURE PARAMETERS RELATED
TO AFW PERFORMANCE

Parameter	Pressure (psig)	Source*
Steam generator operating pressure	910	FSAR
Steam generator safety valve set point (lowest)	1050	FSAR
Safety valve set point plus 10% accumulation	1155	FM-4117-28(Q)
AFW Pump Shutoff Head**		
Suction from DST	1484	FM-4117-28(Q)
Suction at transfer set point	1363	FM-4117-28(Q)
Steam turbine maximum pressure	1050	(based on safety valve set point)
Steam turbine minimum pressure	30	M-739

* FM designation indicates a Bechtel calculation number; M indicates a Bechtel drawing.

** Bechtel calculation FM-4117-28(Q) addresses the turbine-driven pump overspeed case. That calculation is considered adequate and the overspeed case need not be addressed in this evaluation.

It was concluded that appropriate ranges for AFW system parameters exist and that an appropriate range of operating modes were considered in both the implementing documents and calculations.

4.2.1.2 ACCIDENT ANALYSIS CONSIDERATIONS -- TOPIC 1.2-1

The review originally identified for this topic consisted of a criteria-only review; however, in order to adequately review the consistency and completeness of those criteria it was necessary to review associated implementation documentation. The review consisted of a review of FSAR accident analyses and related B&W studies and evaluations, including the B&W anticipated transient operator guidelines (ATOG) document.

The AFW system is required in response to a number of accident scenarios. The Consolidated Criteria and Commitments List identifies criteria applicable to the design of the AFW system and states that the AFW system must be capable of responding to all accidents for which credit is taken for the availability of the system. The documentation review consisted primarily of the accident analyses presented in Chapter 15 of the FSAR and related implementing documentation such as the B&W ATOG document.

The review of Chapter 15 indicated that the FSAR addresses the accident scenarios usually found in FSARs and is in compliance with the standard format and content guide issued by the NRC. It was noted that anticipated transients without scram (ATWS) events were not addressed; however, given the status of regulatory requirements regarding this consideration this is not unexpected. The IDVP considers resolution of the design basis for ATWS to be outside the scope of the program.

The review concluded that the criteria and commitments applicable to accident analysis considerations are complete, consistent, and adequately defined to allow implementation. Appropriate accident analysis events are considered for the design of the AFW system and consideration has been given to failures of the AFW system which could exacerbate an existing condition. The IDVP performed a separate review of failure modes and effects analyses and single-failure analyses. These topics are discussed elsewhere in this report.

The review of this topic resulted in the preparation of five OCRs, of which one was a Confirmed Item (which was subsequently resolved) and one was issued as an Observation. The other three OCRs were Open Items which were resolved internally by the IDVP project team upon further review.

The Confirmed Item, C-025, and the Observation, B-152, associated with this topic are both related to the steam generator tube rupture accident analysis. As described in Section 3.0 of this report, the AFW system incorporates design features which limit the AFW flow to the intact steam generator for initiating events which involve steam generator fault (e.g., steam line and feedwater line breaks). These features, known as the FOGG (feed only good generator) system, are initiated through logic which uses the differential pressure between the steam generators as an input. The logic is based upon the assumption that the higher pressure steam generator is the "good" generator. For a tube rupture event, the steam generator with the ruptured tube will appear to be the "good" generator. The Midland design relies upon operator action to recognize the tube rupture event and place the AFW control system in the manual mode. C-025 was written because it appeared that engineering judgement was used to reach the conclusion that manual operation was adequate. The Confirmed Item was resolved when CPC provided a calculation supporting their judgement and the IDCVP accepted the calculation as a reasonable basis. The associated Observation noted that the calculation was prepared after the fact, whereas, the IDCVP project team believes that it would be a better practice to have properly documented calculations rather than relying upon engineering judgement in such circumstances. Furthermore, the Observation noted three very minor discrepancies in the calculation.

The review of accident analysis considerations resulted in the conclusion that adequate criteria exist for consideration of accident analyses and that appropriate analyses have been performed. Appropriate consideration has been given to a significant set of accident scenarios and the information contained in FSAR

Chapter 15 indicates that the AFW system will respond appropriately. The information resulting from this review was used in the consideration of other topics such as system heat removal capability, single failure, and failure modes and effects analysis.

4.2.1.3 SINGLE FAILURE ANALYSIS AND FAILURE MODES AND EFFECTS ANALYSIS -- TOPICS 1.3-1 AND 1.23-1

The original scope for this review consisted of a criteria and commitments review, a review of implementing documents, and a check of calculations or evaluations. In the course of gathering the documentation to perform this review, it was noted that no consolidated documentation packages for either the single-failure evaluation or failure modes and effects evaluation could be identified. These evaluations were performed through a series of individual evaluations conducted over the duration of the Midland project. Summary results are presented in the FSAR, but a complete supporting evaluation could not be located. These summary results include a failure modes and effects analysis for the AFW system which is presented in Table 10.4-6 of the FSAR. In addition, a single-failure analysis of the auxiliary feedwater actuation system (AFWAS) was performed by B&W and is presented in Table 7.3-5 of the FSAR.

The sample review matrix did not contain a review topic for failure modes and effects analysis. This topic was added to the matrix with a scope of review activities defined similarly to the single-failure topic. Both topics are discussed in this report subsection.

The General Design Criteria of 10 CFR 50 Appendix A require that the AFW system be designed such that its safety function is achieved assuming a single failure. Guidance on the application of the single-failure criteria is taken from Regulatory Guide 1.53, Application of Single Failure Criteria to Protection Systems. The AFW system is required to perform its intended safety function under concurrent conditions of a loss of offsite power, an earthquake, and a single failure.

The AFW system is designed to meet the single-failure criteria. The evaluation of the Topic 1.15-1, Power Supplies, showed that the two full capacity AFW trains are powered from separate, independent, and diverse motive sources. The Topic 1.16-1, Electrical Characteristics, confirmed that physical (space) and electrical (independence) separation is maintained for the power supplies to the two AFW trains. Furthermore, it was found that the power supplies are not interconnected nor can they be interconnected through cross-ties or swing busses. The AFWAS initiation system is specified to maintain channel independence and separation as stated in the FSAR. Physical mechanical and electrical separation is maintained for the AFW actuated components. For example, the AFW pumps are located in separate seismic Category I pump rooms and the associated valves and piping are physically separate. The design of the AFW system incorporates features which enable it to perform its safety functions in spite of single failures and their effects.

The AFW system P&ID was reviewed for specific design features which mitigate the effects of single failures. These design features include the ability of either AFW pump to supply either steam generator with water, the ability to use the multiple sources of water, the fact that the AFW system can achieve its function with water from either service water train, and the existence of redundant components such as the AFW pumps (again two full capacity trains). In addition, a stuck-open steam generator (S/G) level control valve is mitigated by S/G hi hi level isolation, and level control valve failure (closed) is mitigated by a cross-over valve from the opposite AFW train. For example, a failure of valve 405 (Figure 3-1) is compensated by the availability of valve 298. Other design features which mitigate the effects of single failures are described in Table 10.4-6 of the FSAR.

Observation B-059, issued as a result of the IDVP review in this area, stated that although it was obvious that single failure was considered in the design of the AFW system, it would be desirable to have a formal single-failure evaluation. The IDVP concluded that the most expeditious approach would be to incorporate within the IDVP a single-failure and failure modes and effects analysis of the AFW system.

The IDVP-originated confirmatory single-failure evaluation identified no single failures that would prevent the achievement of the system's safety functions. The effects of any postulated single failures did not adversely affect the ability of the AFW system to perform its safety function. Thus, it can be concluded that the criteria and commitments were properly and consistently implemented. It is also concluded that the single failure and failure modes and effects topics have been adequately considered in the design of the AFW system.

4.2.1.4 SYSTEM ALIGNMENT/SWITCHOVER, AND SYSTEM ISOLATION/INTERLOCKS -- TOPICS 1.5-1 AND 1.7-1

The review scopes for Topics 1.5-1 and 1.7-1 both consisted of reviews of implementing documents in addition to the review of criteria and commitments performed for each review topic. These reviews are closely related and were directed at the systems engineering aspects of these design considerations. The design details associated with the system alignment/switchover and system isolation/interlocks topics are reviewed in Subsection 4.2.3, which discusses the instrumentation and control aspects of the AFW system.

The AFW system incorporates an automatic switchover from its normal lineup with the condensate storage tank to the Category I suction from the service water system. This automatic switchover is interlocked such that it can occur only on low suction pressure with a concurrent AFW actuation signal. Other interlocks exist for the AFW level control system, FOGG system, and AFW low flow (recirculation) condition.

The AFW system is designed to be normally aligned with the condensate storage tank which is the preferred source of water for the system. Because the condensate storage tank is neither Seismic Category I nor designed for tornadoes, it is necessary to back up the preferred water supply with a source of water which is Seismic Category I and designed for the effects of a tornado. For the Midland plant this is accomplished through a transfer of suction from the condensate storage tank to the service water system. This transfer is accomplished automatically upon sensing low suction pressure in conjunction with an AFW actuation system (AFWAS) signal. Major valve position changes for this situation are shown in Table 3-1. As noted in Subsection 4.2.1.3, the single-failure review determined that this transfer may be accomplished given a single failure. The hydraulic design aspects of this transfer were considered in the review of the hydraulic design topic. The instrumentation and control aspects are reviewed in topics associated with these design areas.

When suction is taken from the deaerator storage tank during startup, it is necessary to close the valve in the line from the condensate storage tank. This is necessary because during startup the pressure in the deaerator storage tank may be sufficiently low that the static head in the condensate storage tank would prevent flow from the deaerator to the AFW pump suction. During startup and shutdown, the deaerator is the preferred source of water since water from this source minimizes thermal transients to the steam generators. The closure and subsequent reopening of the valve in the line from the condensate tank is a manual operation. The review considered the consequences of a failure to reopen the valve once the deaerator pressure was sufficiently high to prevent flow from the condensate storage tank. It was concluded that this potential operator error did not produce unacceptable safety consequences. Upon detection of low suction pressure in the presence of an AFWAS signal, the service water system would provide water to the AFW system. Although there is no safety concern with this arrangement, a failure to reopen the valve from the condensate storage tank and a subsequent demand for operation of the AFW system would result in the injection of service water into the steam generator.

An economic penalty may result due to the time and expense associated with re-establishing proper secondary side water chemistry. No Confirmed Items resulted from the IDVP review of system alignment and switchover.

The system isolation and interlocks which are of interest include those associated with the multiple water sources which can supply the AFW system. The switchover between these sources is discussed in above. The system interlocks are designed to minimize the possibility that service water will be inadvertently introduced into the AFW system; however, the design must also be such that the interlocking does not conflict with single-failure considerations when the AFW system is providing a safety function.

Bechtel has determined that the condenser hotwell can no longer serve as a potential source of AFW water. A design change to disable the connection between the hotwell and the AFW system was in the approval process at the time the IDVP initiated its review of the system. The reason for this design change is the possibility of inadequate NPSH when the system was aligned to the hotwell. Another design consideration noted is the interlock to trip the AFW pumps on low suction pressure when an AFWAS signal is not present. The review of the AFW system considered the design bases for these interlocking features.

Isolation of nonessential portions of the AFW system is provided automatically on the basis of either an AFWAS signal or another appropriate signal such as low suction pressure. The review identified interlocks described in the FSAR and required by criteria. These interlocks were then reviewed at the piping and instrument diagram (P&ID) level. All were found to be implemented as shown on the P&ID. These interlocks include:

- o Pump running signal for AFW steam generator level control
- o Low pump suction pressure automatic switchover
- o Feed only good generator (FOGG) system interlocks
- o Steam generator isolation on hi hi steam generator level

- o AFW low flow (recirculation)
- o Turbine steam inlet interlocks
- o Interlocking of valve 2MO-3956 (valve 008 on Figure 3-1) with AFWAS.

The design details associated with the automatic switchover to service water, FOGG interlocks, and level control system interlocks were considered part of the instrumentation and control-related topics discussed in Subsection 4.2.3 of this report. The alignment and interlocking considerations determined to be required based upon design criteria, commitments made in the FSAR, or considerations determined to be important by the IDCVP project team were found to have been shown on the implementing documents for this review (primarily the FSAR).

Two Open Items, which were associated with these topics and were identified by the IDCVP, were resolved without the issuance of Confirmed Item reports. No other OCRs resulted from the review.

The system alignment/switchover and system isolation/interlocks review topics for the AFW system are considered to be complete by the IDCVP. The design criteria for these topics were found to be properly and consistently implemented.

4.2.2 MECHANICAL EVALUATION

4.2.2.1 OVERPRESSURE PROTECTION -- TOPIC 1.8-1

The initial scope for this topic was limited to a criteria review for overpressure protection of the AFW system. As the review progressed, the need for further review of piping system integrity was determined to be necessary because of the existence of field change requests, a Bechtel-identified potential suction line overpressure condition, and changes to industry practice. The expanded review scope included reviews of implementing documents and calculations, and the performance of a confirmatory analysis. Included within the scope of this review was the evaluation of the actions taken in response to Management Corrective

Action Report 65 (MCAR 65) regarding potential for overpressure conditions in the AFW suction piping. MCARs are the project mechanism for tracking activities associated with items potentially reportable under 10 CFR 50.55(e).

The review concentrated on three specific areas: (1) suction piping as a result of an incident at another plant which has a design somewhat similar in Midland, (2) pressure retaining capability of pump discharge piping inside and outside containment, and (3) proposed changes to reduce the AFW turbine drain line design pressure.

During the review, it was noted that more current versions of ASME code require an analysis of overpressure protection, although none was required by the 1971 code through the Summer 1973 addenda to which the Midland project is committed.

MCAR 65 identified the possibility of overpressurization of the AFW suction piping due to check valve leakage. The design of the suction piping is such that check valves are located in the suction lines as well as the discharge lines. The suction line check valves are provided to prevent loss of suction line integrity in the event that damage occurs to the non-Category I water supplies from the condensate storage tank and the deaerator storage tank. Thus, it is possible that leakage back through the discharge check valves could result in pressurization of the suction piping which could be prevented from being relieved by a tight suction check valve. This situation occurred at the McGuire plant of Duke Power Company. A review of the AFW design by Bechtel indicated that a similar situation could occur in the Midland design. MCAR 65 was issued to monitor resolution of this concern. Although this concern was identified prior to the review of overpressure protection by the IDVP, it was decided that the IDVP would review any design changes which resulted. The Midland P&ID has been revised by adding relief valves to eliminate the overpressure concern discussed in MCAR 65. The IDVP concluded that this is a reasonable approach for resolution of the concern.

A Bechtel calculation, which determines the temperature and pressure of auxiliary feedwater piping for stress analysis input, was reviewed as part of a verification of AFW system piping overpressure protection. This review included a check of the sources of pertinent design values used by Bechtel. These values were used in a comparable analysis performed by the IDVP. With the exception of one minor calculational error, the portions of the calculation which were reviewed were found to have been performed in a consistent manner directly reflecting expected design conditions.

Two AFW piping sections were selected for additional review to determine their capability to withstand potential overpressure conditions. It was concluded that based upon the selected sample the piping both inside and outside containment can withstand postulated overpressure conditions. As noted above, while the potential exists for an increase in suction pressure under certain conditions, the addition of relief valves in response to MCAR 65 eliminates concerns in this area.

The IDCVP received a field change request which recommended the reclassification of design pressure for a selected portion of the turbine drain line piping. Although the field change request was approved, the IDCVP could not initially locate documentation which provided justification for the approval of the design change. OCR C-026 was issued to cover this item. This item was subsequently resolved upon receipt of additional information from Bechtel, which provided the bases for approval of the design change.

The resolution of C-026 and MCAR 65 eliminated IDCVP concerns in the area of overpressure protection for the AFW system; however, it is noted that the field engineers are requesting changes to specified design pressures in order to accomplish hydrostatic testing. This is not an unusual situation because design engineers often very conservatively select the design pressures for portions of piping. Difficulties in hydrostatic testing may arise where higher design pressure piping is connected to lower design pressure piping without provisions for isolation. In such situations, either an isolation device (such as a valve) must be added or the piping with the higher design pressure rating must be reduced so that its pressure is compatible with the other piping for testing purposes. The mechanism for these changes is the Bechtel field change request procedure. In responding to such requests, the design engineers must be fully cognizant of the design bases which led to the original assignment of design pressures in the piping. The IDVP issued an Observation (B-158) concerning the bases for acceptance of the field request. This item was not classified as a Confirmed Item because of the conservatism in the specification of fluid parameters and the capability of the piping to accommodate higher pressures. In other systems or circumstances the design pressure could be inappropriately reduced. The Observation was issued to identify to Bechtel the need for appropriate consideration of such changes. No Findings were associated with this topic. It is concluded that overpressure protection has been appropriately considered in the design of the AFW system.

4.2.2.2 SYSTEM HYDRAULIC DESIGN -- TOPIC 1.10-1

The initial scope for review of the system hydraulic design included criteria and commitment review, review of implementing documents, and check of calculations and evaluations. Subsequently, a confirmatory calculation was added to the scope of this review. The purpose of this portion of the review was to evaluate the determination of hydraulic design parameters and their use in subsequent steps of the design process. The P&ID and flow diagram were used in the implementing document review. Calculations that were reviewed include those for automatic switchover to service water, low suction pressure set points determination, and pump discharge pressure requirements.

The determination of the adequacy of the system hydraulic design used the results of Topic 1.11-1, System Heat Removal Capability, to define the required pressure and flow to the steam generators as noted in Subsection 4.2.2.3. During the course of the review, a question arose as to the appropriate value for the flow required at the steam generator due to apparently conflicting documents which contained flows lower than that specified in the B&W interface document for the AFW. A figure of 850 gpm was subsequently determined to be the basis upon which the IDCVP would complete its activities. The adequacy of the

850 gpm to remove the heat required in order to conform to design criteria is assessed in Subsection 4.2.2.3 of this report.

An important calculation which was reviewed was the determination of low pressure set points. These set points are used in the automatic transfer from condensate storage to service water in the event of a loss of pressure integrity of the condensate storage line. The set point must be sufficiently high to allow the transfer to be complete before the pump runs dry. On the other hand, it must be low enough to detect a real loss of suction pressure and not a normal operating variance. The calculational method was reviewed and found to be correct. It was noted, however, that an important assumption was made in performing this calculation. Specifically, it was assumed that the check valve in the suction lines from both the deaerator storage tank and the condensate storage tank would close when integrity of upstream piping was lost. This assumption was made in spite of the fact that these valves are not Category I (see Figure 3-1 for the locations of these valves relative to the seismic/non-seismic interface). The justification for this assumption was based upon the fact that although the valves were not Category I, they were included in the scope of the seismic analysis.

OCR C-010 was written concerning the potential loss of integrity in the suction line following a seismic event. Bechtel responded that although the P&ID shows a portion of the suction line to be non-seismic, the line in fact was analyzed for seismic loads. Bechtel pointed out that a number of lines which do not require seismic analysis to meet functional requirements were analyzed seismically due to other considerations such as the need to prevent a failure of a non-Category I line from damaging a Category I component. The Bechtel calculations were reviewed and it was verified that the line's piping analysis did include seismic loads. Thus, the Confirmed Item was resolved.

Subsequently, an additional OCR (C-043) was written because of the concern that although the line was equivalent to a seismically analyzed line, this conclusion depended upon assurance that the pipe supports were properly installed. The project response to C-043 was that the line was subject to the "hanger critical" procedures of Bechtel specification M-327. The IDCVP reviewed a Bechtel computer printout (M-480) containing a column which was said to indicate which piping was hanger critical and determined that the line was not so indicated. As a result of this discrepancy, the Confirmed Item became a Finding (F-043). In response to the Finding, Bechtel stated that M-480 is not the controlling document, but that M-327 requires the use of another document to determine which hangers are hanger critical. The IDCVP reviewer determined that the other document correctly listed the hangers affecting the seismically analyzed, but non-Q portion of the line. The Finding was resolved on the basis that Bechtel procedures were being properly used and that the hangers were correctly categorized.

Three Observations were issued as a result of the review of hydraulic design calculations. One of the Observations (B-158) is discussed in Subsection 4.2.2.1; the other two were minor errors that had no effect on the calculations.

It was concluded that the required flows can be provided by the AFW system and that hydraulic design has been adequately considered in the design of the AFW system. Appropriate consideration has been given to hydraulic factors such as adequate NPSH and piping pressure drops. OCRs that were issued concerning this topic have been resolved. As discussed above, one of the OCRs (C-043) became a Finding which was subsequently resolved.

4.2.2.3 SYSTEM HEAT REMOVAL CAPABILITY -- TOPIC I.11-1

The scope of the system heat removal capability review included criteria implementing documents and calculation reviews. Additionally, a confirmatory calculation of the heat which must be removed by the AFW system was performed. Although not included in the original scope, a confirmatory calculation of the system's requiring heat removal capability was performed.

The safety function of the AFW system is to remove heat generated in the reactor core following shutdown when normal feedwater is not available. Additionally, the AFW system must be capable of removing heat added to the primary system by the reactor coolant pumps.

The review determined that a B&W calculation was performed early in the project in order to determine the size of the AFW pumps. This calculation was based upon a decay heat relationship in a B&W report. Subsequently, an American Nuclear Society (ANS) standard was adopted for determining decay heat after reactor shutdown and the NRC essentially endorsed this standard with the addition of a 20 percent margin (i.e., 12 times the ANS value). The ANS standard and the NRC curve predict somewhat different values for decay heat than is given by the B&W relationship.

The FSAR was reviewed to determine commitments made relative to the decay heat calculation. It was found that in one portion of the FSAR, references were made to the use of 1.0 times the ANS value whereas elsewhere a commitment was made to use the NRC method. In fact neither of these methods was used; the B&W calculation formed the basis for the AFW design. In any event the two FSAR statements were in conflict since the NRC method would produce 20 percent greater decay heat than the ANS method with a 1.0 multiplier. The FSAR was later amended to clarify the bases for sizing the AFW system.

This discrepancy concerning the method of decay heat calculation was issued as a Confirmed Item (C-018) and subsequently became a Finding. The project provided additional information to resolve the concern and the IDCVP prepared a confirmatory calculation and considered the possible ranges in these values. A flow of 850 gpm was determined to remove the decay heat calculated using the method of ANS 5.1-1979 assuming long-term operation at 2452 MWt (license power level), 20 percent margin, and reactor coolant pump heat. This flow matches the heat removal requirements approximately 50 seconds after shutdown.

The IDCVP concluded that adequate heat removal capability exists and F-018 was resolved.

OCRs C-017 and C-020 were also issued concerning heat removal capability. C-017 concerned apparent inconsistencies among documentation regarding the AFW system flow requirements and hence heat removal capability. The project confirmed that 850 gpm was the controlling value (and was the highest of the listed values) and the IDCVP used this figure in other evaluations. C-020 concerned conflicts among the possible temperatures for the AFW water. The project provided documentation that the effect on the AFW's heat removal capability was minor if the suction temperature is increased to 105°F from 90°F. The IDCVP accepted the analysis presented by the project but used the more conservative 105°F in its own calculation.

The IDVP has concluded that the AFW system has adequate heat removal capability to meet reasonable design criteria. The criteria, which were originally identified for the AFW system together with apparent inconsistencies in the FSAR, led to a concern regarding the adequacy of the stated AFW flow rate to achieve the necessary heat removal capability. This concern was documented in Finding F-018. This Finding was subsequently resolved based upon additional information provided by the project, clarifications to the FSAR, and calculations performed by the IDVP. In particular, the conclusion that adequate heat removal capability exists is based upon an assumption of a reactor power level of 2452 MWt, use of the ANS 5.1-1979 decay heat methodology with a margin of 20 percent, and AFW water temperature of 105°F. Use of alternate assumptions could result in conclusions that either substantially more capability exists in the AFW system than is required or that the AFW system capacity is unable to meet interface requirements specified by the NSSS vendor. The assumptions used by the IDVP in the confirmatory calculation are consistent with NRC guidelines.

The factors which could influence this conclusion include consideration of the methodology for calculating residual heat, the assumed power level, and the assumed water temperature. For example, the reactor power level of 2452 MWt is the license power level. In the IDVP calculations, a 2 percent margin was added to account for instrument error, which was also considered in accident analyses contained in the FSAR. However, certain accident analyses assumed power levels were as high as approximately 2600 MWt. This figure derives from an "ultimate" power level of 2552 MWt plus the 2 percent instrument error margin. The water temperature could be as high as 135°F under certain conditions. The parameters assumed in performing the confirmatory calculation were appropriate for the license power level; however, it is noted that the 2552 MWt power level was described in the FSAR as "ultimate." In the event that CPC elects to seek permission to operate Midland above 2452 MWt, further analysis of the AFW system's capability should be made.

An additional factor considered was a criterion in an interface document between B&W and CPC which states that the AFW system design basis should be to remove the heat generated at 30 seconds after shutdown. Using the assumptions discussed in the preceding paragraph, the Midland AFW system design does not meet this interface criterion. However, further consideration shows that there is no requirement that the AFW system deliver full flow at 30 seconds after shutdown. In fact, elsewhere in the interface document, 40 seconds is allowed for the AFW system to achieve full flow. The Midland AFW system meets this heat removal criterion at 50 seconds after shutdown, which is 10 seconds after full flow is achieved. It was determined by B&W, and reviewed and accepted by the IDVP, that this 10-second difference results in much less than a one-degree change in primary water temperature. The inability to meet this interface criterion was determined to be insignificant and the Finding was resolved; however, a broader question of the extent to which the other B&W interface criteria are being implemented is being reviewed by the IDVP and will be reported upon in a subsequent report.

4.2.2.4 WATER SUPPLIES -- TOPIC 1.13-1

The AFW system has several water supplies, the preferred water supply under most circumstances is the condensate storage tank. During startup and shutdown conditions the deaerator storage tank is used as the primary source of water.

Should neither of these systems be available, such as after a seismic event, the service water system is used to supply water to the AFW system. The service water system is seismic Category I and the cross connection with service water allows AFW to meet the commitment to have a Category I water supply. Reviews conducted as part of the single-failure analysis, system alignment/switchover, and system hydraulic design indicate that the switchover to service water is correctly designed. Appropriate commitments are made regarding the volume of water available for plant shutdown.

The AFW system water supplies meet the criteria and commitments established for them. The service water system is intended to meet the criterion that the AFW system have a Category I water supply. The water contained in the condensate storage tank provides the normal water supply for the system and meets the water chemistry requirements established by B&W. Use of the deaerator storage tank during the startup and shutdown reduces the thermal transients on the steam generators. The criteria for the water supplies were found to be consistent, complete, and sufficiently detailed to allow implementation. The review of the P&ID and flow diagrams indicated appropriate implementation of these criteria and commitments. Further reviews of the implementation of these criteria and commitments were accomplished in conjunction with reviews of system hydraulic design, system heat removal capability, failure modes and effects, and single failure. No OCRs resulted from this review.

4.2.2.5 COMPONENT FUNCTIONAL REQUIREMENTS -- TOPIC 1.9-1

The component functional requirements review includes reviews of design criteria and commitments, implementing documents, calculations, and a check of drawings and specifications. The scope of component functional requirement reviews included evaluation of selected mechanical, electrical, instrumentation and control components to determine their compliance with their functional requirements. The development of the functional requirements can be traced from the design criteria through system performance review areas such as hydraulic design, heat removal capability, and system operating limits to the specifications and drawings which formed the design output document for the design process. After resolution of Open Items discussed in other topics, the design parameters determined to be correct were used in the balance of the review. The design criteria and commitments extracted in the review process were consolidated into a single design criteria list which is discussed in Subsection 4.1 of this report.

The Component Functional Requirements topic represents a summary of many of the other topics in that the criteria and commitments reviewed in other topics and checked for implementation (through reviews of calculations and implementing documents) are evaluated further through the review of specifications and drawings. The review of drawings and specifications considers results of the reviews conducted for the other topics. Drawing and specifications represent the end product of the engineering design process. For the purposes of the IDVP, the drawings reviewed were primarily vendor drawings for various components such as the AFW pumps and valves. Other drawings, such as piping isometric and hanger isometric drawings, are reviewed in conjunction with reviews of calculations or in association with topics, which will be included in subsequent reports (such as reports covering topics in Section II of the sample review matrix, Figure A-3). Further reviews of vendor drawings and specifications are made in other categories including reviews of the instrumentation, control systems, and actuation systems topics. The objective of this review was the determination that component functional requirements and design criteria such as flow rate, NPSH, voltage, and similar characteristics are reflected in the procurement documents and that vendor documents reflect the as-supplied equipment. These documents were reviewed against component functional requirements which had been validated through other reviews. Other checks of Bechtel drawings were made for incorporation of vendor requirements such as valve operator orientation. Equipment, seismic, and environmental qualifications are considered in other topics and will be incorporated within the scope of a subsequent report.

The results of the hydraulic design, overpressure protection, water supplies, and other topics were used in the review of component functional requirements. As discussed at length above, the AFW must supply 850 gpm based upon B&W-

supplied interface criteria and confirmatory calculations prepared by the IDCVP. Furthermore, the system must supply this flow given a single failure (e.g., a pump fails to operate). Thus, it is clear that each AFW pump must be capable of providing at least 850 gpm. In the component functional review, area specifications and vendor documents were reviewed against this figure and found to be consistent. Other parameters were also used to determine whether design criteria and specifications/drawings were consistent.

Seven OCRs were prepared in reviewing this subject: four Confirmed Items, one Observation, and two Open Items were prepared. The Open Items were resolved within the IDCVP without the issuance of a Confirmed Item.

Two of the Confirmed Items (C-027 and C-028) related to apparent conflicts among documents containing design criteria. C-027 is concerned with the power level which should be used for evaluating the AFW system and C-028 discusses the minimum AFW water temperature. C-027 was resolved when the IDCVP determined that 2452 MWt (plus 2 percent allowance for instrument error) should be used for the confirmatory calculation since it is the license power level. C-028 noted that a B&W interface document specifies a minimum 40°F temperature for auxiliary feedwater, whereas the service water could be as cold as 32°F. In response to the OCR, B&W explained that their analyses assume multiple cycles of operation with 40°F AFW water, whereas injection of service water is a rare event. The impact on their analysis of a single injection at 32°F rather than 40°F was stated by B&W to be minimal. Furthermore, the B&W analysis would be revised if such a transient did occur. The IDCVP agreed with the B&W response and resolved the OCR.

C-038 was the most significant Confirmed Item in the review of this topic. This item was resolved based upon the confirmatory calculation prepared under the heat removal capability topic. The concern raised by C-038 was whether the minimum flow recirculation valve for the turbine-driven AFW pump should be operable under station blackout conditions. The IDCVP calculations showed that adequate time was available for operator action so that the valve did not need to be operable during a blackout and thus the item could be resolved.

C-081 is concerned with a number of errors in a calculation used to specify pressures and temperatures and various operating modes for the piping stress analysis for the AFW system. Because the calculation package considers all of the operating modes of the AFW system, it is a fairly complex calculation in that many cross-references are needed. The calculation check performed by the IDCVP reviewer found that there were discrepancies in numbering the nodes and in pressures and temperatures when sections of the calculation were compared with each other. Because design input assumptions for the calculation changed, Bechtel revised the calculation while the IDVP review was in progress. The revision of the calculation corrected the errors which were in the previous version and thus corrected the errors noted by the IDCVP.

One Observation was also issued in this review to record the fact that the B&W interface criteria document should be clarified to ensure its consistency with the FSAR and the resolved OCRs.

The IDCVP has concluded that the functional requirements for the AFW system components are properly specified in design criteria (or may be determined through application of those criteria) and that those functional requirements are correctly reflected in specifications, vendor drawings, and other documents.

4.2.3 ELECTRICAL, INSTRUMENTATION, AND CONTROL EVALUATION

4.2.3.1 POWER SUPPLIES -- TOPIC 1.15-1

The initial scope of the AFW power supply review included criteria and commitment review and implementing document review. The scope of review was expanded to include a check of drawings and specifications. This expansion of scope was motivated by previously identified and resolved design problems associated with safety-related power supplies. One of these problems concerned the power supplies to the AFW Steam Generator (S/G) level control valves.

The criteria and commitments, implementing document, and check of drawings reviews included a review of the NSSS vendor, industry, regulatory, architect/

engineer, and CPC design criteria for the AFW system. Because the Midland FSAR has been used by the project as an implementing document for design criteria, it was reviewed as an implementing document by the IDVP. The check of drawings and specifications included a review of logic and schematic diagrams pertaining to AFW system components to check for incorporation of the criteria into design drawings.

For this review topic, the Midland FSAR was found to incorporate the appropriate power supply design criteria and commit the project to it. The AFW system P&ID (M-439), plant single line drawings (E-1 and E-24), and AFW component logic and schematic diagrams were reviewed to check the quality of the design in light of the committed criteria. The design drawings were found to reflect the FSAR criteria in that the AFW Train A (motor-driven pump train) components (including the pump and valves) are powered from Class 1E ac power which is backed by a safety-related emergency diesel generator. The AFW Train B components are powered from steam or safety-related dc (battery) power. Several AFW components are powered from 120 Vac preferred power which is ac power backed by station batteries (dc). This is equivalent to dc power and is adequate. The AFW turbine controls and B Train instrumentation are also powered from preferred power which is consistent with the design criteria.

The design approach taken by the project satisfies the criteria regarding the redundancy, diversity, and quality of the required AFW power supplies. Some inconsistencies were found in the implementation of the design approach. The first such inconsistency was found in the review of the power supplies to the FOGG relays 3x-1 and 3x-2. These relays interlock with the AFW turbine steam isolation valve control circuits shown on schematic diagram E-158. The steam isolation valves are designated 2MO-3277A and B. The relays 3x-1 and 3x-2 were found to be powered by Class 1E instrument ac power rather than a dc source or dc-backed power source. The isolation valves are dc-powered. The effect of this design discrepancy would be that on loss of all ac power, the relays 3x-1 and 3x-2 deenergize causing the close control circuits to be energized for valves 2MO-3277A and B. The valves, being dc-powered, would close, causing a loss of steam to the turbine-driven AFW pump and therefore a loss of all AFW flow (the motor-driven pump would be inoperable). The existing design, therefore, did not meet the two-hour operability requirement for the station blackout conditions. This Confirmed Open Item was documented in OCR C-012 which later resulted in a Finding Report which is discussed in Section 5.2 of this report.

The other potential inconsistency found was that valves 2MO-3226 (valve 073) and 2MO-3968B (valve 004) are in the B Train but are ac-powered rather than dc-powered. This was documented in OCR O-041 which has been resolved within the IDVP without the preparation of a Confirmed Item. Because these valves are normally open an additional failure (i.e., one of these valves being left closed) would have to be postulated before an adverse result (loss of AFW) could occur in the station blackout event. Consideration of an additional failure during the blackout event is not required; therefore, the valves are assumed to be in their proper open position and their Class IE ac power source is adequate.

The quality, diversity, and redundancy design requirements for the power supplies of the AFW system are consistent with industry and regulatory requirements and have been implemented in the Midland FSAR. These requirements were appropriately reflected in the AFW design drawings with one exception (Finding F-012) which has been corrected by Bechtel.

4.2.3.2 ELECTRICAL CHARACTERISTICS -- TOPIC 1.16-1

The Engineering Program Plan (EPP) defined those aspects of electrical characteristics to be reviewed as consisting of physical separation, electrical separation, and cable and raceway sizing including terminal voltage. The initial scope of review activities included only design criteria and commitments. This scope was expanded to include a review of implementing documents and a check of calculations. The motivation for this expanded review scope came as a result of the review of previous design and construction problems related to this topic. The previous problems identified concerned physical separation and inoperable control circuits due to excessive cable lengths. The scope of review of cable and raceway sizing including terminal voltage was limited to reviewing calculations for power and control circuit cable lengths which include the consideration of circuit voltage drop or terminal voltage.

The purpose of the electrical characteristics evaluation was to assess the adequacy of the AFW system electrical and physical separation and to check the adequacy of cable sizing design calculations for both power and control circuits. The design criteria were identified which pertain to the review including the criteria (both regulatory and industry) pertaining to physical separation (Regulatory Guide 1.75 and IEEE Standard 384), electrical independence (Regulatory Guide 1.6), and cable sizing (IPCEA publications on "Power Cable Ampacities" and "Ampacities - Cable In Open Top Cable Trays"). The Midland FSAR commits the project to these criteria and serves as an implementing document for the criteria. The implemented criteria are consistent with industry and regulatory requirements. Additional criteria applicable to this topic, but reviewed elsewhere, concern single failure which is reviewed as Topic 1.3-1.

During the engineering evaluation of physical separation, it was noted that the Midland FSAR in Appendix 3A commits the Midland Project to compliance with Regulatory Guide 1.75 Rev. 1 which endorses IEEE-384-1974. The provisions of IEEE-384, as modified by Regulatory Guide 1.75, were reviewed against drawing E-47 "Notes and Details for Separation of Class 1E Equipment and Circuits." In the review it was noted that the design criteria contained in drawing E-47 adequately comply with the provisions of IEEE-384 and Regulatory Guide 1.75 on a subject-by-subject basis. (The wording of much of the document E-47 is taken directly from IEEE-384.) One exception taken by the Midland Project to Regulatory Guide 1.75 is in reference to marking cables to designate channel or division. According to regulatory guidelines cables should be marked every five (5) feet. The Midland Project marks cables every fifteen (15) feet. This difference was not considered to be significant by the IDVP.

A review of electrical separation criteria, commitments, and implementing documents was also performed. The Midland FSAR in Section 10.4.9.3 states that complete electrical separation is maintained throughout the AFW pump controls, control signal, electrical power supplies, and instrumentation for each AFW pump train. The FSAR also commits the project to compliance with Regulatory Guide 1.6. Elec[illegible] separation is achieved by dividing the electrical power system into two separate load groups (I and II) with power distribution, batteries, preferred power, and instrument power associated with each load group separate from the other load group. This was verified by drawings E-1, E-22, and E-24 which are the plant single line drawings. The plant single line drawings and AFW schematic diagrams E-153 (Turbine Valves), E-154 (AFW Pump Motor), and E-158 (AFW System Valves) correctly implement the electrical separation load group philosophy.

The circuit schedule, drawing E-37, also shows that the power, control, and instrumentation circuits [illegible]nnelized into A, B, C, D, N, and E channels. E channel is a swing [illegible]een load group I and II. N channel is non-divisional. The channel designations for the power supplies for the AFW system components were reviewed. The power cables are properly channelized to maintain electrical separation in accordance with Regulatory Guide 1.6 in that the two standby power sources (load group I and II) are maintained electrically separate with no provision for cross connecting between load groups. Load group I power cables are in channel A, while load group II power cables are in channel B.

The maximum cable length calculation QPE-8, Rev. 2, for 600-volt power and control cable was reviewed. The calculation listed appropriate references and assumptions, was correctly performed with no process or math errors, and the calculation was checked or reviewed by an independent reviewer. The methodology applied by the IDVP reviewer was to selected AFW cables from the drawing E-37, "Electrical Circuit Schedule" which shows the cable length as routed by design and actual installed length. This information was used to select cables for detailed review such that the actual installed length approached the generalized maximum design length for the appropriate cable size in QPE-8. All AFW cables were reviewed in this process. The calculation was applied to the selected cables to determine whether or not the specific maximum design length as calculated per QPE-8 was exceeded by the actual installed length.

Of seven cables for which the maximum length review was performed, one was found to have an installed length greater than its maximum allowable length. This discrepancy was documented in OCR C-040. This OCR has been resolved based upon the fact that the circuit(s) in which the cable is used can tolerate a much larger voltage drop than is assumed by the calculation. The calculation assumes a two-and-one-half percent voltage drop, while the load can tolerate a 20 percent voltage drop from bus nominal voltage. If bus voltage is 10 percent less than nominal, which it can be under some plant operating conditions, there still remains substantial voltage drop margin. In addition, the particular load in question is an intermittent load (valve motor). The valve motor load contribution to the heat rise in a cable tray or conduit is less than the contribution of a similar size continuous duty load. The cable sizing calculation is based on the continuous duty load which means that there is additional margin for the intermittent load cable size.

While not significant in this instance, the cable length OCR raised a concern regarding the potential impact of several cables in series which could be improperly sized by small amounts. To resolve this concern and the OCR, another cable length calculation, QPE-17 (Motor Starter Control Circuit Sizing) was reviewed and applied to selected circuits to determine if the total cable lengths (several cables in series) were excessive to the point of preventing circuit operation. The calculation QPE-17 determines the maximum serial cable length that a particular size motor controller could tolerate while remaining functional (enough terminal voltage to actuate the control relays to start the motor). This calculation was reviewed and applied to a complex (worst case) motor control circuit. It was found that the maximum cable lengths were not excessive and that the control circuit would function. It was on this basis that the OCR C-040 was resolved.

The results of the review indicate that the appropriate design criteria have been incorporated into the design process. This is true for both the physical and electrical separation criteria. The design ensures that sufficient physical separation exists such that a failure in one load group of the electrical system will not affect the other. In addition, the two load groups are electrically separate such that a failure in one is not propagated to the other. The AFW system cables have been sized to ensure that excessive heat will not be generated by the cables and that the functional integrity of the electrical circuits is maintained.

4.2.3.3 PROTECTIVE DEVICES/SETTINGS -- TOPIC I.17-I

The review of electrical protective devices/settings included the design criteria and commitment, implementing document, and design drawing reviews. These activities were focused on electrical protection features for the AFW pump motor, electrical penetration assemblies, and motor-operated valve circuits. The review did not include the sizing of breakers since such a review is addressed in the SEP system review.

The purpose of the Protective Devices/Settings evaluation was to assess the design adequacy and compliance with regulatory and industry requirements of the electrical protection features for key AFW system components. The components chosen for review included electrical penetration assemblies, AFW pump motor protection, and motor-operated valve control circuit protection bypasses. The criteria applied to the review were as follows: IEEE-588, "Guide to AC Motor Protection;" Regulatory Guide 1.63, concerning the design of electric penetration assemblies; Regulatory Guide 1.106, concerning the thermal overload bypass; and IE Circular 81-13, concerning the torque switch bypass for safeguard service valve motors.

The schematic diagrams for the motor-operated valves in the AFW system were reviewed to verify the opening torque switch bypass and thermal overload bypass features. The schematics and valves are listed in the following table. The opening torque switch bypass is a hardware feature in the valve control circuit as is the thermal overload bypass. Both bypasses should ensure that a safety-related valve will try to operate under emergency conditions in spite of either high opening torque or thermal overload actuation.

AFW valves having overload and torque switch bypass:

Valve	Function	Power
2MO-3965A, B	S/G AFW ISOLATION	dc
2MO-3970A, B	S/G AFW ISOLATION	ac
2MO-3226	AFW TURB STM ISO.	ac
2MO-3956	COND STOR TANK FW SUPP.	ac
2MO-3993 A1, A2, B1, B2	SERV. WATER AFW SUPP.	ac
2MO-3277A, B	S/G AFW ISOLATION	dc
2MO-3968A, B	AFW ISOLATION	ac

The thermal overload bypass design uses safety-related hardware, actuation system (ESFAS) input and is testable. The bypass circuit design is such that the protective feature is bypassed only on emergency actuation. The circuits meet appropriate criteria of IEEE-279. The overload bypass and torque switch bypass criteria are met for the fourteen (14) motor-operated valves in the AFW system.

The electrical penetration protective design criteria are dictated by Regulatory Guide 1.63. The Midland position in regard to the criteria is detailed in Appendix 3A of the FSAR with additional clarification as discussed below.

In accordance with Regulatory Guide 1.63, the electrical penetration assemblies are designed to withstand, without loss of mechanical integrity, the maximum fault current vs time conditions which could occur as a result of single random failures of circuit overload devices. As an alternate to providing adequate self-fusing characteristics within the penetration conductors themselves, compliance is achieved by implementing system design methods which employ time coordinated, multiple-levels of protection.

The time-current characteristics for the power and control circuits for the AFW system penetrations are shown in Figures 8.3-25A and 8.3-29B of the FSAR. In the case of the power circuit (Figure 8.3-25A), the figure shows that even in the event of a protective device random failure (failure of either the 30A HFCP fuse or 20A breaker) to interrupt a fault the alternative device time-current characteristics would not exceed the mechanical damage line of the penetration. FSAR

Figure 8.3-29B for the control circuit penetration has been revised. The drawing reflects the replacement of #14 AWG penetration modules with #12 AWG modules. This modification to the electrical penetration meets the design criteria. The penetration will maintain its mechanical integrity in spite of a single failure in the protection scheme.

The AFW pump motor protection design criteria is summarized in IEEE 588 "Guide for AC Motor Protection." This standard guides the designer to provide relays for overload, locked rotor, short circuit, ground fault and undervoltage protection. Guidance is also given for protective relay settings. The AFW pump motor schematic diagram shows protective devices for overload, locked rotor, etc., in accordance with the IEEE Standard 588. The project is committed to the relay settings guidance of IEEE 588.

The electrical protection devices and design features dictated by industry codes and standards and by regulatory guidance have been incorporated into the Midland AFW system design. Protective device bypass features required for safety-related operation of motor-operated valves and for ac motor and electrical penetration protection have also been appropriately included in the AFW design. The control circuits for motor-operated valves incorporate design features to bypass thermal overload and opening torque switches in an accident situation. The ac motor protection scheme includes provisions for overload, locked rotor, short circuit, ground fault and undervoltage protection. The electrical penetration protection scheme ensures the mechanical integrity of the penetration in the presence of a single random failure.

4.2.3.4 INSTRUMENTATION -- TOPIC 1.18-1

The scope of the instrumentation topic review activities included design criteria and commitments review, implementing documents review, check of calculations, and a check of drawings and specifications. These activities were applied to the instrumentation required to operate, monitor, and protect the AFW system. Design criteria were compiled from industry, regulatory, architect/engineer, NSSS vendor, and CPC. An instrument setpoint calculation was reviewed for the check of calculation activity. System drawings including P&ID, schematic diagrams, instrument index, and instrument loop diagrams and instrument specifications were reviewed in the check of drawings and specification activity.

The criteria used as a basis for judging the adequacy of the instrumentation design reflect current industry and regulatory practice and are consistent with the Midland FSAR commitments. The criteria represent a conservative design approach in that the AFW instrumentation is required to meet Class IE requirements and it is required to be adequate to monitor system status over normal operational, accident, and expected plant transient conditions.

The AFW system P&ID, instrument loop diagrams, schematic diagrams, panel drawings, and material specifications were reviewed against the applicable design criteria. The parameters monitored for the AFW system at both the main control room (MCR) and the auxiliary shutdown panel (ASP) include AFW system valve positions, S/G pressure, S/G water level, flow rates, pump suction pressure, pump discharge pressure, supply water level, AFW pump motor status, turbine status and turbine-driven steam inlet pressure. The instrumentation hardware was found to consist of quality components with the required redundancy. The design drawings were found to be consistent with each other. Alarms are provided for hi/low flow to each S/G, hi hi S/G level, low AFW pump suction pressure, AFW turbine hi inlet temperature and cooling water low flow, and deaerating feed tank high and low level alarms. The ESFAS alarms indicate actuation of the affected components which is discussed under Topic 1.20-1, Actuation. FOGG actuation is also alarmed and indicated in the MCR.

The ranges for S/G water level measurement, AFW pump suction pressure, and AFW flow instruments were checked and found to be satisfactory. The instrument index incorrectly stated the range of the AFW pump suction, pressure transmitters (2PT-39000 B2 and B4) as 0-1000 psig rather than the correct 0-100 psig. The instruments were correctly ordered with the 0-100 psig range.

It was also noted that the AFW flow transmitters, which provide the signal source for the recirculation control, are blind in that there is not an indication of the transmitter output. This was judged as not significant because there is another indication of AFW flow and there is a valve position indication for the recirculation valve at the MCR and ASP.

The ESFAS-Trip Setpoint and Allowable Value-Steam Generator Low Level (J-6052) calculation was reviewed against the criteria of Regulatory Guide 1.105, Methodology for Determining Instrument Spans and Setpoints. The calculation J-6052 considered or documented the calculation assumptions, purpose and safety function of the instrumentation. The S/G level transmitter and trip bistable error was calculated. The calculation considered the accident analysis process limit, the drift over the calibration period and determined the Technical Specification Trip Setpoint. The calculation was judged to be adequate and was consistent with the requirements of Regulatory Guide 1.105.

OCR 0-023 documented the fact that the S/G water level measurement system is uncompensated for changes in reference leg temperature during accident conditions. When the OCR was originated, the reviewer was not aware that Bechtel was addressing the potential problems caused by the uncompensated level measurement and was in the process of making design changes to correct the potential deficiency. The in-progress design changes had not been incorporated into the design documentation. The following actions are planned by Bechtel: insulate the S/G reference legs, give operator reference leg temperature indication, and change the narrow range level transmitter to decrease the temperature effect. In addition, B&W in calculation 32-1131293-02 showed that with these changes the S/G low water level setpoint could be set within the allowable physical band (in the S/G) while taking the accident temperature effects into account. The Open Item has been resolved on the basis that the B&W calculation has been reviewed. It shows that the safety-related function (the S/G low water level trip or setpoint) can be accomplished using the methods documented in the calculation and proposed by Bechtel.

OCR O-019 indicated that there is not a specific leak detection system for the AFW system which would automatically isolate portions of the system upon detecting a leak. This OCR was resolved on the basis that a room water level monitoring system, using Class IE level instrumentation and design, monitors the water level in each of the AFW pump rooms. If there is water in the sump where the water level monitoring switches are mounted, an alarm will sound in the MCR to alert the operator.

The AFW instrumentation will adequately monitor the system status during normal and accident plant conditions. The capability to monitor the system exists outside the control room. The AFW instrumentation is specified to be procured to safety grade requirements and is designed with the redundancy, separation, and power supplies required for Class IE systems. The parameters monitored include those required by Regulatory Guide 1.97 Rev. 2, GDC-13 Instrumentation and Control, NSSS vendor requirements, and Midland FSAR commitments.

4.2.3.5 CONTROL SYSTEMS -- TOPIC 1.19-1

The range of review activities applied to the Control Systems Topic included the review of design criteria and commitments, review of implementing documents, check of calculations, and check of drawings and specifications. These activities included the identification of all design criteria pertinent to the Control Topic review, an FSAR review for design commitments, and a review of instrument loop diagrams, logic and schematic diagrams, and equipment supplier documentation. The initial scope was to include a review of calculations, but it was found that there were no calculations appropriate to review. This resulted in OCR C-022 which has been resolved and is discussed below.

The control systems scope for the AFW system review included the control circuits for the AFW pumps, motor-operated valves, and, in particular, the steam generator water level control system.

The detailed control provisions were verified by a check of logic diagrams against schematic diagrams. The typical control circuit for AFW motor-operated valves includes permissives (such as AFW pump running for S/G level control valve operation), inhibits (such as S/G hi hi level closing the level control valve), interlocks (such as Feed Only Good Generator - FOGG), manual and automatic control or actuation, bypasses of motor protection upon AFWAS initiation signal and indication of bypassed status (usually accomplished by using an indication of presence or absence of power to control circuit). In summary, the control approach used for the AFW system components can be traced back from schematic to logic diagrams to FSAR critèria to industry and regulatory criteria.

The S/G water level control system was evaluated in detail. The system is designed, when permitted by an AFW pump running signal, to control S/G level at two feet (with forced primary circulation), to allow for manual control of S/G level at the MCR or ASP (overriding automatic control in the MCR), to increase S/G level to 20 feet for natural circulation and to limit the level rise rate to four inches per minute. The level control valves are capable of continuous modulation. The control system is built from Foxboro Spec 200 components and has provisions for the required design characteristics.

Although the appropriate components appeared to be utilized in the S/G water level control system, there was no analysis or calculation with which to verify its response, stability and functional capability to meet the performance design requirements. OCR C-022 documented the lack of such an analysis. The OCR was resolved on the basis that preoperational and startup tests will verify S/G water level control system performance to the design requirements. Preoperational test 2TP AFW.01 will be used to establish the S/G level rise rate adjustment. The Hot Functional Test (2TP AFW.02) will be used to verify that levels are controlled to required values and that ramp rates are within acceptable criteria. Failures of level control valves and AFW pumps will be simulated to confirm control system stability. Additional tests (loss of offsite power and natural circulation) will test the control system stability and ramp rate control at low and high decay heat levels.

OCR C-011 concerned an apparent requirement for FOGG control capability at the ASP and was resolved on the basis that the ASP design requirements do not include postaccident shutdown. The concern documented in OCR C-153 was that the ASP panel assembly drawing did not agree with the system P&ID. The item was resolved on the basis that the demarcations shown on the panel drawing had been misinterpreted and did not represent a S/G. This clarification eliminated the apparent conflict with the P&ID.

AFW control system design criteria were identified and compared to the committed FSAR criteria for the project. The FSAR criteria are consistent with the industry and regulatory criteria, are internally consistent and are sufficiently specific to allow implementation. The criteria have been effectively implemented in control circuitry for the AFW pumps and valves. The control circuits contain local and remote manual features, automatic initiation features, status indication, permissives, inhibits, interlocks (all consistent with system operational requirements) and motor protection features (including protection bypass features evaluated in Topic 1.17-1, Protective Devices/Settings). The controls are designed to safety-grade criteria.

The S/G water level control system consists of quality components which meet the design criteria. The design will be verified by preoperational and startup testing. The features to be verified include the system stability and ability to control S/G water level at specified setpoints and ramp level between setpoints under low, high and no decay heat (steam demand) situations. This approach is judged to be adequate.

4.2.3.6 ACTUATION SYSTEMS -- TOPIC 1.20-1

The Actuation System review activities included the review of design criteria and commitments and a check of drawings and specifications. The check of drawings and specifications represents an expansion to the original scope of the review. This expansion was motivated by a previous design problem with the

FOGG system actuation that had been resolved. All design drawings (logic and schematic diagrams) for actuated equipment were reviewed for application of the design criteria. The Actuation System material requisition (specification) was reviewed for consistency with the design criteria.

The actuation system for the AFW system is a subset of the engineered safety features actuation system (ESFAS) and is named the auxiliary feedwater actuation system (AFWAS). AFWAS automatically initiates AFW flow by starting the proper pumps, aligning the necessary valves, and directing flow to the intact steam generator. The AFWAS is required to be a Class IE, safety-related system designed to protection system criteria. The General Design Criteria regarding protection system functions, reliability, independence, separation from control systems, failure modes and protection against anticipated operational occurrences all apply to the design of AFWAS. Criteria regarding protection against natural phenomena apply as does criteria for single failure, physical and electrical independence, periodic testing, and manual initiation. The criteria are summarized by IEEE-279, Criteria for Protection Systems for Nuclear Power Generating Systems.

The criteria applied to the AFWAS review represent industry and regulatory requirements. The Midland project commitments, as represented by the FSAR, are consistent with these requirements. The AFW system logic diagrams for both AFW pumps and all motor-operated valves were reviewed to ensure that the actuation design criteria had been implemented in the control logic for the AFW components. The logic diagrams were then used to review the component schematic diagrams to verify implementation of the logic into final design documents.

It was found that AFWAS is initiated upon sensing low S/G water level, loss of three reactor coolant pumps, loss of both main feed pumps, Class IE bus undervoltage, emergency core cooling actuation digital subsystem (ECCAS) signal, or low S/G pressure. The AFWAS automatically starts flow to S/Gs by properly starting the AFW pumps and aligning the appropriate valves. The FOGG logic automatically detects a faulted S/G and directs AFW flow to the intact S/G. The suction supply to the AFW system will automatically switch over to the safety grade source on low suction pressure with an AFWAS signal present or the AFW pumps will trip on low suction pressure without an AFWAS initiation signal present. It is also noted that the actuation system design incorporates or allows manual initiation at the system and component levels.

The ESFAS (AFWAS) material requisition was reviewed to ensure that the system was correctly specified in accordance with the design criteria. The review showed that it is specified to meet Class IE requirements in accordance with the provisions of IEEE 279. Those provisions include requirements for identification of the AFWAS as being safety-related and detailing the applicable codes and standards. The codes and standards referenced included all those identified as being applicable to the Actuation Topic in addition to those applicable to Class IE electrical equipment. The Material Requisition also delineated the requirements relative to quality of components, station variables to be monitored, system performance, number of sensors, control and protection interfaces, channel bypass, and test and calibration and indications. All other features required by IEEE 279 were specified.

The AFW actuation system (AFWAS) design criteria and commitments, implementing document and design drawings (logic diagrams and schematic diagrams) were correctly implemented in the documents that have been reviewed. The review included the functions of AFW initiation, alignment of flow paths, manual initiation, automatic suction switchover, FOGG and manual control of AFW system components. The actuation system for AFW (AFWAS) is a conservative design in the safe direction which has been confirmed by a review of the relevant design documentation. No OCRs resulted from the review of this topic.

5.0 REVIEW RESULTS

As discussed in Section 4.0, the Independent Design Verification Program (IDVP) review of the auxiliary feedwater (AFW) system resulted in the preparation and subsequent resolution of both Findings and Confirmed Items. Observations were also issued. Table 5-1 is a tabulation of the number of OCRs in each category. All of the OCRs prepared by the Independent Design and Construction Verification Program (IDCVP) for the review scope covered by this report have been resolved. The resolved Open Items indicated in the table are items which were resolved internally within the IDCVP in accordance with the Project Quality Assurance Plan (PQAP). Table 5-2 breaks down the summary information of Table 5-1 by review topic. A review of Table 5-2 indicates that the primary areas of concern which resulted from the IDVP review were in the following topics.

5.1 EVALUATION OF CONFIRMED ITEMS AND OBSERVATIONS

The PQAP specifies that Confirmed Items are <u>apparent</u> errors in the design and that Findings are <u>verified</u> errors in design. Findings are discussed in detail in Section 5.2 of this report. Observations are minor discrepancies which do not constitute design errors, but which the IDCVP project team recommends correction or further review by Consumers Power Company (CPC) or Bechtel, even though they are not significant enough to warrant further review within the IDCVP. Although resolved Confirmed Items and Observations are not design errors, it is worthwhile to summarize the significance of these items.

Most of the Confirmed Items resulted from the lack of specific project design criteria documents and discrepancies among project documents. The lack of design criteria resulted in OCRs such as C-020, C-025, and C-038. Had the assumptions and design bases for the AFW been clearly specified, the concerns discussed in those OCRs would not have existed.

The lack of centralized design criteria documents may lead to potential conflicts among project documents because it is not always clear which document is controlling. Midland, like many other plants, attempts to use the FSAR as a

TABLE 5-1

SUMMARY OCR STATUS

STATUS	NUMBER
Resolved Open Items	15
Resolved Confirmed Items	13
Resolved Findings	3
Observations	6
Total	37

TABLE 5-2

OCR STATUS BY TOPIC

Topic Number and Title		OCR No.	Status* O/R	C/R	F/R	OBS
1.1-1	System Operating Limits	None				
1.2-1	Accident Analysis Considerations	006	X			
		007	X			
		024	X			
		025		X		
		152				X
1.3-1	Single Failure	059				X
1.5-1	System Alignment/Switchover	013	X			
		014	X			
1.6-1	Remote Operation/Shutdown	None				
1.7-1	System Isolation/Interlocks	None				
1.8-1	Overpressure Protection	003	X			
		004	X			
		026		X		
1.9-1	Component Functional Requirements	027		X		
		028		X		
		038		X		
		062	X			
		072	X			
		080				X
		081		X		
1.10-1	System Hydraulic Design	010		X		
		043			X	
		063				X
		064				X
		158				X
1.11-1	Heat Removal Capability	017		X		
		018			X	
		020		X		

TABLE 5-2

OCR STATUS BY TOPIC
(CONTINUED)

Topic Number and Title	OCR No.	Status* O/R	C/R	F/R	OBS
1.12-1 Cooling Requirements	None				
1.13-1 Water Supplies	None				
1.15-1 Power Supplies	012			X	
	041	X			
1.16-1 Electrical Characteristics	040		X		
1.17-1 Protective Devices/Settings	None				
1.18-1 Instrumentation	019	X			
	023	X			
	029	X			
1.19-1 Control Systems	008	X			
	011		X		
	022		X		
	030	X			
	153		X		
1.20-1 Actuation Systems	None				
1.23-1 Failure Mode and Effects	None				

* Status Categories:
O/R Opened and subsequently Resolved
C/R Confirmed and subsequently Resolved
F/R Resolved Finding
OBS Observation

Note: Where an OCR is related to two or more topics, it is listed in the table based upon the first topic number identified for the OCR in the monthly OCR tracking system summary table.

criteria document; however, the FSAR also serves to summarize project analyses, including analyses requested by the NRC. After multiple amendments, it is difficult to determine whether a statement in the FSAR is a design basis for the plant or an assumption used for a special analysis. OCRs such as C-017, C-027, and C-028 resulted from conflicts among project documents.

The IDVP review was also affected by the lack of documentation for certain analyses such as failure modes and effects analyses and single-failure analyses. This concern was documented in an Observation and the IDVP performed a confirmatory evaluation in these areas. No errors were found as a result of the confirmatory analysis, which indicates that the process used by Bechtel produces acceptable results although more documentation than just a summary in the FSAR is desirable. Failure modes and effects and single failure analyses are being considered in the reviews of the other two systems within the IDVP. The results of those reviews will be discussed in the reports on system performance for those systems.

A number of the Observations resulted from minor errors in calculations which did not effect the actual design, but which should have been found in the normal checking process applied to safety-related calculations. The IDVP project team is reviewing additional Bechtel calculations as part of the remaining IDVP scope. The conclusion of those reviews and this review will be used in reaching overall conclusions regarding the general adequacy of calculations.

5.2 EVALUATION OF FINDINGS

As indicated in Tables 5-1 and 5-2, the review of the AFW resulted in the issuance of three Findings, F-012, F-018, and F-043. These Findings, actions taken by the Midland project, and the generic implications of each Finding are discussed in the following subsections.

5.2.1 FINDING F-012, POWER SUPPLIES -- TOPIC 1.15-1

The Finding F-012 was noted during the review of schematic diagram E-158 for AFW valves. A check of the power supply to each of the AFW components, including auxiliary relays, revealed the fact that the feed only good generator (FOGG) interlock relays did not receive their power from a dc-backed source. A check of the logic diagram (J-501) showed that no power supply was specified for the FOGG relays 3x-1 and 3x-2. A check of plant single-line diagrams, E-1 and E-24, confirmed that the actual power supply to the FOGG relays was 120 Vac instrument power (non-dc backed power). A review of the control circuitry for valves 2MO-3277A and B (block valves for admission of steam to the AFW pump turbine) on drawing E-158 clearly indicated that in the event of a loss of all ac, the valves would automatically close and would not reopen even if manual control were imposed. This deficiency was documented in the Management Corrective Action Report (MCAR) 68 and reported to the NRC by CPC in accordance with 10 CFR 50.55(e).

5.2.1.1 ACTIONS/MODIFICATIONS TAKEN BY THE MIDLAND PROJECT

In MCAR 68, dated August 15, 1983, the following corrective actions were listed and documented as having been taken:

- Revise design drawings so as to power FOGG relays with Class 1E dc backed 120 Vac power
- Bechtel engineering review of all power supplies to Class 1E interlocks for valves and prime movers requiring Class 1E dc backed power
- Engineering instructions to include a review of power supplies conformance to FSAR requirements during design verification.

Bechtel issued for construction a design change package incorporating the necessary design modifications in July 1983. The actions taken were considered adequate to resolve the Finding.

5.2.1.2 GENERIC IMPLICATIONS

This Finding is the third design discrepancy in assignment of power supplies identified during the Midland design process. The two prior discrepancies were found and corrected prior to the initiation of the IDCVP. The first of these was reported in June 1980, and documented in MCAR-39 which identified an improper power supply assignment to an emergency core cooling actuation (ECCAS) digital subsystem. The apparent cause of the discrepancy was a misinterpretation of the Midland plant 120 Vac preferred power system. The problem was corrected by a reassignment of the power supply to one ECCAS digital subsystem.

The second discrepancy of a similar nature to Finding F-012 was documented by MCAR-57, AFW Level Control Valves Power Supplies. It was found that the AFW level control valves were powered from 120 Vac power and would not be functional during station blackout. The satisfactory solution to this problem was to power the valves from preferred power. Other corrective actions taken in response to this MCAR included a review of the FSAR to verify that all commitments to feed components and/or systems from any of the Class IE and non-Class IE 120 Vac preferred power systems were met. An attachment to MCAR 57 did not identify the FOGG auxiliary relays as one of the components for which the FSAR had made a commitment regarding preferred power.

In an effort to determine root cause and extent for Finding F-012, it was noted that the power supply type and source for the auxiliary relays was not specified on the FOGG logic diagram (J-501). As part of the MCAR 68 corrective action, all Class IE schemes for AFW were reviewed against their corresponding logic diagrams. No other deficiencies were found. The problem identified by Finding F-012 could have been found in the earlier MCAR 57 review had the power supply requirements been specified on the logic diagram. The lack of this information on the logic diagram appears to have been a contributing factor to the root cause of Finding F-012.

Station blackout design considerations evolved within the nuclear industry during the design of the Midland plant. The NRC considers capability to withstand a blackout event to be a design requirement; however, this condition is not formally considered part of the Midland design basis by CPC. Various evaluations of the plant's capability to safely deal with the station blackout event have been performed by CPC, and the AFW system has the capability to perform its necessary functions during the assumed two-hour blackout event. The IDCVP believes that the blackout event should be treated as a design basis for Midland. The impact of changing regulatory criteria, as well as the decision not to formally adopt the station blackout event as a design basis, may have contributed to the series of design discrepancies concerning this event which are discussed above.

5.2.2 FINDING F-018, DESIGN PARAMETERS -- TOPICS 1.10-1, 1.11-1

This Finding is concerned with the discrepancies that were found in the design criteria applicable to the AFW system. These criteria involved the assumptions used to determine the required flow for the AFW system which, of course, is a fundamental parameter for the AFW system. For example, the method of calculating decay heat was incorrectly described in the FSAR and parameters such as water temperature and reactor power level varied depending upon the document reviewed. For this Finding the IDVP was able to resolve its concerns by performing its own calculations which determined that the AFW system flow rate was adequate assuming that appropriate criteria are selected.

5.2.2.1 ACTIONS/MODIFICATIONS TAKEN BY THE MIDLAND PROJECT

As noted above, appropriate selection of criteria and commitments allows this finding to be resolved without change to AFW components. In order to achieve this situation, however, it was necessary that clarifications be added to the FSAR to remove misleading statements regarding the decay heat calculation method employed for sizing the AFW system. Actions being taken by the Midland project to ensure the adequacy of the interface between B&W and the project and to ensure that FSAR commitments have been implemented will be discussed in a subsequent report. In addition, actions taken by the project to document in a consistent fashion the design criteria and commitments applicable to the plant will be discussed.

5.2.2.2 GENERIC IMPLICATIONS

A generic concern raised by this Finding is the possibility that the interface between the Midland project (CPC and Bechtel) and B&W may not have been adequate to ensure appropriate implementation of interface criteria. A secondary concern is that the root cause of this Finding may be the lack of centralized design criteria against which various aspects of the design could be checked. The IDVP is making further reviews in these areas and will address the generic implications of this finding in more detail in a subsequent report. It should be noted that the concern about adequate design criteria has been raised in the reviews of the other two systems within the IDVP and, furthermore, it is noted that the Construction Project Evaluation (Rev. I, March 2, 1983) performed by Management Analysis Company (MAC) also indicated that there was a concern in this area.

5.2.3 FINDING F-043, CLASSIFICATION OF SUCTION PIPING -- TOPIC 1.10-1

This Finding arose due to confusion regarding which of several documents was controlling. The area which was of concern for this Finding had to do with the method for identification of which hangers are subject to the "hanger critical" provisions of Bechtel specification M-327. This designation applies to certain hangers, including those for piping which is seismically analyzed but not ASME Section III. Bechtel advised the IDVP that a degree of uncertainty also existed within the project and that a procedural change was required to ensure that errors did not occur. The IDVP reviewed a change notice to a project specification which clarified the situation. Because no errors were found which affected end products and the documentation was correct, it is concluded that no significant generic implications exist.

5.2.3.1 ACTIONS/MODIFICATIONS TAKEN BY THE MIDLAND PROJECT

As noted above, one Bechtel specification was modified to clarify its intent. The Midland project determined that no other action was necessary. The IDVP concurs in that conclusion.

5.2.3.2 GENERIC IMPLICATIONS

Nuclear power plant projects require appropriate procedures to control the activities being conducted. Equally important, however, is the need that those procedures be clearly written and avoid ambiguities. In this case it was determined that the procedure was being implemented properly and that the specification change notice confirmed the method being used. The IDVP therefore concluded that no significant generic concerns exist regarding this matter.

5.2.4 SUMMARY OF FINDINGS

The three Findings discussed in this report have different levels of significance. Clearly, F-012 is the most significant because the AFW system would not have been able to function in the blackout condition had the error remained uncorrected. CPC recognized the significance of this problem, reported it to the NRC in accordance with 10 CFR 50.55(e), and took prompt corrective action. The lack of a specific design commitment for the blackout event and design criteria documents may have contributed to the error, but failure to adequately verify implementation of criteria may have been a contributing factor. It should be noted that the relay error discussed in F-012 may have been found during plant testing. The IDVP gave no credit for this testing because the detailed test procedures were not complete and the objective of the IDVP is to test the quality of the end product of the design process.

F-018 resulted from the problems inherent in trying to use the FSAR as a criteria document and a summary of project evaluations. Although not as serious an error as F-012, the FSAR has to be corrected so that it reflects the actual design bases of the system. F-018 is considered less serious than F-012 as far as the AFW system is concerned because the AFW could have achieved its safety function had the FSAR not been amended.

It may not have been necessary for F-043 to have been classified as a Finding. The supports which were of concern regarding their classification as "hanger critical" were, in fact, properly classified. The Finding originated because of a lack of certainty as to which of two Bechtel documents is controlling. Bechtel has issued a change notice to clarify the situation. The Bechtel action appears to have resulted from questions raised by Bechtel site personnel who were using the documents. The Bechtel change notice for the M-327 document was issued while the IDVP was reviewing M-327. The refinement of documents such as M-327 is an ongoing process for any large project. Thus, the significance of F-043 is much less than either F-012 or F-018 because no error actually existed.

5.3 ONGOING ACTIVITIES

The IDVCP evaluated all Observations, Confirmed Items, and Findings for generic implications. While the Observations and Confirmed Items did not individually warrant additional review, collectively two potential causes of many of these inconsistencies were identified. Potential causes under investigation are the lack of centralized design criteria documents and calculation control procedure implementation. Likewise the evaluation for generic implications of the Findings identified two potentially generic concerns regarding the adequacy of implementation of balance-of-plant (BOP) interface criteria and evolving regulatory criteria. While it is premature to report general conclusions with applicability to systems other than the AFW, verification activities for the other IDVP systems and review topics have been augmented to address these concerns to ensure that no safety-significant design deficiencies remain undetected. A subsequent IDVP report will address the evaluation of these general concerns.

5.3 CONCLUSIONS

Based upon the IDCVP review and independent confirmatory evaluations, it is concluded for areas within the scope of this report that confidence exists that the AFW system will perform its intended safety functions. This conclusion is predicated upon implementation of design modifications which are necessary to ensure operation of the AFW system during a postulated station blackout event. The error in the design associated with the station blackout event may have been found during system testing, although this could not be verified by the IDCV project team.

APPENDIX A

OVERVIEW OF THE MIDLAND INDEPENDENT
DESIGN AND CONTRUCTION VERIFICATION
PROGRAM

APPENDIX A

OVERVIEW OF THE MIDLAND INDEPENDENT DESIGN AND CONSTRUCTION VERIFICATION PROGRAM

A1 INTRODUCTION

A1.1 BACKGROUND AND PURPOSE

The Nuclear Regulatory Commission (NRC) issued a letter on July 9, 1982, which requested that Consumers Power Company (CPC) provide for an independent assessment of the design adequacy of the Midland plant. CPC responded to this request on October 5, 1982, by submitting an outline of the scope of a proposed independent review program. A public meeting was held on October 25, 1982, at the NRC's Bethesda, Maryland offices to discuss details of the proposed program, the scope of which included an evaluation of the Midland Unit 2 auxiliary feedwater (AFW) system. During this meeting, the NRC requested that the scope of the independent design assessment program be expanded, including an assessment of the quality of construction. The NRC requested that CPC identify three candidate systems for scope expansion based, upon their contribution to plant risk, from which one system would be selected.

CPC responded to NRC with a letter dated December 3, 1982, which identified the standby electric power system (diesel generator), safeguards chilled water system, and containment isolation system as candidate systems. A public meeting was held on February 8, 1983, at Midland, Michigan, to discuss details of the program related to the evaluation of the AFW system and to provide information regarding the status of that review.

On March 22, 1983, the NRC selected the standby electric power (SEP) system and the control room HVAC (CR-HVAC) system for scope expansion. Proposed elements of the scope of evaluation for these systems as well as the AFW system were discussed at another public meeting held on April 13, 1983, at the NRC's Bethesda, Maryland offices.

TERA Corporation was selected by CPC to scope, manage, and implement the Midland Independent Design and Construction Verification Program (IDCVP). By a letter dated May 3, 1983, the NRC approved the selection of TERA and TERA's Engineering Program Plan (EPP), Project Instruction PI-3201-009, of the Project Quality Assurance Plan (PQAP), for evaluating the AFW system. The selection of TERA was based upon the firm's technical qualifications, experience, and independence from the Midland project. Such independence includes all individuals who may contribute to the IDCVP. On July 22, 1983, the NRC issued a letter approving TERA's EPP for all three systems and the IDCVP PQAP. In a letter dated February 10, 1984, TERA identified a need to supplement selected topical reviews within the Independent Design Verification Program (IDVP) with an evaluation of engineering procedures, action plans and their implementation where Midland project design-related activities are ongoing. Details of TERA's plans were discussed at a March 13, 1984, public meeting. The NRC indicated approval of TERA's plans in a letter dated June 6, 1984.

The IDCVP approach selected is a review and evaluation of a detailed "vertical slice" of the Midland project with a focus on providing an overall assessment of the quality of the design and the constructed plant. Therefore, the primary emphasis of the IDCVP evaluation is on the end results of the design and construction process and not on an evaluation of the process itself which is typical of the more common quality assurance audit. The "vertical slice" constitutes a carefully selected sample of three safety systems from which the results of the IDCVP may be extrapolated to other similarly designed and constructed systems. Thus, the IDCVP is intended to provide the necessary assurance to CPC, NRC, and the public that the Midland Plant is designed and constructed such that it is capable of functioning in accordance with its safety design bases and NRC regulations, and that applicable licensing criteria and commitments have been properly implemented.

The execution of the IDCVP has been structured to create an auditable trail of documentation for IDCVP conclusions. Summaries of the IDCVP review process, engineering evaluations, and conclusions are provided in an series of topical reports to which this programmatic overview is appended.

A1.2 OVERVIEW OF THE IDCVP SCOPE AND DEPTH OF REVIEW

The Midland IDCVP consists of two major components: the Independent Design Verification Program (IDVP) and the Independent Construction Verification Program (ICVP). The Unit 2 auxiliary feedwater (AFW) system, the standby electric power (SEP) system and the control room heating, ventilating and air conditioning (CR-HVAC) system related to control room habitability have been selected as applicable samples of the design engineering and construction efforts at the Midland plant. The AFW system was selected by TERA based upon the system selection criteria discussed in Section A3.2 of this appendix. The SEP and CR-HVAC systems selected by the CPC and NRC have a sufficiently high profile for each of these criteria to justify their selection.

The scope of review corresponds directly to the design and construction chains, addressing major activities and outputs of the various contributing engineering and construction disciplines. Accordingly, the products of the design and construction process, from concept to installation, hydrostatic heating, functional and preoperational testing and turnover are evaluated. Interfaces among CPC; Babcock and Wilcox (B&W), the nuclear steam supply system (NSSS) vendor; Bechtel, the architect-engineer (A-E); and other contractors are identified and evaluated relative to such items as the proper transfer and interpretation of design or construction information.

Figure A-1 shows the interrelationship between the design and construction process and corresponding categories of review within the IDCVP scope. When these categories of review are combined with a listing of design/construction topics, a matrix is formed which is utilized to direct conduct of the IDCVP. The design review matrix is divided into three major divisions: System Performance Requirements, System Protection Features, and Structures that House the

INTER-RELATIONSHIP BETWEEN THE MIDLAND DESIGN AND CONSTRUCTION PROCESS AND THE MIDLAND IDCV PROGRAM

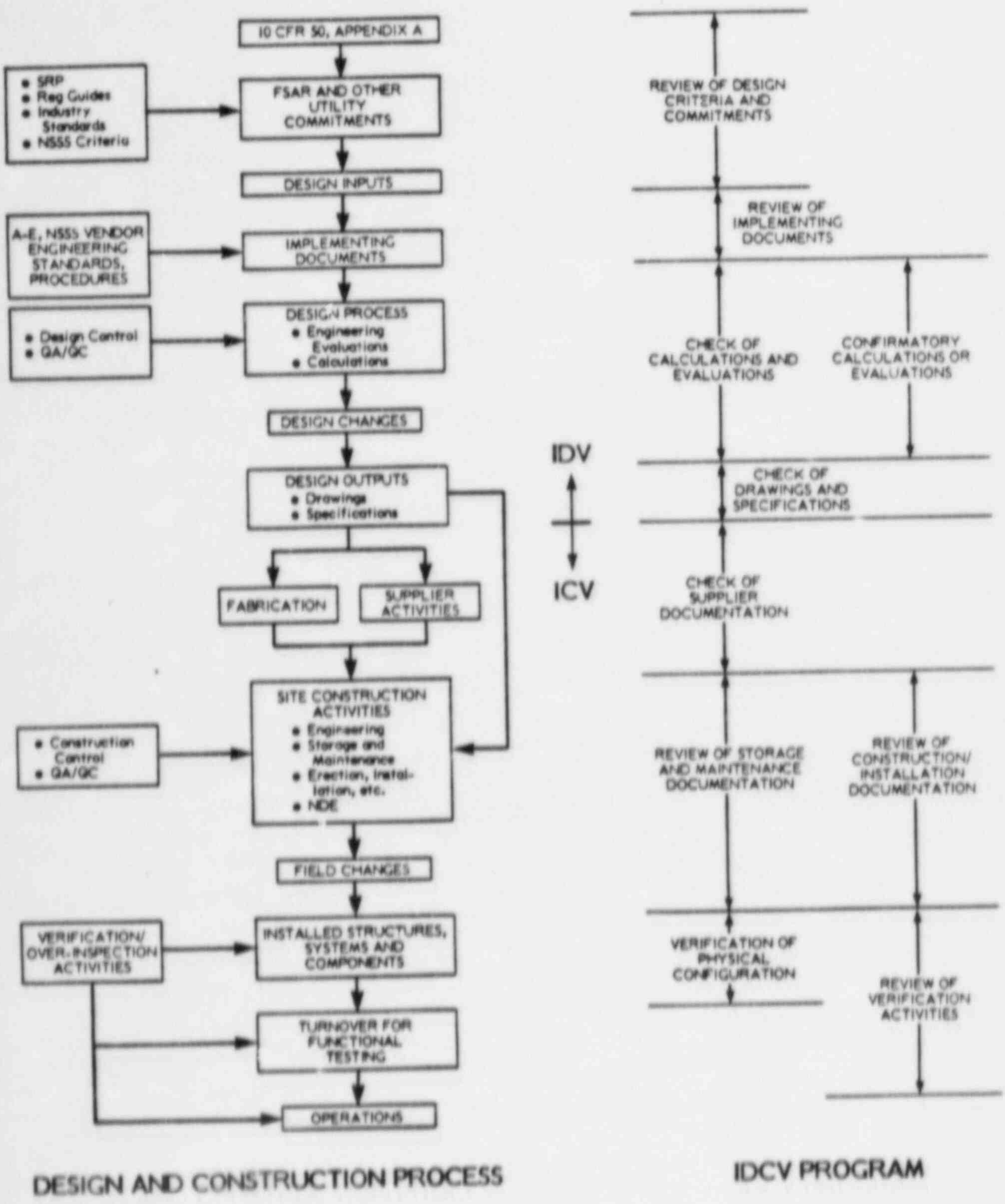

FIGURE A-1

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System. The construction review matrix is divided into five major divisions corresponding to various component types: Mechanical, Electrical, Instrumentation and Control, HVAC and Structural.

The following figures present the IDCVP sample review matrices for the AFW, SEP and CR-HVAC systems.

Figures

System	Design Verification	Construction Verification
AFW	A-2, A-3	A-4
SEP	A-5, A-6	A-7
CR-HVAC	A-8, A-9	A-10

It should be noted that the scope of technical review is dynamic and subject to change as more emphasis is given to specific review areas that meet prescribed criteria. These criteria are documented in Section A3.2 of this appendix. Accordingly, any additions or deletions of scope as represented on the initial sample review matrices are indicated on the appropriate sample review matrices.

A1.3 INTERRELATIONSHIP WITH OTHER PROGRAMS

In addition to the Midland IDCVP, there are several other NRC approved independent review activities which are evaluating specific aspects of the Midland project.

- o Independent Management Appraisal Program (IMAP)
- o Construction Implementation Overview (CIO)
- o Soils Overview

The IMAP is under the direction of Cresap, McCormick and Paget with technical assistance from TERA Corporation. This program is designed to provide an

INITIAL SAMPLE REVIEW MATRIX FOR THE AUXILIARY FEEDWATER SYSTEM
MIDLAND INDEPENDENT DESIGN VERIFICATION PROGRAM[1]

TOPIC NUMBER	DESIGN AREA	SCOPE OF REVIEW: REVIEW OF DESIGN CRITERIA AND COMMITMENTS	REVIEW OF IMPLEMENTING DOCUMENTS	CHECK OF CALCULATIONS AND EVALUATIONS	CONFIRMATORY CALCULATION OR EVALUATION	CHECK OF DRAWINGS AND SPECIFICATIONS
	AFW SYSTEM PERFORMANCE REQUIREMENTS					
1.1-1	SYSTEM OPERATING LIMITS	X	X	X		
1.2-1	ACCIDENT ANALYSIS CONSIDERATIONS	X	•			
1.3-1	SINGLE FAILURE	X	X	X	•	
1.4-1	TECHNICAL SPECIFICATIONS	X	X			
1.5-1	SYSTEM ALIGNMENT/SWITCHOVER	X	X			
1.6-1	REMOTE OPERATION AND SHUTDOWN	X				
1.7-1	SYSTEM ISOLATION/INTERLOCKS	X	X			
1.8-1	OVERPRESSURE PROTECTION	X	•	•	•	
1.9-1	COMPONENT FUNCTIONAL REQUIREMENTS	X	X	X		X
1.10-1	SYSTEM HYDRAULIC DESIGN	X	X	X	•	
1.11-1	SYSTEM HEAT REMOVAL CAPABILITY	X	X	X	•	
1.12-1	COOLING REQUIREMENTS	X				
1.13-1	WATER SUPPLIES	X	X			
1.14-1	PRESERVICE TESTING/CAPABILITY FOR OPERATIONAL TESTING	X	•	•		
1.15-1	POWER SUPPLIES	X	X			•
1.16-1	ELECTRICAL CHARACTERISTICS	X	•	•		
1.17-1	PROTECTIVE DEVICES/SETTINGS	X	X			X
1.18-1	INSTRUMENTATION	X	X	X		X
1.19-1	CONTROL SYSTEMS	X	X	X		•
1.20-1	ACTUATION SYSTEMS	X				•
1.21-1	NDE COMMITMENTS	X	•			•
1.22-1	MATERIALS SELECTION	X	X			
1.23-1	FAILURE MODES AND EFFECTS	•	•		•	

KEY

X - INITIAL SCOPE OF REVIEW

(X) - DELETED SCOPE OF REVIEW

• - ADDED SCOPE OF REVIEW

NOTE

1. INITIAL SAMPLE DOCUMENTED IN REV. 0 AND 1 OF THIS PLAN HAS BEEN MODIFIED EFFECTIVE 4/13/83

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FIGURE A-2

INITIAL SAMPLE REVIEW MATRIX FOR THE AUXILIARY FEEDWATER SYSTEM MIDLAND INDEPENDENT DESIGN VERIFICATION PROGRAM (CONTINUED)[1]

TOPIC NUMBER	DESIGN AREA	SCOPE OF REVIEW: REVIEW OF DESIGN CRITERIA AND COMMITMENTS	REVIEW OF IMPLEMENTING DOCUMENTS	CHECK OF CALCULATIONS AND EVALUATIONS	CONFIRMATORY CALCULATION OR EVALUATION	CHECK OF DRAWINGS AND SPECIFICATIONS
	AFW SYSTEM PROTECTION FEATURES					
II.1-1	SEISMIC DESIGN	X				
II.2-1	• PRESSURE BOUNDARY	X	X	X	X	X
II.3-1	• PIPE/EQUIPMENT SUPPORT	X	X	X	X	X
II.4-1	• EQUIPMENT QUALIFICATION	X	X	X		X
II.5-1	HIGH ENERGY LINE BREAK ACCIDENTS	X				
II.6-1	• PIPE WHIP	X	X	X		X
II.7-1	• JET IMPINGEMENT	X				
II.8-1	ENVIRONMENTAL PROTECTION	X				
II.9-1	• ENVIRONMENTAL ENVELOPES	X	X	X	X	X
II.10-1	• EQUIPMENT QUALIFICATION	X	X	X		X
II.11-1	• HVAC DESIGN	X				
II.12-1	FIRE PROTECTION	X	X	X		
II.13-1	MISSILE PROTECTION	X				
II.14-1	SYSTEMS INTERACTION	X	X	X		
	STRUCTURES THAT HOUSE THE AFW SYSTEM					
III.1-1	SEISMIC DESIGN/INPUT TO EQUIPMENT	X	X	X		X
III.2-1	WIND & TORNADO DESIGN/MISSILE PROTECTION	X				
III.3-1	FLOOD PROTECTION	X				
III.4-1	HELBA LOADS	X				
III.5-1	CIVIL/STRUCTURAL DESIGN CONSIDERATIONS	X				
III.6-1	• FOUNDATIONS	X	X	X		
III.7-1	• CONCRETE/STEEL DESIGN	X	X	X		X
III.8-1	• TANKS	(X)	(X)	(X)		

KEY

X - INITIAL SCOPE OF REVIEW

(X) - DELETED SCOPE OF REVIEW

• - ADDED SCOPE OF REVIEW

NOTE

1. INITIAL SAMPLE DOCUMENTED IN REV. 0 AND 1 OF THIS PLAN HAS BEEN MODIFIED EFFECTIVE 4/13/83

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FIGURE A-3

INITIAL SAMPLE REVIEW MATRIX FOR THE AUXILIARY FEEDWATER SYSTEM
MIDLAND INDEPENDENT CONSTRUCTION VERIFICATION PROGRAM[1]

TOPIC NUMBER	SYSTEM/COMPONENT	SCOPE OF REVIEW: REVIEW OF SUPPLIER DOCUMENTATION	REVIEW OF STORAGE AND MAINTENANCE DOCUMENTATION	REVIEW OF CONSTRUCTION/ INSTALLATION DOCUMENTATION	REVIEW OF SELECTED VERIFICATION ACTIVITIES	VERIFICATION OF PHYSICAL CONFIGURATION
	MECHANICAL					
I.1-Ic	• EQUIPMENT	X	X	X	X	X
I.2-Ic	• PIPING	X		X	X	X
I.3-Ic	• PIPE SUPPORTS	X		X	X	X
	ELECTRICAL					
II.1-Ic	• EQUIPMENT	X	X	X	X	X
II.2-Ic	• TRAYS AND SUPPORTS	X		•	•	X
II.3-Ic	• CONDUIT AND SUPPORTS	X		•	•	X
II.4-Ic	• CABLE	X	X	X	X	X
	INSTRUMENTATION AND CONTROL					
III.1-Ic	• INSTRUMENTS	X	X	X	X	X
III.2-Ic	• PIPING/TUBING	X				X
III.3-Ic	• CABLE	X		•	•	X
	HVAC					
IV.1-Ic	• EQUIPMENT	X	X	X	X	X
IV.2-Ic	• DUCTS AND SUPPORTS	X				X
	STRUCTURAL					
V.1-Ic	• FOUNDATIONS	X		X		
V.2-Ic	• CONCRETE	X		X		X
V.3-Ic	• STRUCTURAL STEEL	X		X		X
VI.1-Ic	NDE/MATERIAL TESTING PROGRAM					•

KEY

X - INITIAL SCOPE OF REVIEW

(X) - DELETED SCOPE OF REVIEW

• - ADDED SCOPE OF REVIEW

NOTE

1. INITIAL SAMPLE DOCUMENTED IN REV. 0 AND 1 OF THIS PLAN HAS BEEN MODIFIED EFFECTIVE 4/13/83

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INITIAL SAMPLE REVIEW MATRIX FOR THE STANDBY ELECTRIC POWER SYSTEM
MIDLAND INDEPENDENT DESIGN VERIFICATION PROGRAM

TOPIC NUMBER	DESIGN AREA	SCOPE OF REVIEW: REVIEW OF DESIGN CRITERIA AND COMMITMENTS	REVIEW OF IMPLEMENTING DOCUMENTS	CHECK OF CALCULATIONS AND EVALUATIONS	CONFIRMATORY CALCULATION OR EVALUATION	CHECK OF DRAWINGS AND SPECIFICATIONS
	STANDBY ELECTRIC POWER SYSTEM PERFORMANCE REQUIREMENTS					
1.1-2	SYSTEM OPERATING LIMITS - DG	X	X	X		
1.2-2	ACCIDENT ANALYSIS CONSIDERATIONS - DG, AC, DC	X	X			
1.3-2	SINGLE FAILURE - DG, PDS, AC, DC	X	X	X	X	
1.4-2	TECHNICAL SPECIFICATIONS - DG, DC	X	X			
1.6-2	LOCAL OPERATION - DG	X				
1.7-2	SYSTEM INTERLOCKS - DG	X	X			
1.9-2	COMPONENT FUNCTIONAL REQUIREMENTS - DG, PDS, AC, DC	X	X	X		X
1.12-2	COOLING/HEATING REQUIREMENTS - DG	X	X	X		
1.14-2	PRESERVICE TESTING/CAPABILITY FOR OPERATIONAL TESTING - DG	X	X	X		X
1.16-2	ELECTRICAL CHARACTERISTICS - DG, PDS, AC, DC	X	X	X		X
1.17-2	PROTECTIVE DEVICES/SETTINGS - DG, PDS	X	X	X		
1.18-2	INSTRUMENTATION - DG, AC, DC	X	X	X		X
1.19-2	CONTROL SYSTEMS - DG	X	X	X		X
1.20-2	ACTUATION SYSTEMS - DG	X	X	X		X
1.23-2	FAILURE MODES AND EFFECTS - DG, PDS, AC, DC	X	X	X		
1.24-2	ELECTRICAL LOAD CAPACITY - DG, PDS, AC, DC	X	X	X	X	
1.25-2	ELECTRICAL LOADS SEQUENCING - DG, PDS	X	X	X		X
1.26-2	ELECTRICAL LOAD SHEDDING - DG, PDS	X	X	X		
1.27-2	FUEL OIL SYSTEM - DG	X	X	X		
1.28-2	LUBE OIL SYSTEM - DG	X	X			
1.29-2	STARTING MECHANISM AND AIR SUPPLY SYSTEM - DG	X	X	X		X
1.30-2	COMBUSTION AIR SUPPLY - DG	X	X	X		
1.31-2	INDEPENDENCE - DG, PDS, AC, DC	X	X	X		
1.32-2	CABLE SIZING/ROUTING/SEPARATION - PDS	X	X	X	X	X

KEY
- DG - DIESEL GENERATOR
- DGB - DIESEL GENERATOR BUILDING
- PDS - POWER DISTRIBUTION SYSTEM
- AC - PREFERRED 120V AC POWER SYSTEM SERVICING AFW SYSTEM
- DC - 125V DC POWER SYSTEM SERVICING AFW SYSTEM

INITIAL SAMPLE REVIEW MATRIX FOR THE STANDBY ELECTRIC POWER SYSTEM MIDLAND INDEPENDENT DESIGN VERIFICATION PROGRAM (CONTINUED)

TOPIC NUMBER	DESIGN AREA	SCOPE OF REVIEW: REVIEW OF DESIGN CRITERIA AND COMMITMENTS	REVIEW OF IMPLEMENTING DOCUMENTS	CHECK OF CALCULATIONS AND EVALUATIONS	CONFIRMATORY CALCULATION OR EVALUATION	CHECK OF DRAWINGS AND SPECIFICATIONS
	<u>STANDBY ELECTRIC POWER SYSTEM PROTECTION FEATURES</u>					
II.1-2	SEISMIC DESIGN	X				
II.2-2	• PRESSURE BOUNDARY - DG	X	X	X		
II.3-2	• PIPE/EQUIPMENT SUPPORT - DG, PDS	X	X	X	X	X
II.4-2	• EQUIPMENT QUALIFICATION - DG, PDS	X	X	X		X
II.5-2	HIGH ENERGY LINE BREAK ACCIDENTS	X				
II.6-2	• PIPE WHIP - PDS, AC, DC	X				
II.7-2	• JET IMPINGEMENT - PDS, AC, DC	X				
II.8-2	ENVIRONMENTAL PROTECTION	X				
II.9-2	• ENVIRONMENTAL ENVELOPES - DG, PDS	X				
II.10-2	• EQUIPMENT QUALIFICATION - DG, PDS	X	X	X		X
II.11-2	• HVAC DESIGN - DG	X				
II.12-2	FIRE PROTECTION - DG	X	X	X		
II.13-2	MISSILE PROTECTION - DG	X				
II.14-2	SYSTEMS INTERACTION - DG, PDS, AC, DC	X	X			
	<u>STRUCTURES THAT HOUSE THE STANDBY ELECTRIC POWER SYSTEM</u>					
III.1-2	SEISMIC DESIGN/INPUT TO EQUIPMENT - DGB	X	X	X		X
III.2-2	WIND & TORNADO DESIGN/MISSILE PROTECTION - DGB	X	X	X		X
III.3-2	FLOOD PROTECTION - DGB	X	X	X		
III.4-2	HELBA LOADS - DGB	X				
III.5-2	CIVIL/STRUCTURAL DESIGN CONSIDERATIONS					
III.6-2	• FOUNDATIONS - DGB	X	X	X		
III.7-2	• CONCRETE/STEEL DESIGN - DGB	X	X	X		X
III.8-2	• TANKS	X	X	X	X	X

<u>KEY</u>

DG - DIESEL GENERATOR
DGB - DIESEL GENERATOR BUILDING
PDS - POWER DISTRIBUTION SYSTEM
AC - PREFERRED 120V AC POWER SYSTEM SERVICING AFW SYSTEM
DC - 125V DC POWER SYSTEM SERVICING AFW SYSTEM

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FIGURE A-6

INITIAL SAMPLE REVIEW MATRIX FOR THE STANDBY ELECTRIC POWER SYSTEM
MIDLAND INDEPENDENT CONSTRUCTION VERIFICATION PROGRAM

		SCOPE OF REVIEW				
TOPIC NUMBER	SYSTEM/COMPONENT	REVIEW OF SUPPLIER DOCUMENTATION	REVIEW OF STORAGE AND MAINTENANCE DOCUMENTATION	REVIEW OF CONSTRUCTION/ INSTALLATION DOCUMENTATION	REVIEW OF SELECTED VERIFICATION ACTIVITIES	VERIFICATION OF PHYSICAL CONFIGURATION
	MECHANICAL					
I.1-2c	• EQUIPMENT - DG	X	X	X	X	X
I.2-2c	• PIPING - DG	X		X		X
I.3-2c	• PIPE SUPPORTS - DG	X		X		X
	ELECTRICAL					
II.1-2c	• EQUIPMENT - DG, PDS, AC, DC	X	X	X	X	X
II.2-2c	• TRAYS AND SUPPORTS - PDS	X		X	X	X
II.3-2c	• CONDUIT AND SUPPORTS - PDS	X		X	X	X
II.4-2c	• CABLE - PDS	X	X	X	X	X
	INSTRUMENTATION AND CONTROL					
III.1-2c	• INSTRUMENTS - DG	X	X	X	X	X
III.2-2c	• PIPING/TUBING - DG	X		X		X
III.3-2c	• CABLE - DG, PDS	X	X	X	X	X
	HVAC					
IV.1-2c	• EQUIPMENT - DG	X				X
IV.2-2c	• DUCTS AND SUPPORTS - DG	X				X
	STRUCTURAL					
V.1-2c	• FOUNDATIONS - DG	X		X		
V.2-2c	• CONCRETE - DG	X		X		
V.3-2c	• STRUCTURAL STEEL - DG	X		X		

KEY
DG - DIESEL GENERATOR
DGB - DIESEL GENERATOR BUILDING
PDS - POWER DISTRIBUTION SYSTEM
AC - PREFERRED 120V AC POWER SYSTEM SERVICING AFW SYSTEM
DC - 125V DC POWER SYSTEM SERVICING AFW SYSTEM

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FIGURE A-7

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INITIAL SAMPLE REVIEW MATRIX FOR THE CONTROL ROOM HVAC SYSTEM
MIDLAND INDEPENDENT DESIGN VERIFICATION PROGRAM

TOPIC NUMBER	DESIGN AREA	SCOPE OF REVIEW				
		REVIEW OF DESIGN CRITERIA AND COMMITMENTS	REVIEW OF IMPLEMENTING DOCUMENTS	CHECK OF CALCULATIONS AND EVALUATIONS	CONFIRMATORY CALCULATION OR EVALUATION	CHECK OF DRAWINGS AND SPECIFICATIONS
	CONTROL ROOM HVAC SYSTEM PERFORMANCE REQUIREMENTS					
1.1-3	SYSTEM OPERATING LIMITS	X	X	X		
1.2-3	ACCIDENT ANALYSIS CONSIDERATIONS	X	X			
1.3-3	SINGLE FAILURE	X	X	X		
1.4-3	TECHNICAL SPECIFICATIONS	X	X			
1.5-3	SYSTEM ALIGNMENT/SWITCHOVER	X	X			
1.7-3	SYSTEM ISOLATION/INTERLOCKS	X	X	X		X
1.9-3	COMPONENT FUNCTIONAL REQUIREMENTS	X	X	X		X
1.10-3	SYSTEM PNEUMATIC DESIGN	X	X	X	X	X
1.12-3	COOLING/HEATING REQUIREMENTS	X	X	X		
1.14-3	PRESERVICE TESTING/CAPABILITY FOR OPERATIONAL TESTING	X	X			
1.15-3	POWER SUPPLIES	X	X			
1.18-3	INSTRUMENTATION/DETECTION	X	X	X		X
1.19-3	CONTROL SYSTEMS	X	X			X
1.20-3	ACTUATION SYSTEMS	X	X	X		X
1.21-3	NDE COMMITMENTS	X	X	X		
1.22-3	MATERIALS SELECTION	X	X	X		X
1.23-3	FAILURE MODES AND EFFECTS	X	X	X		
1.33-3	FILTRATION	X	X	X		X
1.34-3	PRESSURIZATION	X	X	X		X
1.35-3	VENTILATION	X	X	X	X	X

FIGURE A-8

INITIAL SAMPLE REVIEW MATRIX FOR THE CONTROL ROOM HVAC SYSTEM
MIDLAND INDEPENDENT DESIGN VERIFICATION PROGRAM (CONTINUED)

TOPIC NUMBER	DESIGN AREA	SCOPE OF REVIEW: REVIEW OF DESIGN CRITERIA AND COMMITMENTS	REVIEW OF IMPLEMENTING DOCUMENTS	CHECK OF CALCULATIONS AND EVALUATIONS	CONFIRMATORY CALCULATION OR EVALUATION	CHECK OF DRAWINGS AND SPECIFICATIONS
	CONTROL ROOM HVAC SYSTEM PROTECTION FEATURES					
II.1-3	SEISMIC DESIGN	X				
II.2-3	• PRESSURE BOUNDARY	X	X	X		
II.3-3	• DUCT/PIPE/EQUIPMENT SUPPORT	X	X	X		X
II.4-3	• EQUIPMENT QUALIFICATION	X	X	X		X
II.5-3	HIGH ENERGY LINE BREAK ACCIDENTS	X				
II.6-3	• PIPE WHIP	X				
II.7-3	• JET IMPINGEMENT	X				
II.8-3	ENVIRONMENTAL PROTECTION	X				
II.9-3	• ENVIRONMENTAL ENVELOPES	X	X	X	X	X
II.10-3	• EQUIPMENT QUALIFICATION	X	X	X		X
II.12-3	FIRE PROTECTION	X	X			
II.13-3	MISSILE PROTECTION	X				
II.14-3	SYSTEMS INTERACTIONS	X				
	STRUCTURES THAT HOUSE THE CONTROL ROOM HVAC SYSTEM					
III.1-3	SEISMIC DESIGN/INPUT TO EQUIPMENT	X	X	X		
III.5-3	CIVIL/STRUCTURAL DESIGN CONSIDERATIONS	X				
III.7-3	• CONCRETE/STEEL DESIGN	X	X			
III.9-3	• LEAK TIGHTNESS	X	X	X		

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FIGURE A-9

INITIAL SAMPLE REVIEW MATRIX FOR THE CONTROL ROOM HVAC SYSTEM
MIDLAND INDEPENDENT CONSTRUCTION VERIFICATION PROGRAM

TOPIC NUMBER	SYSTEM/COMPONENT	SCOPE OF REVIEW: REVIEW OF SUPPLIER DOCUMENTATION	REVIEW OF STORAGE AND MAINTENANCE DOCUMENTATION	REVIEW OF CONSTRUCTION/ INSTALLATION DOCUMENTATION	REVIEW OF SELECTED VERIFICATION ACTIVITIES	VERIFICATION OF PHYSICAL CONFIGURATION
	MECHANICAL					
I.1-3c	• EQUIPMENT	X	X	X	X	X
I.2-3c	• PIPING	X		X		X
I.3-3c	• PIPE SUPPORTS	X		X		X
	ELECTRICAL					
II.1-3c	• EQUIPMENT	X		X	X	X
II.2-3c	• TRAYS AND SUPPORTS	X		X		X
II.3-3c	• CONDUIT AND SUPPORTS	X		X		X
II.4-3c	• CABLE	X		X		X
	INSTRUMENTATION AND CONTROL					
III.1-3c	• INSTRUMENTS/DETECTORS	X	X	X	X	X
III.2-3c	• PIPING/TUBING	X		X		X
III.3-3c	• CABLE	X		X		X
	HVAC					
IV.2-3c	• DUCTS AND SUPPORTS	X	X	X		X
	STRUCTURAL					
V.2-3c	• CONCRETE	X		X		X
V.3-3c	• STRUCTURAL STEEL	X		X		X
VI.1-3c	NDE/MATERIALS TESTING PROGRAM					X

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FIGURE A-10

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assessment of the project management's capability to complete the Midland project in accordance with the NRC regulations. Organizations, systems and methods are evaluated under the scope of the IMAP. The CIO and Soils Overview are under the direction of Stone and Webster Engineering Corporation (S&W). These programs are designed to evaluate the implementation of procedures related to the project's Construction Completion Program (CCP) and Soils Remedial Program. As such, S&W has maintained an in-process presence, overviewing the process of execution of construction activities.

In addition to these efforts, CPC has commissioned various other review programs which have been independent of the project completion cycle. These have included the Institute of Nuclear Operations Construction Project Evaluation and several biennial quality assurance audits by the Management Analysis Company (MAC).

The Midland IDCVP is unique relative to all of the other review programs based on its focus on a verification of the quality of end design and construction products. While these other programs touch upon end products, their emphasis is more directly placed on an evaluation of the processes for completing the end products which are reviewed under the IDCVP.

Collectively, the set of programs provide oversight over essentially all elements of the project completion cycle. The combination of process-oriented reviews with the IDCVP end product reviews improves the overall level of confidence that can be reached in verifying that the Midland plant has been designed and constructed in conformance with NRC regulations. Accordingly, the IDCVP process of execution has included a sensitization to information flowing from these other programs and the IDCVP integrated assessment is designed to assimilate this information in reaching conclusions.

A1.4 DESCRIPTION OF THE MIDLAND PROJECT

A1.4.1 PLANT DESCRIPTION

Each of the two units at the Midland plant employ a Babcock and Wilcox-designed pressurized water reactor (PWR), nuclear steam supply system (NSSS) rated at 2468 megawatts thermal (MWt). This rated power level includes 2452 MWt generated in the core plus 16 MWt added by the four reactor coolant pumps. The maximum core design output (excluding pump heat) is 2552 MWt. This power level is referred to as the stretch or ultimate level and is the value used in the radiological accident analyses. The Midland plant is unique in that the heat generated will be used not only to produce electrical energy but also to produce steam. The facility's turbine generators will produce 504 megawatts electrical (MWe) from Unit 1 and 852 MWe from Unit 2. The remaining heat from Unit 1 will normally be used to produce 460 kg/s (approximately 3.6×10^6 lb/hr) at 1200 kPa gauge (175 psig) and 50 kg/s (approximately 0.4×10^6 lb/hr) at 4100 kPa gauge (600 psig) of process steam. The process steam system is a tertiary system utilizing heat extracted from the secondary steam system of the Midland plant. Dow Chemical Company has stated that it no longer wants to participate in the project by being the user of the process steam. This adds a degree of uncertainty regarding the final design of Unit 1. In May 1984, CPC stated that it may not complete Unit 1, and only complete Unit 2. The IDVP has, since its inception, focused on Unit 2.

The reactor coolant system (RCS) consists of two separate loops, each provided with a steam generator and two pumps. An electrically heated pressurizer will establish and maintain the reactor coolant pressure and provide a surge chamber to accommodate reactor coolant volume changes during operation. Heat generated by the reactor will be transported by the reactor coolant to the steam generators where it will be transferred to the secondary (steam) system. The steam thereby produced will flow to a turbine generator where about one-third of the thermal energy will be converted to electrical energy or will flow to an evaporator system to produce process steam. The thermal energy will be transferred in the various condensers to a once-through circulating water system that draws cooler water from and discharges the heated water to a cooling pond constructed at the southern edge of the power block area.

The NSSS is supported by a variety of auxiliary systems which are necessary to support power generation and to ensure safe operation. Three such systems are included within the scope of the Midland IDCVP; the AFW system, the CR-HVAC system, and the SEP system.

The AFW system provides several functions for the Midland Plant. The most significant of these is the supply of water to the steam generators during periods when normal feedwater is unavailable. Typical transients which require the use of the AFW system include loss of offsite power and load rejection events. The AFW system is also used for normal startup and shutdown of the plant. Additionally, the AFW system functions as the sole means of cooling the plant during a postulated station blackout condition. Because of this variety of functions, the AFW system is both redundant and diverse, and a large number of specific operating conditions or modes must be accounted for in the design of the system.

The SEP system consists of one diesel generator complete with its accessories and fuel storage and transfer systems for each safety-related load group. It is designed to supply electric loads necessary to shut down and isolate the reactor reliably and safely in the event of a loss of offsite ac power. Each diesel generator is rated at 5250 kW for continuous operation, and at 5775 kW for 2 hours short-time operation in any 24-hour period. Each diesel generator is connected exclusively to the 4.16 kV bus of its load group. In addition to the diesel generator and its support systems, the IDCVP SEP system scope includes the power distribution system, the preferred 120 Vac power system and the 125 V dc power system.

The CR-HVAC system is designed to maintain habitable conditions within the control room under both normal and post-accident operation. It also maintains an environment necessary to protect equipment located within the control room.

The major components of the system include redundant supply/re-circulation air handling units, recirculation air filtration trains, makeup air filtration trains, coolers, exhaust fans, pressurization tanks, piping, valves, instrumentation and control.

The major plant structures for the Midland plant are the two reactor buildings (containments), a common auxiliary building, a diesel generator building, the turbine building, the evaporator and auxiliary boiler building, a solid radwaste building, and two cooling water intake structures (one each for the circulating water and service water systems). Structural design considerations for the auxiliary building and the diesel generator building are within the scope of the Midland IDCVP. The reactor buildings house the NSSS. The auxiliary building houses most of the engineered safety features (ESFs), waste treatment facilities, the control room, various auxiliary systems, and the spent fuel storage pool and new fuel storage facilities. The intake structures contain pumps that provide water for cooling the plant components. The circulating water system is connected to the turbine building by underground piping. The turbine building houses the two turbine generators (one for each unit), the condensers, the feedwater heaters and pumps, and the turbine auxiliaries. The diesel generator building houses four emergency diesel generators (two for each unit) to provide emergency power.

A1.4.2 MIDLAND PROJECT ORGANIZATIONS AND INTERFACES

CPC is the owner of the plant and primarily functions during the design and construction of the plant as overall manager of the project including review and approval of primary design and construction activities of Bechtel, Babcock & Wilcox (B&W) and other major contractors. Bechtel is the engineer-constructor for the project and as such performs the vast majority of the design and construction activities, most generally those associated with the balance-of-plant (BOP) scope. B&W, as NSSS vendor, supplies, fabricates, and installs the reactor, steam generators, and reactor coolant system including pumps and certain other components. Additionally, B&W identifies the criteria to which the BOP (i.e., all systems, components and structures other than that within the

NSSS scope) must be designed to adequately interface with the NSSS. All three principal organizations have additional subcontractors and consultants who have responsibility for smaller portions of the project. For example, CPC has used the services of companies such as Pickard, Lowe and Garrick, NUTECH, NUS, M. Jones, to perform certain engineering evaluations and studies. Bechtel has used companies such as Grinnell as subcontractors to perform design-related functions.

The IDCVP scope focuses primarily on verification of Bechtel design and construction products; however, an important element of the program is verification of interfaces between Bechtel, CPC, B&W and major subcontractors. The interfaces which are evaluated are defined in specific IDCVP topical reports.

A1.5 INDEPENDENCE REQUIREMENTS

The Midland IDCVP is conducted in accordance with the "independence" criteria documented in a letter from Nunzio J. Palladino, Chairman, NRC, to the Honorable John D. Dingell, Chairman, Committee on Energy and Commerce, United States House of Representatives, dated February 1, 1982. This letter was originally written as applicable to Pacific Gas and Electric Company's Diablo Canyon project; however, it is being applied to the Midland IDCVP, and the reader should interpret the words PGandE or Diablo Canyon to mean CPC or Midland, respectively. The following criteria are excerpted from Enclosure 3 of this letter:

> The competence of the individuals or companies is the most important factor in the selection of an auditor. Also, the companies or individuals may not have had any direct previous involvement with the activities at Diablo Canyon (Midland) that they will be reviewing.
>
> In addition, the following factors will be considered in evaluating the question of independence:
>
> o Whether the individuals or companies involved had been previously hired by PG&E (CPC) to do similar seismic (delete seismic) design work.

- o Whether any individual involved had been previously employed by PG&E (CPC) (and the nature of the employment).
- o Whether the individual owns or controls significant amounts of PG&E (CPC) stock.
- o Whether members of the present household of individuals involved are employed by PG&E (CPC).
- o Whether any relatives are employed by PG&E (CPC) in a management capacity.

In addition to the above considerations, the following procedural guidelines will be used to ensure independence:

- o An auditable record will be provided of all comments on draft or final reports, any changes made as a result of such comments, and the reasons for such changes; <u>or</u> the consultant will issue only a final report (<u>without</u> prior licensee comment).
- o NRC will assume and exercise the responsibility for serving the report on all parties.

A2 MIDLAND IDCVP ORGANIZATION, AUTHORITY, RESPONSIBILITY AND CONTROL

The Midland IDCVP organization, authority, responsibility and control are addressed in the Project Quality Assurance Plan (PQAP), Midland Independent Design and Construction Verification Program, Project 3201. Figure A-11 provides the project organization chart. Technical and administrative personnel (not shown) receive assignments directly from the Project Manager (PM).

The PM serves as the principal point of contact with CPC, NRC and outside parties. He is responsible for overall planning and direct supervision of all in-house activities undertaken to fulfill the project requirements. All documentation, correspondence, reports, calculations, etc., issued to CPC, NRC and other outside parties are issued under his signature or otherwise receive his approval as required by applicable Engineering Control Procedures or Project Instructions defined in the PQAP.

The Principal-in-Charge (PIC) is responsible for helping establish the general philosophy of review, setting forth guidance to the Project Manager and the Managers, Design and Construction Verification, assisting as an interface with the Senior Review Team (SRT), NRC, and CPC, and reviewing/concurring in reports issued to CPC, NRC and other outside parties.

The Project Quality Assurance Engineer reports directly to the Vice President, TERA. He is responsible for verification of the implementation of the PQAP and will perform audits evaluating the implementation of applicable procedures and instructions in accordance with the PQAP. The Project Quality Assurance Engineers will identify internal quality assurance deficiencies, provide clarification relative to identified deficiencies and any recommendations made by them for resolution.

The Managers of Design Verification and Construction Verification are responsible for overall planning, management, and supervision of all activities within the IDVP and ICVP portions of the Midland IDCVP, respectively, and coordination

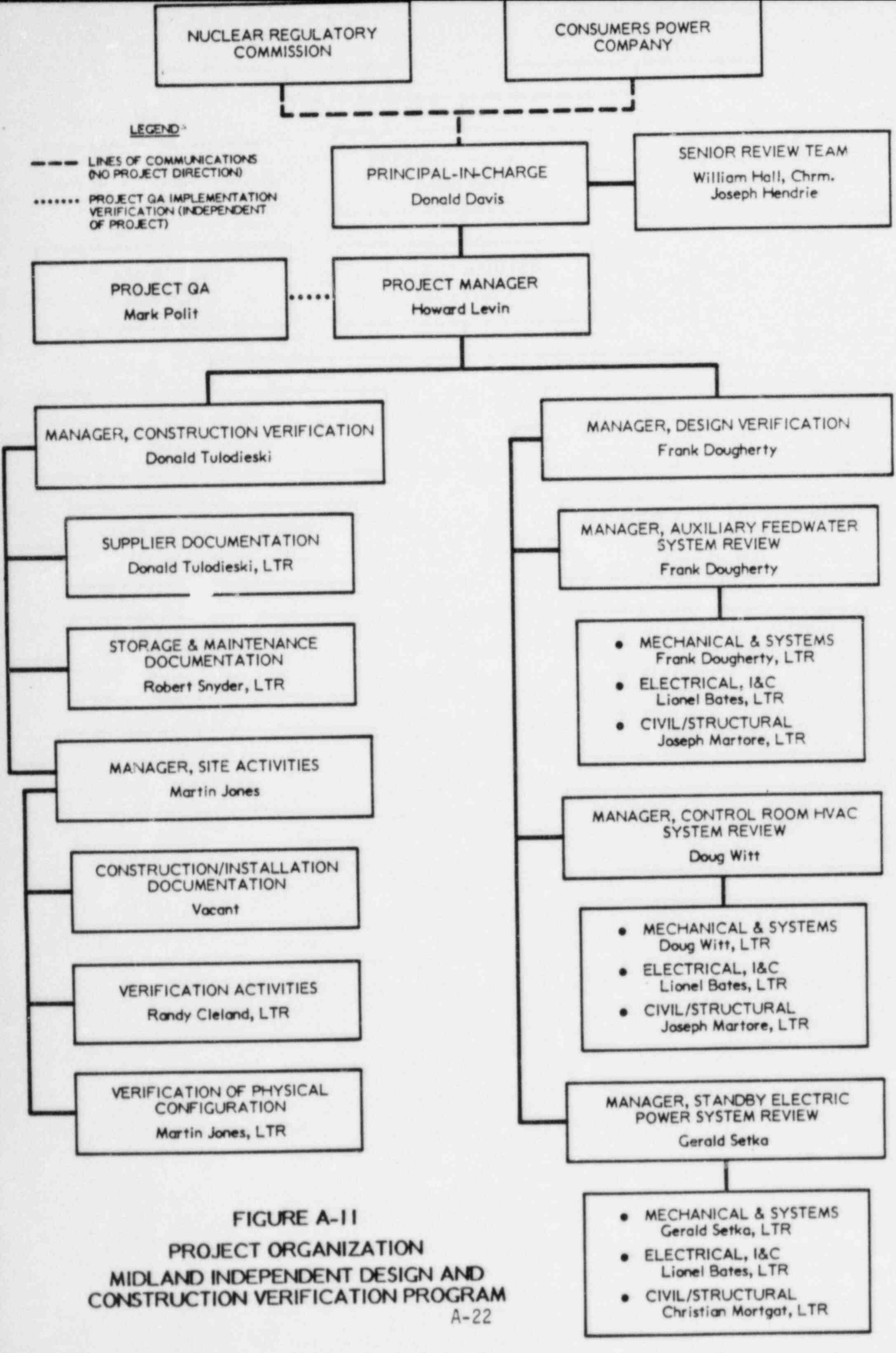

FIGURE A-11

PROJECT ORGANIZATION
MIDLAND INDEPENDENT DESIGN AND CONSTRUCTION VERIFICATION PROGRAM

between each other to assure that IDVP and ICVP interfaces are adequately addressed. These individuals report directly to the Project Manager.

The Managers of the AFW, SEP and CR-HVAC system reviews are responsible for management and implementation of design review activities necessary to complete an integrated review of their respective systems, coordination of activities between Lead Technical Reviewers (LTRs) under their supervision and coordination with the ICVP LTRs. These individuals report to the Manager of Design Verification.

The Manager of Site Activities is responsible for planning, management and supervision of all Midland site related activities and the Construction/Installation Documentation, Verification Activities and Verification of Physical Configuration categories of review. He reports directly to the Manager of Construction Verification.

The Senior Review Team (SRT) is responsible for the review of Open, Confirmed or Resolved (OCR) Item Reports, as requested by the PIC, Finding Reports, Finding Resolution Reports, as well as Interim Technical (Topical) Reports and Final Reports. The SRT may at any time recommend to the PIC that the PM expand the scope of review, provide clarification or reassess elements of the review to assess the technical validity and significance of project team conclusions and the proper classification of OCRs and Findings. (These reports are defined in Section A4.0 of this appendix). The SRT is also responsible for the review of Monthly Status Reports, OCRs as directed by the SRT Chairman, and any Draft Interim Technical (Topical) Reports to maintain current awareness and assure a high level of technical quality. They will provide recommendations to resolve differing technical views which may arise among project team members. The SRT Chairman is responsible for coordination and direction of SRT activities.

The Lead Technical Reviewers are responsible for implementation of all review activities within their discipline of review, including technical supervision of individuals on the project and outside activities performed by Associates. The

IDVP LTRs report to the Managers of the AFW, SEP and CR-HVAC system reviews. The ICVP LTRs report to either the Manager, Construction Verification or the Manager, Site Activities as shown on Figure A-11. The LTRs are responsible for the classification of OCRs and Findings, and the preparation of Finding Reports and Finding Resolution Reports.

Midland IDCVP procedures and instructions addressed in the PQAP, are implemented to control documentation which is subject to quality assurance and control measures or is required to provide an auditable record of the review process leading to Findings. The following documents are controlled: engineering evaluations, Monthly Status Reports, Draft and Final Interim (Topical) Reports and Draft and Final Reports, calculations, analyses, computer analyses, PQAP, quality assurance documents, personnel qualifications, correspondence, Open, Confirmed and Resolved Item Reports, Observations, Finding Reports, Finding Resolution Reports, the Engineering Program Plan and records documenting external communications and meetings.

A3 METHODOLOGY

A3.1 OVERVIEW OF THE REVIEW PROCESS AND GENERAL APPROACH TO VERIFICATION

The Midland IDCVP has been structured to provide a direct focus on an overall assessment of quality of the design and the constructed plant. The primary emphasis is on the end results of the design and construction process, its products, not on an evaluation of the processes which have/are produced/producing these products. The methodology has been termed a "vertical slice" since it falls into a general category of approaches relying upon a selected sample of one or more safety systems from which the results may be extrapolated to other similar systems. The breadth of review covers a large percentage of engineering and construction activities necessary to complete the Midland plant. Input is assimulated from other programs as described in Section A1.3 of this appendix to focus and/or expand verification activities in an effort to improve the "bias" of the sample, assist in reaching conclusions, including extrapolation as appropriate. The depth of review varies within specific design or construction topics because more emphasis and a higher frequency of sampling are devoted to areas experiencing repeated problems in the industry or by the Midland project.

The IDCVP review process incorporates a systematic review to established criteria, the intent being to develop an initial sample capable of ensuring that significant deficiencies could not propagate undetected through the systems under evaluation. Additional sampling or verification is conducted if discrepancies are identified until a high degree of assurance is established that the system is capable of functioning in accordance with its safety design bases and in conformance with NRC regulations.

The initial review step includes the identification and review of pertinent documents to permit an understanding of the design and construction chains including the interrelationships between the organizations and suborganizations participating in the Midland project. Next, the design bases in the form of regulatory requirements and design criteria are identified and reviewed in parallel with a review of project design and construction related experience. The design bases review provides an overall understanding of the plant and system design. The project design and construction experience review ensures that the IDCVP scope encompasses previously identified problem areas to verify that these have been adequately addressed and that they do not exist elsewhere in the same or similar form.

The IDCVP methodology employs applicable design verification guidelines of ANSI N45.2.11, including such diverse approaches as checking original calculations; conducting alternative confirmatory calculations/evaluations; checking design outputs against drawings and specifications; reviewing construction/installation documentation; and physically inspecting, measuring, and testing the constructed facilities. After a determination and evaluation of the design bases and an evaluation of the implementation of these commitments, an introspective evaluation and integrated assessment follows to identify the cause and extent of any discrepancies, to verify whether the discrepancies are restricted to specific items or work by specific organizations, or if they cut across many interfaces and apply to similarly designed and constructed items.

The IDCVP review process is documented in a auditable form and certain outputs are periodically reported to the NRC, CPC and outside parties. In order to preserve and assure adherence to strict independence requirements, the IDCVP is conducted in accordance with an NRC mandated protocol which has been set for TERA, the reviewing organization and its personnel. The documentation, reporting and protocol requirements are summarized in Section A4.0 of this appendix.

A3.2 SYSTEMS AND SAMPLE SELECTION CRITERIA

The selection of the AFW system was based upon the following six criteria:

- o <u>Importance to Safety</u>: The system should have a relatively high level of importance to the overall safety of the Midland plant.

- Inclusion of Design and Construction Interfaces: The system should be one which involves multiple interfaces among engineering and construction disciplines as well as design and construction organizations, such as the NSSS vendor, architect engineer, constructor, and subtier contractors. The system should also be one where design or construction changes have occurred and thus provide the ability to test the effectiveness of the design and construction process exercised by principal internal and external organizations or disciplines in areas of design or construction change.

- Ability to Extrapolate Results: The system should be sufficiently representative of other safety systems such that the design criteria, design and construction control and change processes are similar so that extrapolation of findings to other systems can be undertaken with confidence.

- Diverse in Content: The major engineering and construction disciplines should all have input to the design of the system.

- Sensitive to Previous Experience: The system should be one which includes design or construction disciplines or interfaces which have previously exhibited problems and thus a test of the system should be indicative of any generic condition.

- Ablity to Test As-Built Installation: The system configuration should be sufficiently completed that the as-built configuration can be verified against design.

The AFW system was selected after consideration of a number of other candidate systems. The Midland Plant probabilistic risk assessment (PRA) was utilized as a tool to assess the relative importance to safety of plant systems on the basis of their contribution to overall plant risk. The profile for this criterion as well as each of the other five criteria is sufficiently high for the AFW, SEP and CR-HVAC systems to justify their selection.

The systems selection criteria also apply to the selection of specific structures or components to be reviewed within each design or construction area of the IDCVP, including the depth of review in each area.

The IDVP selection is based upon engineering judgment, as statistical techniques are considered to be largely inappropriate for a design verification program. Senior members of the project team with requisite experience are responsible for selecting the sample and determining its size. This process provides greater assurance than a random sampling plan since the initial IDVP sample is purposely biased towards typical problem areas. Furthermore, the initial sample is considered broad enough to ensure that significant deficiencies could not propagate through the systems under evaluation without being detected.

Certain ICVP verification activities may utilize statistical methods. These methods may be applied in establishing sample sizes and statistical levels of confidence for the assessment of repetitive production activities such as concrete and steel properties or welding records. The efficacy of using these approaches will be documented in specific topical reports along with an identification of areas utilizing statistical techniques, including the bases for the technical approach and how it is applied.

In the course of designing a nuclear power plant, numerous reviews and evaluations are typically performed. These reviews and evaluations may result in the identification of areas requiring additional work. These reviews and evaluations reflect the project's design experience and are a valuable input to the refinement of the IDCVP scope and sample selection. In order to make use of this information, a review is made of the ongoing CPC inspection programs, 50.55e reports, CPC Safety Concern and Reportability Evaluation (SCRE) reports, Bechtel Management Corrective Action Reports (MCAR), NRC inspection reports, audit reports, and similar documentation. Three principal criteria are used to modify the technical review scope and the initial sample, providing more emphasis or a higher frequency of sampling:

- o Criterion 1: Areas experiencing repeated problems within the industry or specifically on the Midland Project, to verify that these do not exist in the same or similar form
- o Criterion 2: Areas not previously receiving a substantial level of IDCVP review to achieve a sufficient level of assurance

- o Criterion 3: Areas where suspect items or Findings have been identified to provide further confirmation, close out outstanding issues and fully assess the extent and root cause.

In response to issues meeting Criterion 3, additional sampling or verification within the scope of the IDCVP or outside the scope into other systems is conducted if discrepancies are found. The level of additional sampling or verification is based upon the nature of the discrepancy. In all cases when discrepancies are found, an introspective evaluation follows to identify the extent and root cause. The root cause may either be random or systematic (generic). The additional reviews attempt to verify whether the discrepancy is restricted to the specific system, component, or structure under review; restricted to work by a specific design organization; or if the discrepancy cuts across many interfaces and applies to similarly designed systems, components, and structures. As a rule, mathematical errors do not precipitate additional sampling and verification unless these are found in significant numbers, lead to significant deficiencies or are a compounding of errors. Judgement in making this assessment is required on a case-by-case basis.

A3.3 REVIEW OF DESIGN/CONSTRUCTION CHAINS

The review of the design and construction chains of the Midland project is not of primary importance to the IDCVP methodology; however, knowledge of work processes and interfaces is important to the understanding of information transfer paths and an identification of inputs and outputs of intra- and interdisciplinary activities of organizational units to be sampled. A verification of inputs and intermediate outputs is important to reaching conclusions on the quality of end products. It is important that transferred information be current, accurate, clearly stated, and properly interpreted by the receiving organization. If discrepancies related to inputs and outputs are identified, then additional verification of the work of the sending or receiving organization in the design or construction chain is undertaken by the IDCVP review team.

In view of the extensive and complex interfaces among CPC, Bechtel, B&W, and other entities and the nuclear project interfaces within each of those organizations, it is necessary to define a reasonable set of limits on the scope of work of the IDCVP.

IDCVP criteria were established to define the end points of the design and construction chain. The majority of the design and construction management was performed by Bechtel. However, portions of the design and construction may have been performed or affected by work performed by other organizations including, but not limited to, Babcock & Wilcox (B&W), engineering and construction contractors, and equipment vendors. For the purposes of the IDCVP, the following limitations apply. The information supplied by B&W does not receive an independent evaluation. The verification program verifies that data obtained from B&W are consistent and reasonable based upon engineering judgment. If the B&W data are suspect, additional investigation into the causes may be warranted. Equipment vendors are reviewed to verify that the documents with which they were supplied are accurate and current and that the results of their design efforts conform with the specified requirements given to them by Bechtel or CPC. Vendor documentation is reviewed to determine that the product does, in fact, meet applicable requirements of the specifications. In the event that deviations are determined to exist, the appropriate IDCVP reporting procedures will be applied. For major engineering or construction contractors, the scopes of work applicable to these contractors are determined and, in general, they are treated as if they are part of the Bechtel organization. That is, they are not treated like a vendor who is given a specification and is expected to deliver a product in conformance with that specification. They are treated as part of a design or construction organization which has similar responsibilities to other parts of the Bechtel project organization.

A3.4 REVIEW OF PREVIOUS EXPERIENCE

Industry and Midland project experience has an important influence on the execution of the IDCVP. Accordingly, "sensitivity to previous experience" is one of the sampling criteria adopted by the IDCVP. The intent of previous experience consideration is to improve the "bias" of the sample, to aid in extrapolation of results, and to verify that areas experiencing problems have been adequately addressed and that problems do not exist in the same or similar form.

The conceptual development of the initial sample review matrices included consideration of experience at operating plants, plants under construction and project-unique experience. Sensitivity is maintained as the IDCVP proceeds, leading to an evolution of the review scope represented on the matrices.

Due to the limited IDCVP knowledge of the Midland project at the early stages of the Engineering Program Plan development, industry experience had a greater influence on the initial sample review matrices. For example, review topics or evaluations were included in the areas of piping/supports, seismic design, installation of commodities and organizational interfaces because these areas have typically presented challenges to virtually all nuclear construction projects. The scope and sample selection were later refined after the initial IDCVP survey of the Midland project design/construction chains and history; thus, increasing the influence of the project experience. Verification activities were influenced in such areas as civil/structural design, HVAC installation, power supplies, welding, cable routing, and overpressure protection. Ongoing activities were focused even further in response to such industry issues related to the Transamerica Delaval Incorporated (TDI) diesel generator problems, and small bore piping, and to such project-unique areas as seismic analysis/design and failure modes and effects.

A3.5 DESIGN VERIFICATION METHODOLOGY

ANSI N45.2.11 defines design verification as the "process of reviewing, confirming, or substantiating the design by one or more methods to provide assurance that the design meets specified inputs." Design inputs include design bases or criteria, regulatory requirements, codes and standards, and other design commitments. The IDVP includes a determination of the design inputs; an evaluation of their accuracy, consistency, and adequacy; and an evaluation of the implementation of these commitments. The emphasis is on making a determination of the overall quality of the design and an assessment of its compliance with licensing commitments and NRC regulations. The review approach is designed to be introspective in making this overall quality assessment by integrating the many design inputs and licensing commitments. This integrated assessment ensures that all parameters have been considered which are important for the system in meeting its functional requirements.

The IDVP methodology utilizes the applicable guidelines of ANSI N45.2.11. The methodology includes diverse approaches such as checking original calculations, conducting alternative confirmatory calculations, or checking design ouputs including drawings or specifications. Where independent calculations are utilized, they may incorporate methods which are either similar to or different from the original design. In certain instances these independent calculations are "blind," in that the original design calculations are compared to the independent calculations upon their completion, without prior review by the IDVP analyst.

The categories reviewed for certain design areas include Review of Design Criteria and Commitments, Review of Implementing Documents, Checks of Calculations and Evaluations, Confirmatory Calculations or Evaluations, and Checks of Drawings and Specifications. These categories are defined in Section A3.5.1. As a rule, all design areas are not reviewed in each of the preceding categories. For example, a design area for the AFW system is "heat removal capability." This item does not typically have drawings and specifications associated with it as a direct output. In other instances, it may be the judgment of the review team based upon experience that emphasis is not needed in certain categories for each design area.

The definition of the scope of review is provided in the following sections of this appendix:

System	Section
AFW	A3.5.2
SEP	A3.5.3
CR-HVAC	A3.5.4

In the period from late 1983 through early 1984, TERA identified a need to supplement the scope of the IDVP with a review of Midland project engineering programs associated with ongoing design related activities. A summary of the recommended approach was provided in a February 10, 1984, letter and discussed at a March 13, 1984, public meeting.

The supplemental verification activities include maintaining the existing vertical slice approach to design verification by reviewing end products for the majority of the sample and reviewing engineering procedures and action plans and their implementation for the remainder of the sample where project design related activites are in progress. Approximately 10 to 20 percent of the sample is subject to verification in this manner. The topics affected include those found in the System Protection Features section of the design verification matrices, including such topics as Fire Protection, Equipment Qualification and Systems Interaction. The ongoing licensing/confirmatory evaluations to be reviewed are directed at completing products such as the fire hazards analysis and preparation of SQRT and environment qualification documentation packages. The IDVP verification product will be enhanced since the results of the end product review will be combined with a review of engineering programs ensuring greater confidence in the conclusions reached.

The IDVP is conducted utilizing detailed checklists which are described in Section 3.1.6 of the Engineering Program Plan.

A3.5.1 CATEGORIES OF REVIEW: THE DESIGN CHAIN

The categories of review selected include the major design activities identified in the design chain. The IDVP review categories included are:

- o Review of Design Criteria and Commitments
- o Review of Implementing Documents
- o Check of Calculations and Evaluations
- o Confirmatory Calculations or Evaluations
- o Check of Drawings and Specifications

Each of these categories is described in detail in sections A3.5.1.1 through A3.5.1.5, respectively. Checklists have been prepared for each of these categories to aid IDCVP reviewers in the implementation of their review. These checklists are discussed in section 3.1.6 of the Engineering Program Plan.

A3.5.1.1 REVIEW OF DESIGN CRITERIA AND COMMITMENTS

An identification and review of the design criteria and commitments concerning each specific design area is performed. This review category provides the assurance that all necessary design inputs are considered in the IDVP. The results of this review of design criteria and commitments are then used in subsequent stages where appropriate. The review of design criteria and commitments begins with an identification of appropriate criteria for the system. Such criteria may be determined from sources such as the FSAR, the docket file, 10 CFR 50, Appendix A, criteria supplied by the NSSS vendor, industry codes and standards, and other documents which provide criteria for system design. Questions such as the following are addressed in this category of review:

- o What are the design inputs for the design area under review?
- o Do any of these design inputs affect other design areas?

- Do any of these design inputs affect interfacing systems outside the scope of AFW or vice versa?
- Are the design inputs for this design area complete?
- Are the identified design inputs for this design area consistent?
- Are the design inputs adequately defined to allow implementation for the design area?

A3.5.1.2 REVIEW OF IMPLEMENTING DOCUMENTS

Implementing documents are those design documents which translate the design inputs into working level documentation. Typically, implementing documents include design criteria documents, project procedures, standard design practices, specific plant design basis documents, drawings, and calculations. Most frequently, implementing documents are intermediate steps in the design process which are subsequently used to produce design outputs. It is important that design inputs are properly interpreted and documented in implementing documents. Therefore, the objective of the review is to determine the existence and general reasonableness of the documentation and whether the documentation correctly reflects the design inputs. Design outputs are defined as documents such as drawings, specifications, and similar materials defining technical requirements for the fabrication, installation, or construction of the system. The design output documents are reviewed for the application of the design criteria and commitments as part of the check of drawings and specifications. Questions such as the following are addressed in this category review:

- What is the identity (title, document number, revision number, date, etc.) of the implementing document being reviewed?
- For the design inputs being reviewed, is the document complete and internally consistent?
- Are design interface requirements specified?
- Have the design inputs been correctly interpreted and incorporated in this implementing document?

- o Is this implementing document consistent with other implementing documents being reviewed for this area?
- o Are assumptions and limitations on the use of the document adequately defined?
- o Where appropriate, are quality assurance requirements specified?

A3.5.1.3 CHECK OF CALCULATIONS AND EVALUATIONS

When specified, a detailed check of calculations and evaluations is made (i.e. inputs, assumptions, methodology, outputs, etc.). This activity follows the review of design criteria and commitments and the review of implementing documents. The check may take several forms, ranging from a number-by-number detailed mathematical check to a review and evaluation of outputs for reasonableness. The overall presentation of the sampled calculations and evaluations are also reviewed to verify that all steps are clearly presented and consistent throughout. The IDVP reviewer may, at his discretion, choose to conduct an alternative calculation as a means of confirming his judgment on the adequacy of the design calculation or evaluation. Where computer programs were used in an analysis selected for review, the reviewer selectively verifies that appropriate inputs have been used in the calculation, and that the appropriate outputs have been identified. Additionally, it is necessary to determine that the computer programs used have been verified in accordance with appropriate verification procedures. Questions such as the following are addressed in this category of review:

- o What is the identity of the calculation or evaluation being checked?
- o What is the purpose of the calculation or evaluation?
- o Are the data sources identified?
- o Are the assumptions listed?
- o Are the assumptions reasonable and valid?

- Was the calculation or evaluation checked and approved within the originating organization?
- Are the equations and methods specified?
- Are the equations and methods appropriate for the intended purpose?
- If computer programs were used, were such programs verified?
- Are the calculation or evaluation results reasonable?
- Have design outputs been compared to the acceptance criteria to allow verification that design requirements have been satisfactorily accomplished?

A3.5.1.4 CONFIRMATORY CALCULATIONS OR EVALUATIONS

For selected areas, confirmatory calculations or evaluations are performed. Generally, these evaluations are made to confirm judgements relative to the review of areas which are suspect to the IDCVP reviewer; however, "blind" confirmatory calculations are undertaken in pre-selected areas to independently verify the original design calculations. Such confirmatory calculations are performed by obtaining the necessary input data and independent specification of calculation or evaluation objective. The reviewer selects and applies the appropriate techniques to achieve the end results. Such calculation methods are performed without benefit of first reviewing the existing design calculational method. In order to preserve the "blind" nature of this approach, it is necessary that a person other than the reviewer of the implementing documents perform the confirmatory calculation or evaluation. The confirmatory calculation or evaluation is performed under procedures appropriate for the type of calculation or evaluation being performed. To the extent appropriate, the calculation or evaluation is equivalent to that initially performed. After completion of the confirmatory calculation or evaluation, a comparison between the original calculation and the confirmatory methods is made to determine whether differences exist. If differences occur, a determination is made to assess whether these differences are due to the inherent nature of the calculation methods chosen or due to errors.

For example, differences may result due to the selection by the originator of simplifying or conservative assumptions. In the event that the original calculation is more conservative than the confirmatory calculation and meets design basis acceptance criteria, no further action is necessary. On the other hand, if the confirmatory calculation uses more conservative methods, a check of the original calculation is made to determine whether the difference in degree of conservatism is appropriate.

A3.5.1.5 CHECK OF DRAWINGS AND SPECIFICATIONS

Where appropriate, design outputs such as drawings and specifications are reviewed and checked to assure that they accurately and consistently reflect that which has been called for in design documents such as calculations or engineering evaluations. Drawings and specifications are also reviewed to determine whether design change notices and field change notices have been incorporated. In cases where several related drawings exist, a cross-comparison among drawings is made. Additionally, a review is made of correspondence with vendors to determine the existence of deviations from the specifications and the approval by the design organization of such changes. Questions such as the following are addressed in this category of review:

- o What is the identity of the drawing or specification (e.g. number, revision number, date)?
- o Does the drawing or specification reflect the selected design inputs?
- o Is the drawing or specification consistent with related calculations or evaluations?
- o Has this drawing or specification been checked by the originating organization?
- o Is the drawing or specification complete with regard to the selected design inputs?
- o Where appropriate, have adequate handling, storage cleaning, and shipping requirements been specified in the specification?

- o Where appropriate, has adequate allowance been made for in-service inspection, maintenance, repair, and testing?

A3.5.2 SCOPE OF THE AFW SYSTEM REVIEW

Section A3.5.1 identified the categories of review which essentially correspond to major activities of the design chain. When combined with a listing of each of the design areas (or topics), a matrix is formed which can be utilized to direct the conduct of the IDVP effort for each system in the program. This matrix is shown on Figures A-2 and A-3 for the AFW system. A set of "X" marks are shown which indicate the review scope applicable to each design area. The criteria discussed in section A3.2 of this Appendix were incorporated to develop the initial sample review matrix. The design areas of the IDVP review matrix for the AFW system are divided into three major divisions: AFW System Performance Requirements, AFW System Protection Features, and Structures that House the AFW System. The definition of design areas addressed within each of these major divisions are discussed in Sections 3.1.3.1, 3.1.3.2, and 3.1.3.3 of the Engineering Program Plan, respectively.

Because the AFW system sample selection interfaces with other systems, it is necessary to define the boundaries for items within the scope of the IDCVP. In general for the AFW system, the selection was made to include all components identified as being part of the AFW system on Bechtel P&ID drawing M439 sheets 3A, revision 9, and 3B, revision 10. Specific interface points are shown on Table A-1.

A3.5.3 SCOPE OF THE SEP SYSTEM REVIEW

The categories of review identified in Subsection A3.5.1 are also applicable to the review of the standby electric power (SEP) system. Similarly, the criteria discussed in Subsection A3.2 were incorporated to develop the initial sample review matrix shown on Figures A-5 and A-6. The design areas (or topics) of the IDVP review matrix for the SEP system are somewhat different from those for the AFW system, consistent with the differences in the functions and physical configuration of these systems. The review philosophy, matrix concepts and

TABLE A-1

AFW SYSTEM SAMPLE SELECTION BOUNDARIES

Interfacing System	Interface Point (component included in AFW)
Main Steam	Valves 074 and 077 [1]
NSSS	Steam Generator Nozzles
Service Water A	Valve 283
Service Water B	Valve 282
Unit 2 Condensate Tank (from)	Valve 008
Condenser Hotwells	Valve 006
Unit 1 Condensate Tank (return)	Valve 019
Cooling Pond (return)	Valve 017
ac/dc Power System [2]	Breaker or fuse interfacing AFW components with power source
ESFAS	AFW actuation system and FOGG
Main FW Loop A	Valve 303
Vents and Drains	First Valve
HVAC	AFW pump room fan coolers and associated ductwork and supports

Notes:

[1] P&ID M-432, Sheet 1A, Revision 5

[2] Power supplies dedicated to AFW system are within sample selection boundaries.

organization remain the same. In this regard the diesel-generator vendor is reviewed on the same basis as other vendors. That is, the IDVP in general does not review the process by which the vendor developed data supplied to Bechtel but will review the interface data for consistency and reasonableness. The design areas for the SEP system review matrix are divided into three major divisions: SEP System Performance Requirements, SEP System Protection Features, and Structures that House the SEP System. The definition of design areas addressed within each of these major divisions are discussed in sections 3.1.4.1, 3.1.4.2 and 3.1.4.3 of the Engineering Program Plan, respectively.

Because the SEP system sample selection interfaces with other systems, it is necessary to define boundaries for items within the scope of the IDCVP. The SEP system as defined in the IDCVP includes four major elements: the diesel generator (DG) and its support systems; the power distribution system (PDS); the preferred 120 Vac power system (ac) and the 125 Vdc power system (dc). Continuity with the AFW system review is emphasized by drawing the boundaries of evaluation for the PDS and the two low voltage ac and dc systems as they service the AFW system. The PDS boundaries are drawn at breakers interfacing with the 480 V buses. The DG and all of its support systems are included within the sample selection boundaries of the SEP system. Specific interface points are are shown on Table A-2.

A3.5.4 SCOPE OF THE CR-HVAC SYSTEM REVIEW

The categories of review identified in section A3.5.1 are also applicable to the review of the control room HVAC (CR-HVAC) system. Similarly, the criteria discussed in section 3.2 of the Engineering Program Plan were incorporated to develop the initial sample review matrix shown on Figures A-8 and A-9. The design areas (or topics) of the IDVP review matrix for the CR-HVAC system are somewhat different from those for the AFW or SEP systems, consistent with the differences in the functions and physical configuration of these systems. The review philosophy, matrix concepts and organization remain the same. The design areas for the CR-HVAC system review matrix are divided into three major divisions: CR-HVAC System Performance Requirements, CR-HVAC

TABLE A-2

STANDBY ELECTRIC POWER SYSTEM
SAMPLE SELECTION BOUNDARIES

Interfacing System	Interfacing Point
Station Power and Offsite Power	Breakers connecting 4160 V Class IE and non-IE buses: 2305 1200A 2405 1200A
Non-Class IE 4160 Volt Bus Loads	Breakers at 4160 V Class IE Buses: 2599 1200A 2A0612 1200A
Class IE Electrical Distribution	Includes distribution system from 4160 V buses to the breaker at the 480 V buses: 2766 1600A 2866 1600A and distribution to loads fed directly at 4160 volts.
Aux. Feedwater System (AFW)	Include all portions of the Class IE power supply which feed essential components in the AFW, including the 480 Vac, 120 Vac, and 125 Vdc loads.
Diesel Generator	Include all portions of the Class IE power supply which feed essential components for the diesel generator and supporting systems discussed below, including the 480 Vac, 120 Vac, and 125 Vdc loads.
Control Room HVAC System (CR-HVAC)	Include all portions of the Class IE power supply which feed essential components for the CR-HVAC including the 480 Vac, 120 Vac and 125 Vdc loads.
Class IE Loads	For loads other than AFW, DG, and CR-HVAC, the review will be limited to confirming that all Class IE loads have been included in establishing the system design electrical loads.
DG Fuel Oil Storage and Transfer System	System (FSAR Figure 9.5-25) is included. Interface with Demineralized Water Supply is at DeLaval interface.
DG Cooling Water System	System integral to diesel is included (FSAR Figure 9.5-26). Service Water boundary is at DeLaval interface.
DG Starting System	System (FSAR Figure 9.5-27) is included.
DG Lubrication System	System (FSAR Figure 9.5-28) is included.
DG Combustion Air Intake and Exhaust System	System (FSAR Figure 1.2-27) is included.
Structures	DG building and foundations, and foundation for fuel oil storage tank.

System Protection Features and Structures that House the CR-HVAC System. The definition of design areas addressed within each of these major divisions are discussed in sections 3.1.5.1, 3.1.5.2 and 3.1.5.3 of the Engineering Program Plan, respectively.

Because the CR-HVAC system sample selection interfaces with other systems, it is necessary to define boundaries for items within the scope of the IDCV. In general the CR-HVAC system sample selection boundaries include the control room area ventilation system (CRAVS), its support systems and components important to control room isolation and habitability during accident conditions; either radiological or chemical. Specific interface points are shown on Table A-3.

A3.6 CONSTRUCTION VERIFICATION METHODOLOGY

The IDCVP consists of a review and evaluation of the quality of construction of selected components, commodities, and structures associated with the AFW, SEP and CR-HVAC systems. The construction activities reviewed include the major activities of the construction chain. These include the fabrication, storage, maintenance, installation or construction, and verification activities associated with the acceptance of the system or component, as further defined in Section A3.6.1 herein. The emphasis is on making a determination of the overall quality of construction and an assessment of its compliance with licensing commitments and NRC regulations. The review is conducted to varying stages of construction completion depending upon the specific system, component, or structure under review. The methodology includes diverse approaches such as checking of records, hands-on inspection of hardware, and confirmatory testing. The definition of the scope of review is provided in sections A3.6.2 and A3.6.3 which addresses the documentation and physical verification review activities.

In many instances, a complete verification of the as-built configuration against design documents and other applicable requirements is included. Where possible, systems and components selected for the IDVP are utilized for review in the ICVP thereby providing verification of the complete chain from criteria and

TABLE A-3

CONTROL ROOM HVAC SYSTEM SAMPLE SELECTION BOUNDARIES

Interfacing System	Interfacing Point
ac/dc Power System	All portions of Class IE electric system serving the CR HVAC are included in the Standby Electric Power (SEP) System review (see Section 3.1.4 for SEP sample selection boundaries).
Plant HVAC	Portion of the Control Room Area Ventilation System (CRAVS) (FSAR Figures 9.4-1 and 9.4-2) up to and including: Valves 0MO 6545A, 0MO 6545B, 0MO 6543A, 0MO 6543B, 0XV 6554, 0XV 6557, 0MO 6549, 0MO 6547A, 0MO 6547B
Equip. & Piping Supports	Includes all supports incorporated in the seismic qualification of the Control Room portion of the CRAVS as defined above.
ESFAS	Includes Control Room Isolation System (CRIS) subsystem, FSAR Figure 7.3-5.
Accident Monitoring Inst.	Portions essential for isolation of Control Room and operation of CRAVS, e.g. - intake duct radioactivity - charcoal filter temperature - hazardous gas concentration See FSAR Tables 7.5-1 and 7.5-3.
Plant I&C	Portions essential for isolation of Control Room and CRAVS operation.
Control Room Structure	Portions required for pressure boundary including penetrations and doors.

commitments through to the constructed and verified product. The ICVP is conducted utilizing detailed checklists which are described in section A3.2.6 of the Engineering Program Plan.

A3.6.1 CATEGORIES OF REVIEW: THE CONSTRUCTION CHAIN

Unlike the IDVP, the ICVP review is less dependent on system considerations as the focus is largely at a component, commodity, or structural element level. The quality of these items is represented by physical attributes as well as documentation that presents information having a bearing on quality that may not be directly observable. The categories of review are therefore divided into two distinct divisions, documentation and physical, corresponding to the major construction activities identified in the construction chain. The ICVP review categories included are:

Documentation

- o Review of Supplier Documentation
- o Review of Storage and Maintenance Documentation
- o Review of Construction/Installation Documentation

Physical

- o Review of Selected Verification Activities
- o Verification of Physical Configuration (including testing)

It is necessary to emphasize that the ICVP review is conducted to varying stages of construction completion depending upon the specific system, component or structure under review. As such, the ICVP review includes a detailed review of a static situation, or one which verifies the results of a completed activity, in addition to observations and reviews of a more dynamic environment where the construction activity being reviewed is actually in progress or has not been completed. The results of these types of reviews are integrated with an assessment of selected, on-going over-inspection activities and selected portions of the Quality Verification Program (QVP) element of CPC's Construction

Completion Program (CCP). Proceeding in this manner allows an even-handed, objective appraisal of not only the quality of construction for completed items, but also permits an evaluation of the outputs from on-going site activities undertaken to verify and confirm the quality of construction. The focus of the QVP review is on gaining an understanding of the informaiton sources, program reports, functional interfaces, and document storage and retention practices to enable verfication of relevant quality documentation and facilitate ICVP physical verification. The QVP review activity was added to the ICVP in early 1984 in response to CPC programmatic initiatives which are designed to confirm construction quality by either recreating or confirming existing quality documentation. The review of the completeness and validity of this documentation is essential to meeting ICVP objectives.

Each of these review categories is described in further detail in sections A3.6.1.1 through A3.6.1.5, respectively.

A3.6.1.1 REVIEW OF SUPPLIER DOCUMENTATION

For those components requiring fabrication or manufacture, selected supplier documentation and other associated information including shop inspection documentation are reviewed against design output documents to ensure conformance with requirements. Supplier documentation include such items as drawings, calculations, test reports, certified material property reports, storage and installation requirements, operations and maintenance requirements, and other major supplier documentation and data applicable to the component. For selected components, the review of supplier seismic and environmental qualification documentation against requirements defined in the design process are included. Questions such as the following are addressed in this category of review:

- o What is the identity of the supplier documentation being reviewed (including P.O. number, supplier name, component name and identification number)?
- o Has the documentation been reviewed and accepted by the appropriate organization?

- Is the documentation complete?

- Does the documentation comply with purchase specification requirements?

- Where appropriate, does seismic and environmental qualification documentation comply with purchase specification requirements?

- Have the necessary shipping, handling, storage, installation, and maintenance requirements been specified by the supplier and are these consistent with purchase specification requirements?

A3.6.1.2 REVIEW OF STORAGE AND MAINTENANCE DOCUMENTATION

A review of site documentation is performed to verify that requirements related to storage, including both in-storage and in-place maintenance have been met. Included is the review of receipt inspection documentation. Requirements reviewed include such parameters as temperature and humidity, cleanliness, lubrication, shaft rotation, energization, etc. Where possible, existing warehousing and maintenance documentation are reviewed and associated activities (e.g., system layup associated with Construction Completion Program) observed to provide additional verification that components have been properly stored and maintained during the construction process. Questions such as the following are addressed in this category of review:

- What is the identity of the storage and maintenance documentation being reviewed, including document type (receipt inspection, in-storage/in-place maintenance records, etc.) and document identification (document title, revision, date)?

- What is the identity of the component being reviewed (name, identification number)?

- Does the documentation for the receiving process include component review against purchase specification requirements?

- Are nonconforming items properly identified, processed and closed out?

- o Does the maintenance program meet the necessary requirements specified for the component relative to humidity, cleanliness, lubrication, shaft rotation, energization, etc., as applicable?

A3.6.1.3 REVIEW OF CONSTRUCTION/INSTALLATION DOCUMENTATION

A major factor in the evaluation of the quality of construction is the review of those items constructed or installed on site. The review of documentation associated with the construction/installation process is conducted to verify that the applicable requirements have been met (e.g., conformance to construction specifications is verified). Included in this review is verification of the utilization of proper documents in the process such as design output requirements, construction specifications, erection specifications, installation requirements, construction procedures and other specified construction codes and standards, as applicable. Design changes, field modifications, and other input related to final as-built drawings are reviewed. Included is the review of documentation associated with such items as concrete materials, concrete, the welding process, bolting activities, nondestructive examination (NDE), etc. Inspection requirements, including personnel qualification and training, reports, and associated documentation are also included in the review. Where possible, selected on-going construction/installation activities are observed to provide additional information for the evaluation of this process. Questions such as the following are addressed in this category of review:

- o What is the identity of the construction/installation documentation being reviewed, including type (concrete, welding, bolting, NDE, etc.) and identification (title, revision, date)?
- o What is the identity of the system, component or element and its physical location in the plant?
- o Are all appropriate construction/installation procedures and instructions identified?
- o Are the current revisions of drawings, specifications and other requirements utilized in the work including those specified in Field Change Requests?

- o Does the documentation include verification that the work has been performed by properly qualified personnel?
- o For those activities observed, do the construction/installation activities conform to requirements?
- o Have the necessary inspections been performed?
- o Has the work been performed utilizing the proper tools/equipment? Have such tools/equipment been properly calibrated in accordance with procedures?
- o Have rework activities including Field Change Requests been performed in accordance with requirements and appropriately closed-out?
- o Have deviations from design/supplier requirements been properly documented, processed and closed out?

A3.6.1.4 REVIEW OF SELECTED VERIFICATION ACTIVITIES

Verification activities conducted subsequent to the construction/installation/inspection activity are reviewed and evaluated. Included are over-inspection activities associated with cable separation verification, bolt hardness testing verification, the pipe support reinspection program, the Construction Completion Program; as well as routine cold hydro testing, functional and preoperational testing, other specified preservice system and component testing programs and system walkdowns associated with turn-over. Associated requirements, plans, test reports, etc. are reviewed and, where possible, these verification activities are observed in order to provide additional information and data to support evaluations. Questions such as the following are addressed in this category of review:

- o What is the identity of the verification activity being reviewed (cable separation verification, pipe support reinspection, bolting study, pre-service test, including type, etc.)?
- o What is the identity of the system, component or element(s) included in the verification activity under review?

- What is the identity of the verification activity documentation being reviewed (program plan, procedures, instructions, etc.)?

- What is the quality-related objective of the verification activity and does the activity as specified/documented meet the objective?

- Where verification activities are observed, do the activities comply with requirements and are they properly documented?

- Are nonconformances properly identified, processed and closed out?

A3.6.1.5 VERIFICATION OF PHYSICAL CONFIGURATION

Field verification of the as-built configuration of selected components of a portion of the systems under the scope of the ICVP is conducted to ensure conformance with requirements. Verification addresses such aspects as identification, approximate physical dimensions, location, orientation, name plate data, grounding, use of proper materials, insulation, weld quality, and other features of the configuration as applicable to the component or system. Configuration verification ranges from the review of general features for some components or systems to a 100% detailed dimensional verification of other selected components or systems. Questions such as the following are addressed in this category of review:

- What is the identity of the system, component or structural element being reviewed (name, identification number, location in plant, reference design documents)?

- Has the system, component or element been properly tagged/marked for identification in accordance with requirements?

- On the basis of visual inspection, has the component been properly constructed/installed and has it been maintained and protected during the construction process in accordance with requirements?

- o Does the configuration comply with design requirements, including physical dimensions, location, orientation, name plate data, grounding, use of proper materials, insulation, routing, etc., as applicable?
- o Have deviations from design requirements been properly identified, processed and closed out?

A3.6.2 ICVP SCOPE OF REVIEW

As previously discussed, the ICVP scope of review is oriented largely at the component, commodity or structural element level. Accordingly, the review areas (or topics) of the ICVP are divided into major divisions by component type: Mechanical, Electrical, Instrumentation and Control, HVAC and Structural. The specific identification of the scope of review of components, commodities or structural elements within each of the IDCVP systems is presented on Figures A-4, A-7 and A-10 for the AFW, SEP and CR-HVAC systems, respectively. The criteria discussed in section 3.2 of this appendix were utilized to develop these initial sample review matrices. The definitions of specific construction verification topics are presented in section 3.2.3.1 through 3.2.3.6 of the Engineering Program Plan.

Of particular note is the NDE/Materials Testing Program which supplements documentation verification activities and enhances the ability to verify physical attributes. This program is being conducted with the assistance of Law Engineering Testing Company as a subcontractor to TERA.

As part of the review of Supplier Documentation for system components, Law is assisting in a review to verify conformance of vendor welding, NDE, and materials testing to applicable codes, standards, and procurement specification requirements. The intent of the NDE/Material Testing Program is to supplement the review of Construction/Installation Documentation of welding, NDE, and material testing activities by establishing a program for the performance of NDE and material testing on selected material, components, and structures of the AFW and CR-HVAC systems. The program is conducted as an integral part of the ICVP and includes over-inspection and testing of selected shop-fabricated/-

vendor-supplied components in addition to the over-inspection and testing of onsite welding, weld repair, NDE and other site-material related testing and inspection programs. Results of the testing performed as part of the NDE/Materials Testing Program are documented, reviewed, and compared against vendor supplied and site-generated material testing and NDE test data and against applicable codes and standards.

The direction and degree of testing performed as a part of the NDE/Materials Testing Program is influenced by the results of the Construction/Installation Documentation review as described in sections 3.2.3.1 through 3.2.3.5 of the Engineering Program Plan. The results of the documentation review are integrated with the consideration of a statistical sampling approach and sound engineering judgment to arrive at the quantity and types of components and structures to be tested and the type of testing to be employed.

An intermediate output of the NDE/Materials Testing Program is a listing defining the components/structures to be tested and the corresponding test to be performed. Rationale for component/structure selection is also provided to enable reviewers to easily discern the derivation of the sample and the sample size.

A4 DOCUMENTATION, REPORTING, AND PROTOCOL

Auditable records are maintained to document substantive elements of the IDCVP review and evaluation process, to document technical conclusions including the status of disposition of items associated with the review process leading to Findings, to document the revision of records, and to establish quality assurance measures necessary to provide adequate confidence and assurance of the quality of services. Section A4.1 summarizes requirements for documentation of engineering evaluations, calculations, and field verification results. Section A4.3 summarizes documentation and protocol requirements for external communications.

A4.1 DOCUMENTATION OF ENGINEERING EVALUATIONS, CALCULATIONS, AND FIELD VERIFICATION RESULTS

Engineering evaluations, calculations, and field verification results provide the bases for all substantive conclusions reached in the IDCV. These items provide the "trail" of information which supports IDCVP conclusions, both positive and negative, as the case may be. While the reporting mechanism established in Section A4.3 of this Appendix addresses the documentation of reporting requirements which are generally applicable to negative conclusions, it is equally vital that positive conclusions are documented in an auditable form as well.

The requirements for preparation and control of engineering evaluation documentation required for the Midland IDCVP are contained in Project Instruction PI-3201-001, Engineering Evaluation Preparation and Control. Engineering evaluations are required for tasks such a: design criteria evaluation, commitment compliance evaluation, design evaluation, construction records evaluation, and field verification.

The requirements for preparation and control of Calculation documentation, including computer analyses documentation, required for the Midland IDCVP are contained in Engineering Control Procedure ECP-5.2, Calculation Preparation and Control. Calculations are prepared as required to verify designs, design parameters, design criteria, performance parameters, evaluate data, and otherwise provide quantitative information in accordance with accepted analytical and mathematical methods. Calculations are intended to assist IDCVP reviewers in reaching necessary conclusions relative to the quality of the Midland plant design.

A4.2 DOCUMENTATION AND PROTOCOL FOR EXTERNAL COMMUNICATIONS

The requirements for the preparation and control of documentation for external communications including the protocol for communications are contained in Project Instruction PI-3201-010, External Communications, Protocol and the Preparation of Contact Log Sheets. Under prescribed circumstances, oral communications and meetings that include discussions with parties external to the IDCVP review organization must be documented to provide an auditable record of information which may have an impact on IDCVP conclusions and the preservation of an independent process in reaching these conclusions. Accordingly, all oral communications, meetings and exchanges of written documents with parties external to the IDCV review organization that include discussion of any subjects material to the scope of the Midland IDCVP, Status reporting, Findings and Findings resolution, including recommendations, evaluations, correspondence, interim and final reporting are documented and controlled consistent with the provisions of PI-3201-010.

The protocol governing communications between CPC and TERA is in accordance with the provisions documented in a letter from James G. Keppler, Administrator, NRC Region III to James W. Cook, Vice President, CPC, dated March 28, 1983.

A4.3 PROGRAM REPORTING

The following types of reports are prepared in the IDCVP:

- o Open, Confirmed, and Resolved (OCR) Item Reports

- Observations
- Finding Reports
- Finding Resolution Reports
- Draft and Final Reports
- Interim Technical Topical Reports
- Monthly Status Reports

OCR reports document the disposition of the IDCVP review process leading to either Findings or the resolution of items which have surfaced during the review, but have been resolved after considering additional information.

An item is classified open if an issue is identified which represents a potential deviation in implementation of design or construction procedures, thus requiring additional investigation of information known to exist or confirmatory analysis by IDCVP reviewers in areas such as: quality assurance or design control implementation, licensing criteria or commitments compliance, analytical or mathematical technical approach, design analysis evaluation, specifications review, field configuration and constructed product verification, etc.

If after additional investigation or confirmatory analysis the item remains and it is judged to be an apparent Finding by the review team, it is reclassified as a Confirmed Item. Confirmed Items require action on the part of the Midland Project to identify additional documentation or provide clarification not utilized by the review team. Based upon this additional information, the review team may resolve the item by reclassifying it as a Resolved Item, or alternatively if the Confirmed item is verified, it becomes a Finding.

Observations are deficiencies that are not sufficiently serious to warrant classification as OCRs or Findings, yet cannot be dismissed directly as Resolved Items, but should be reviewed and corrected by CPC during the completion of the Midland project.

Finding Reports document verified deviations in the implementation of design criteria, design, or construction commitments and design or construction procedures in areas such as: quality assurance, design or construction control, analysis, design, engineering evaluation, specification, design or construction implementation or field installation. IDVP Findings generally represent verified deviations in the end products of the design process, drawings or specifications. ICVP Findings generally represent verified deviations in the end products of the construction process, quality documentation, and the physical installation. Findings may fall into two categories: those affecting the ability of systems, components, or structures to meet their intended safety function and those without an impact on safety functions.

Finding Resolution Reports document the conclusions of the review process which has been undertaken to resolve Findings and completely close out any concern about the Findings. Finding resolution may require additional analysis, design, or construction changes or procedural changes. Full resolution requires the identification of root cause and extent and a plan for corrective action if required.

The preparation and control of OCR Reports, Finding Reports, and Finding Resolution Reports is addressed in Project Instruction PI-3201-008, Preparation and Control of Open, Confirmed, and Resolved Item Reports, Finding Reports, and Finding Resolution Reports.

The IDCVP Final Report documents all substantive conclusions reached in the IDCVP, including the process leading to these conclusions. Both positive and negative conclusions will be identified to provide a balanced perspective and to document a complete record. While the overall IDCVP objective is to verify the quality of the Midland project design and construction efforts identifying any deficiencies, it is necessary to have a record which documents items that have been dismissed (i.e., positive conclusions) because the bases for these conclusions are equally important.

The Final Report includes documentation of all conclusions, including references to applicable documents that support these conclusions. A draft Final Report is transmitted to CPC and NRC for their review. Resolution of their comments is documented in an auditable manner. A copy of the draft Final Report is sent to outside parties on the IDCVP Service List. It should be noted that CPC and NRC comments are intended to be of a clarification nature or to correct misinformation. Upon TERA resolution of the comments, the Final Report is issued and distributed to CPC, NRC, and outside parties on the IDCVP Service List.

A5.0 QUALITY ASSURANCE

The Midland IDCVP is performed in accordance with applicable quality assurance requirements of the NRC's regulation 10 CFR 50, Appendix B. Furthermore, the IDCVP complies with:

- o NRC Regulatory Guide 1.28 (6/7/72) including Sections 1, 2, 3, 5, 7, 17, and 18 of ANSI N45.2-1971
- o NRC Regulatory Guide 1.64 (Revision 1, 2/75) including Sections 1, 2, and 6 of ANSI N45.2.11-1974

These requirements are implemented by the TERA Corporate Quality Assurance Plan (QAP), Revision 3 (January 1, 1980) and the Midland IDCVP Project Quality Assurance Plan (PQAP), Revision 5 (June 15, 1984).

Quality assurance audits of project operations are conducted in accordance with ECP-5.6, "Quality Assurance Audits."

APPENIDX B

CPC COMMENTS ON REPORT

(TO BE INCORPORATED IN THE
FINAL VERISION OF THE REPORT)

APPENDIX C

CONSOLIDATED CRITERIA AND COMMITMENTS LIST

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS

Comm #	Description	Source(s)*	Review Topic**
1	GDC 1 - Quality Standards and Records	10CFR FSAR (3.1)	All
2	GDC 2 - Protection Against Natural Phenomena	10CFR FSAR (3.1) B&W	I.5-1 I.9-1 I.13-1 I.15-1 I.18-1 I.19-1 I.20-1 I.23-1 II.1-1 II.14-1 III.1-1 III.2-1 III.3-1
3	GDC 3 - Fire Protection	10CFR FSAR (3.1)	I.6-1 II.12-1
4	GDC 4 - Environmental & Missile Design Bases	10CFR FSAR (3.1) B&W	I.2-1 I.3-1 I.9-1 I.10-1 I.13-1 I.15-1 I.18-1 I.19-1 I.20-1 I.23-1 II.1-1 II.2-1 II.4-1 II.5-1 II.6-1 II.7-1

* See Source Identification List, Attachment A, and References/Sources of Information Form, Attachment B.

** See sample review matrices, Figures A-2 and A-3 of Appendix A to the IDCVP report on AFW System Performance Requirements.

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
4	GDC 4 - Environmental & Missile Design Bases (cont'd)	10CFR FSAR (3.1) B&W	II.8-1 II.9-1 II.10-1 II.11-1 II.13-1 II.14-1 III.2-1 III.4-1
5	GDC 5 - Sharing of Structures, Systems and Components	10CFR FSAR (3.1)	I.2-1 I.3-1 I.4-1 I.5-1 I.9-1 I.10-1 I.12-1 I.13-1
6	GDC 34 - Residual Heat Removal	10CFR FSAR (3.1) B&W	I.1-1 I.3-1 I.4-1 I.5-1 I.9-1
7	GDC 44 - Cooling Water	10CFR FSAR (3.1)	I.9-1 I.12-1 I.13-1
8	GDC 46 - Testing of Cooling Water	10CFR FSAR (3.1)	I.4-1 I.9-1 I.14-1
9	GDC 54/57 - Piping Systems Penetrating Cont. - Closed System Isolation Valves	10CFR FSAR (3.1)	I.3-1 I.7-1 I.9-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
10	Minimum AFW temperature is 40°F (Notes 1, 2)*	B&W (2.11)	1.1-1 1.9-1 1.13-1
11	Maximum Service Water Temperature is 105°F; see also ANS 51.10, paragraph 3.1.1.1(B)(i) (Note 3)	FSAR 10.4.9.2.2	1.1-1 1.2-1 1.9-1 1.11-1 1.13-1
12	Heat Removal Calculation Based on 90°F (Note 3)	B&W (2.14)	1.1-1 1.2-1 1.9-1 1.11-1 1.13-1
13	Minimum AFW Flow Design Value is 850 gpm (injection into steam generators)	B&W (2.2) (2.14)	1.1-1 1.2-1 1.3-1 1.9-1 1.10-1 1.11-1 1.13-1
14	Maximum AFW flow to each steam generator is 2400 gpm (was 1650 gpm in B&W Rev. 1 - draft - BOP criteria) with steam generator at atmospheric conditions	B&W (2.14)	1.1-1 1.9-1 1.10-1
15	Maximum total flow to steam generators is 3200 gpm (in draft Rev. 1 of B&W BOP criteria) for steam line break accident. Criterion deleted in final Rev. 1; but see also ANS 51.10, paragraph 3.1	--	1.1-1 1.9-1 1.10-1

* See Attachment C, Notes.

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
16	Two full capacity systems	B&W (2.1) FSAR 10.4.9.1.1	I.3-1 I.4-1 I.9-1 I.10-1 I.13-1 I.15-1 I.16-1 I.18-1 I.19-1 I.20-1
17	On station blackout system must be capable of operating for two hours	B&W (2.6) FSAR 10.4.9.1.1	I.2-1 I.9-1 I.10-1 I.11-1 I.12-1 I.13-1 I.15-1 II.8-1 II.9-1 II.10-1 II.11-1
18	Primary water source storage based on cooldown to 280°F. See also ANS 51.10 (2.0). The FSAR adds the requirement of four hours at hot shutdown in addition to the cooldown requirement	B&W (2.16) FSAR 10.4.9.3	I.13-1
19	Cooldown limited to 100°F/hr	B&W (2.17)	I.2-1 I.3-1 I.10-1
20	With motor-driven pump available AFW must reduce primary to normal DHR cut-in of 280°F	B&W (2.16)	I.1-1 I.2-1 I.9-1 I.10-1

TERA CORPORATION

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
21	When motor-driven pump is not available, AFW must reduce primary to 325°F (maximum DHR temperature)	B&W (2.16)	I.1-1 I.2-1 I.9-1 I.10-1
22	Primary water source water chemistry requirements per Table I of B&W BOP criteria document	B&W (2.15)	I.9-1 I.13-1
23	System must provide feedwater for normal startup and shutdown; deaerator is preferred source (Note 1)	FSAR (10.4.7.2.3) B&W (2.18)	I.1-1 I.3-1 I.9-1 I.10-1
24	Decay heat based on 1.0 times ANS 5.1-1979	FSAR Page 10A Item 17(e) (Note 4)	I.10-1 I.11-1
25	Decay heat based on method of APCSB 9.2	FSAR Page 10.4-37 (Note 4)	I.10-1 I.11-1
26	Seismic category I water supply available	B&W (2.15)	I.2-1 I.3-1 I.5-1 I.7-1 I.9-1 I.10-1 I.13-1 I.15-1 II.1-1 II.2-1 III.1-1
27	System must have sufficient head to inject water for all transients not involving a secondary system rupture	B&W (2.14)	I.1-1 I.9-1 I.10-1 I.11-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
28	Turbine operates from safety valve setpoint to 96 psia (pressure was 65 psig in draft Rev. 1)	B&W (2.8)	I.1-1 I.9-1 I.10-1
29	Essential portions of AFW are seismic Category I and can withstand other credible natural phenomena	B&W (2.4)	I.2-1 I.5-1 I.9-1 II.1-1 II.2-1 II.3-1 II.4-1 III.1-1 III.2-1 III.3-1
30	Essential portion of AFW system inside containment is quality group B	FSAR 3.2	I.8-1 I.9-1 I.21-1 I.22-1
31	Essential portion of AFW system outside containment is quality group C	FSAR 3.2	I.8-1 I.9-1 I.21-1 I.22-1
32	AFW is capable of responding to all design basis accidents for which it is required	FSAR 10.4.9	I.2-1 I.3-1 I.5-1 I.9-1
33	AFW is testable during normal plant operation	FSAR 10.4.9.4 (and cross ref. to 16.3/4.7.1.2)	I.9-1 I.14-1
34	Power level of 2552 MWt is used for accident analyses and a 1.02 factor is applied for instrument error	FSAR Chapter 15	I.2-1 I.10-1 I.11-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
35	Reactor coolant pump heat (16 MWt) must be added to decay heat	B&W (2.14)	1.10-1 1.11-1
36	Automatic switchover to Cat. I water supply (Note 1)	B&W (2.19) FSAR 10.4.9.2.3, 7.4.1.1.3.3	1.5-1 1.9-1 1.13-1 1.19-1 1.20-1
37	Miminum flow bypass line during low AFW flow conditions must pass 250 gpm (Notes 1, 5)	B&W (2.20) FSAR 10.4.9.2.3	1.1-1 1.9-1 1.10-1 1.19-1
38	Minimum AFW flow provided within 40 seconds following loss of offsite ac power	B&W (2.12)	1.2-1 1.3-1 1.9-1 1.19-1 1.20-1 1.23-1
39	System must meet single failure criteria	B&W (2.2) (2.3) (2.9) FSAR 10.4.9.1.1 10CFR	1.3-1 1.5-1 1.6-1 1.7-1 1.9-1 1.15-1 1.16-1 1.18-1 1.19-1 1.20-1
40	AFW pumps powered from preferred source of energy; powered components use separate and diverse sources of energy; independent trains have diverse power sources	B&W (2.5) (2.6) BTP ASB10-1	1.3-1 1.9-1 1.15-1 1.23-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
41	System must provide decay heat removal capability and termination of flow to faulted S/G assuming SSE, LOOP, resultant environmental conditions, single failure	B&W (2.9)	I.2-1 I.3-1 I.9-1 I.15-1 I.23-1
42	System should be designed to minimize the effects of hydraulic instability (water hammer)	B&W (2.10)	I.10-1
43	Analyses are based on maximum time flow can be started relative to event (except where early starting is more conservative)	FSAR Chapter 15	I.2-1 I.10-1 I.11-1
44	AFW system is high energy	FSAR (3.6)	II.5-1 II.6-1 II.7-1 II.9-1 II.10-1 III.4-1
45	Regulatory Guide 1.26 Quality Group Classifications	FSAR (App 3A)	I.9-1
46	Regulatory Guide 1.27 Ultimate Heat Sink	FSAR (App 3A)	I.2-1 I.3-1 I.13-1
47	Regulatory Guide 1.29 Seismic Design Classification	FSAR (App 3A)	I.9-1 I.13-1 II.1-1 II.4-1 II.14-1 III.1-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
48	Regulatory Guide 1.46 Protection Against Pipe Rupture	FSAR (App 3A)	II.5-1 II.6-1 II.7-1 III.4-1
49	Regulatory Guide 1.47 Bypassed and Inoperable Status	FSAR (App 3A)	I.4-1 I.7-1 I.14-1 I.18-1 I.19-1 I.20-1
50	Regulatory Guide 1.48 Design Limits and Loading Combinations	FSAR (App 3A)	I.9-1 II.1-1 II.2-1 II.3-1 II.4-1
51	Regulatory Guide 1.59 Design Basis Flood	FSAR (App 3A)	III.3-1
52	Regulatory Guide 1.64 QA for Design	FSAR (App 3A)	All
53	Regulatory Guide 1.100 Seismic Qualification of Electrical Equipment	FSAR (App 3A)	II.4-1
54	Fire protection requirements are consistent with Appendix A to BTP 9.5-1 as defined in FSAR Appendix 9A	FSAR (App 9A)	II.12-1
55	Regulatory Guide 1.75 - Physical Independence of Electrical Systems Endorses IEEE 384	FSAR (App 3A)	I.15-1 I.16-1 I.18-1 I.19-1 I.20-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
56	IEEE Std. 384 "Criteria for Independence of Class IE Equipment of Circuits" Specifies requirements for separation in general plant areas, hazardous areas, control panels, including isolation from non IE	FSAR (App 3A)	1.15-1 1.16-1 1.18-1 1.19-1 1.20-1
57	Regulatory Guide 1.6 - Independence Between Redundant Standby Power and Between their Distribution Systems	FSAR (App 3A)	1.15-1 1.16-1
58	IEEE STD 588-1976 "Guide for AC Motor Protection"	FSAR Section 8.3	1.17-1
59	Regulatory Guide 1.63 - Electric Penetration Assemblies in Contaminant Structures - design guidance for electrical penetrations	FSAR (App 3A)	1.17-1
60	Regulatory Guide 1.106 - Thermal Overload Protection for Electric Motors on Motor Operated Valves Guides designer to bypass thermal overload protection for electric motors on motor-operated valves	FSAR (App 3A)	1.17-1
61	Regulatory Guide 1.22 - Requirements for Periodic Testing of Protective Systems	FSAR (App 3A)	1.14-1 1.20-1
62	Regulatory Guide 1.53 - Application of Single Failure Criteria to Protection Systems (Endorses IEEE 379)	FSAR (App 3A)	1.3-1 1.15-1 1.17-1 1.18-1 1.19-1 1.20-1
63	Regulatory Guide 1.62 - Manual Initiation of Protective Actions	FSAR (App 3A)	1.19-1 1.20-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
64	Regulatory Guide 1.118 - Requirements for Periodic Testing of Electric Power and Protection Systems	FSAR (App 3A)	1.14-1 1.20-1
65	Regulatory Guide 1.105 - Methodology for Determining Instrument Spans and Setpoints	FSAR (App 3A)	1.18-1
66	Regulatory Guide 1.97 - Instrumentation for Light Water Cooled Nuclear Power Plants to Assess Plant Conditions During and Following an Accident	FSAR (App 3A)	1.18-1
67	IE Circular 81-13 - Torque Switch Electrical Bypass Circuit for Safeguard Service Valve Motors	Standard Review Plan	1.17-1
68	Cable length shall not exceed maximum design length	FSAR (Chapter 8)	1.16-1
69	GDC 13 - Instrumentation and Control	10CFR FSAR (3.1)	1.18-1 1.19-1
70	GDC 19 - Control Room	10CFR FSAR (3.1)	1.6-1 1.18-1 1.19-1
71	GDC 20 - Protection System Functions	10CFR FSAR (3.1)	1.20-1
72	GDC 21 - Protection System Reliability and Testability	10CFR FSAR (3.1)	1.20-1
73	GDC 22 - Protection System Independence	10CFR FSAR (3.1)	1.20-1
74	GDC 23 - Protection System Failure Mode (Note 7)	10CFR FSAR (3.1)	---

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
75	GDC 24 - Separation of Protection and Control Systems	10CFR FSAR (3.1)	1.19-1 1.20-1
76	GDC 29 - Protection Against Anticipated Operational Occurrences (Note 7)	10CFR FSAR (3.1)	---
77	IEEE STD 279-1971 "Criteria for Protection Systems for Nuclear Power Generating Stations"	FSAR (7.1)	1.19-1 1.20-1
78	Secondary plant variables to be monitored include: a. AFW valve position b. Main steam and feedwater isolation valve position c. S/G pressure d. S/G water level (Note 1)	B&W (3.4)	1.18-1
79	Instrumentation for initiation and control of AFW shall meet Class IE requirements	B&W (3.1)	1.18-1 1.19-1 1.20-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
80	The Main Control Room (MCR) and Auxiliary Shutdown Panel (ASP) shall indicate the following: a. S/G water level b. S/G pressure c. AFW pump suction pressure d. AFW pump motor status e. AFW pump turbine status f. AFW pump discharge pressure g. AFW flow rate to each S/G h. Turbine driver steam inlet pressure i Condensate storage tank level j. Position indications for all AFW power operated isolation and control valves, water supply isolation valves, steam supply inlet isolation valves, and essential manual valves in recirculation line (Note 1)	B&W (3.4)	1.6-1 1.18-1
81	Instrument setpoint ranges are shown in Table II of B&W BOP criteria document. Actual setpoints must consider string error (Note 1)	B&W (3.6)	1.18-1
82	Two separate level indicating ranges are required for instrument accuracy of S/G level measurement (Note 1)	B&W (3.7)	1.18-1
83	When an S/G is isolated, capability must exist to continuously monitor status	B&W (3.11)	1.18-1
84	If control room is uninhabitable, AFW system should be monitored and controlled from the ASP	FSAR 10.4.9.1.1	1.18-1 1.19-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
85	Instrumentation and control features shall be adequate to verify correct system operation	SRP10.4.9	1.18-1 1.19-1
86	Automatic initiation of AFW flow	SRP 10.4.9	1.20-1
87	Redundant AFW supply level indication and alarm	FSAR (App 10A)	1.18-1
88	Safety grade indication of AFW flow to each S/G	FSAR (App 10A)	1.18-1
89	Manual controls at ASP must override auto controls in MCR	B&W (3.3)	1.6-1 1.19-1
90	The MCR and ASP should have controls for: a. AFW pumps b. S/G water level c. Service water supply isolation valve position d. All essential power operated valves e. Turbine speed controller (Note 1)	B&W (3.5)	1.6-1 1.19-1
91	S/G level rate control system shall allow 10 minutes of no operator action (Note 1)	B&W (3.8)	1.19-1
92	Manual start capability for AFW pumps and valves	B&W (3.9)	1.19-1
93	Feed only good generator logic	B&W (3.10)	1.20-1
94	Capability to override FOGG	B&W (3.12)	1.19-1
95	Prevent S/G overfill	B&W (3.14)	1.19-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
96	AFW shall be initiated if: a. S/G pressure is less than 585 psig b. Low S/G water level (either S/G) c. Loss of 3/4 RCPs d. Loss of both MFPs e. Class IE bus undervoltage f. Presence of ECCAS signal	B&W (3.2)	1.20-1
97	Bypass low S/G pressure during startup	B&W (3.13)	1.20-1
98	S/G-AFW level control system shall: a. Put initial value of level setpoint at 2' b. Rate of level increase shall be adjustable c. Be able to manually control level d. Be able to follow level in manual e. Increase level to 20' when natural circulation required	B&W 86-1119130	1.19-1
99	AFW S/G level control valves must be capable of continuous modulation	B&W 86-1119130	1.19-1
100	Initial control valve position can be open or closed	B&W 86-1119130	1.19-1
101	Level control system should be modeled to verify stability (Note 6)	B&W 86-1119130	1.19-1
102	Each AFW pump tripped on 2/4 low suction pressure when AFWAS signal not present	FSAR 10.4.9.2.2	1.5-1 1.7-1 1.19-1 1.20-1
103	S/G level rate increase shall be limited to 3 to 4 inches per min	BAW-1612, Rev. 1	1.19-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
104	FOGG logic based on S/G differential pressure - lower pressure S/G is isolated when ΔP exceeds predetermined value	AFW Config & Control Task Force*	1.19-1 1.20-1
105	AFW initiation signal should start all AFW pumps, align AFW water sources, open AFW flow paths and start any required support systems	SRP 10.4.9	1.20-1
106	Control schematic diagrams shall correctly reflect system logic, and show required instrumentation/indications in accordance with vendor switch development	FSAR (Ch. 7) SRP (Ch. 7)	1.19-1 1.20-1
107	Circuit breaker control schematic diagrams shall be designed in accordance with system logic diagrams and vendor design input	FSAR (Ch. 7) SRP (Ch. 7)	1.19-1 1.20-1
108	AFW logic diagrams shall reflect system design requirements	SRP (Ch. 7)	1.19-1 1.20-1
109	AFW S/G level control is blocked during normal plant operation	FSAR 7.4.1.1.3.2	1.19-1
110	AFW S/G level control is enabled by an AFW pump running signal	FSAR 7.4.1.1.3.2	1.19-1
111	Transfer to manual S/G level control	FSAR 7.4.1.1.3.2	1.19-1
112	Transfer to manual control at ASP overrides automatic control and removes manual control from MCR for S/G level	FSAR 7.4.1.1.3.2	1.19-1

* See Source Identification List, Attachment A.

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
113	2/4 low pump suction pressure plus AFWAS signal initiates supply switchover	FSAR 7.4.1.1.3.2	1.19-1
114	Be able to establish AFW flow to both S/G within 40 sec after initiation	B&W (2.12)	1.19-1 1.20-1
115	Regulatory Guide 1.14 Reactor Coolant Pump Flywheel Integrity	FSAR (App 3A)	II.13-1
116	Regulatory Guide 1.28 Quality Assurance Program Requirements (Design and Construction)	FSAR (App 3A)	All
117	FSAR 3.7-3 and 3.7-4 used in lieu of Regulatory Guide 1.60 Design Response Spectra of Seismic Design of Nuclear Power Plants	FSAR (App 3A)	III.1-1
118	Regulatory Guide 1.61 with exceptions as noted in FSAR Damping Values for Seismic Design of Nuclear Power Plants	FSAR (App 3A)	II.1-1 II.2-1 II.4-1 III.1-1
119	Regulatory Guide 1.76 Design Basis Tornado for Nuclear Power Plants	FSAR (App 3A)	III.2-1
120	Regulatory Guide 1.84 Code Case Acceptability	FSAR (App 3A)	II.1-1 II.2-1 II.3-1
121	Regulatory Guide 1.92 Combining Modal Responses and Spatial Components in Seismic Response Analysis	FSAR (App 3A)	II.1-1 II.2-1 II.3-1 II.4-1 III.1-1

AFW -- CONSOLIDATED CRITERIA AND COMMITMENTS
(Continued)

Comm #	Description	Source(s)	Review Topic
122	Regulatory Guide 1.102 Flood Protection for Nuclear Power Plants	FSAR (App 3A)	III.3-1
123	Regulatory Guide 1.115 Protection Against Low-Trajectory Turbine Missiles	FSAR (App 3A)	II.13-1
124	Regulatory Guide 1.117 Tornado Design Classification	FSAR (App 3A)	III.2-1
125	Regulatory Guide 1.122 Development of Floor Design Response Spectra for Seismic Design of Floor Supported Equipment or Components	FSAR (App 3A)	III.1-1
126	Building Code Requirements for Reinforced Concrete (ACI-318-63 and 318-71)	FSAR (App 3A)	III.5-1 III.6-1 III.7-1
127	GDC 17 - Electric Power Systems	10CFR FSAR (3.1)	I.15-1
128	Fire protection is consistent with the Fire Hazards Analysis	FSAR (App 9A)	II.12-1
129	Design is consistent with safe shutdown analysis (similar to Appendix R)	FSAR (App 9A)	II.12-1
130	NUREG 0588, Interim Staff Position on Environmental Qualification of Safety-related Electrical Equipment, Rev 1, July 1981	EQ Report	II.10-1

ATTACHMENT A

SOURCE IDENTIFICATION

Source	Description
B&W	Unless otherwise noted, "B&W" refers to the B&W BOP interface document 36-1004477, Rev 01, 5/31/83. The numbers in the parentheses refer to paragraph numbers in that document.
FSAR	All FSAR references are to the FSAR as revised by Amendment 49 unless otherwise noted.
AFW Configuration & Control Task Force	This source is a series of memos and other documents contained as attachments to a CPC letter to Bechtel (Postlewait to Curtis), dated 4/16/80, Serial 8631.

REFERENCES/SOURCES OF INFORMATION

TOPIC TITLE AFW - Consolidated Criteria & Commitments TOPIC NO. ______ PAGE ____ OF ____

ENGINEERING EVALUATION ______ CONT. ID. NO. 3201-002-T-002 REV 2 DATE 4/16/84

ORIGINATING ORG./ AUTHOR	IDENTIFICATION/ NUMBER	REV.	DATE	TITLE	WHERE/HOW LOCATED	DOCUMENT TYPE
CPC	FSAR	49	--	FSAR through Amend. 49	TERA file copy	Report
B & W	36-1004477	1	5/31/83	Balance of Plant Criteria - AFW	B&W Response to OCR	Criteria
CPC	EQ Report	1	12/82	Environmental Qualification Report	TERA file copy	Report
NRC	BTP ASB10-1	2	7/81	Design Guidelines for AFW	TERA file copy	Criteria
NRC	NUREG-0800	--	7/83	Standard Review Plan	TERA file copy	Criteria
B & W	86-1119130	0	4/80	Specific Design Criteria for Safety Grade AFW Control System	Bechtel files	Criteria
B & W	BAW-1612	1	3/80	Conceptual Design Study	Bechtel files	Report
NRC	10 CFR	--	12/31/82	Code of Federal Regulations	TERA file copy	Regulations
ANS	51.10	--	11/5/79	American National Standard for Auxiliary Feedwater System	TERA file copy	Criteria
Postlewait (CPC)	8631	--	4/16/80	Letter to Bechtel (Curtis)	Bechtel files	Letter

ATTACHMENT C
NOTES

1. For criteria indicated by Note 1, the B&W interface document does not show the double asterisk, thus indicating that B&W considers the interface specification to be not critical and that it need not be met.

2. See OCR 3201-008-R-028 and Engineering Evaluation 3201-008-091.

3. See OCR 3201-008-R-020 and Engineering Evaluation 3201-008-091.

4. See OCR 3201-008-R-018 and Engineering Evaluation 3201-008-091. FSAR Amendment 49 revised the FSAR to resolve this OCR and remove the inconsistency.

5. See OCR-3201-008-R-038 and Engineering Evaluation 3201-008-002.

6. See OCR 3201-008-R-022 and Engineering Evaluation 3201-001-019.

7. GDC 23 and 29 were evaluated for inclusion in the consolidated criteria and commitments list but were subsequently determined to be applicable only to the ESFAS, the details of which are outside the scope of the IDVP. They are retained in this list for continuity of criteria numbering only.

ATTACHMENT D

CROSS REFERENCES BETWEEN TOPIC NUMBER, CRITERIA AND COMMITMENTS

Review Topic Number	Criteria/Commitment Numbers	Engineering Evaluation Number(s) for Review of Criteria & Commitments
1.1-1	1, 6, 10, 11, 12, 13, 14, 15, 20, 21, 23, 27, 28, 37, 52, 116	3201-001-030
1.2-1	1, 4, 5, 11, 12, 13, 17, 19, 20, 21, 26, 29, 32, 34, 38, 41, 43, 46, 52, 116	3201-001-017
1.3-1	1, 4, 5, 6, 9, 13, 16, 19, 23, 26, 32, 38, 39, 40, 41, 46, 52, 62, 116	3201-001-013
1.4-1	1, 5, 6, 8, 16, 49, 52, 116	3201-001-012
1.5-1	1, 2, 5, 6, 26, 29, 32, 36, 39, 52, 102, 116	3201-001-019
1.6-1	1, 3, 52, 70, 80, 84, 89, 90, 116	3201-001-020
1.7-1	1, 9, 26, 39, 49, 52, 102, 116	3201-001-019
1.8-1	1, 30, 31, 52, 116	3201-001-021
1.9-1	1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 22, 23, 26, 27, 28, 29, 30, 31, 32, 33, 36, 37, 38, 39, 40, 41, 47, 50, 52, 116	3201-001-091
1.10-1	1, 4, 5, 13, 14, 15, 16, 17, 19, 20, 21, 23, 25, 26, 27, 28, 34, 35, 37, 42, 43, 52, 116	3201-001-091
1.11-1	1, 11, 12, 13, 17, 24, 25, 27, 34, 35, 43, 52, 116	3201-001-091
1.12-1	1, 5, 7, 17, 52, 116	3201-001-091
1.13-1	1, 2, 4, 5, 7, 10, 11, 12, 13, 16, 17, 18, 26, 36, 46, 47, 52, 116	3201-001-091
1.14-1	1, 8, 33, 49, 52, 61, 64, 116	3201-001-073
1.15-1	1, 2, 4, 16, 17, 26, 39, 40, 41, 52, 55, 56, 57, 62, 116, 127	3201-001-002

ATTACHMENT D

CROSS REFERENCES BETWEEN
TOPIC NUMBER, CRITERIA AND COMMITMENTS
(CONTINUED)

Review Topic Number	Criteria/Commitment Numbers	Engineering Evaluation Number(s) for Review of Criteria & Commitments
1.16-1	1, 16, 39, 52, 55, 56, 57, 68, 116	3201-001-004
1.17-1	1, 52, 58, 59, 62, 67, 116	3201-001-005
1.18-1	1, 2, 4, 16, 39, 49, 52, 55, 56, 62, 65, 66, 69, 70, 78, 79, 80, 81, 82, 83, 85, 87, 88, 116	3201-001-028
1.19-1	1, 2, 4, 16, 36, 37, 38, 39, 49, 52, 55, 56, 62, 63, 69, 70, 75, 77, 79, 84, 85, 89, 90, 91, 92, 94, 95, 98, 99, 100, 101, 102, 103, 104, 106, 107, 108, 109, 110, 111, 112, 113, 114, 116	3201-001-029
1.20-1	1, 2, 4, 16, 36, 38, 39, 49, 52, 55, 56, 61, 62, 63, 64, 71, 72, 73, 75, 77, 79, 86, 93, 96, 97, 102, 104, 105, 106, 107, 108, 114, 116	3201-001-003
1.21-1	1, 30, 31, 52, 116	3201-001-074
1.22-1	1, 30, 31, 52, 116	3201-001-075
1.23-1	1, 2, 4, 38, 40, 41, 52, 116	3201-001-013
11.1-1	1, 2, 4, 26, 29, 47, 48, 50, 52, 116, 118, 120, 121	3201-001-042
11.2-1	1, 4, 26, 29, 50, 52, 116, 118, 120, 121	3201-001-042
11.3-1	1, 29, 50, 52, 116, 120, 121	3201-001-042
11.4-1	1, 4, 29, 47, 50, 52, 53, 116, 118, 121	3201-001-022
11.5-1	1, 4, 44, 48, 52, 116	3201-001-009
11.6-1	1, 4, 44, 48, 52, 116	3201-001-009

ATTACHMENT D

CROSS REFERENCES BETWEEN
TOPIC NUMBER, CRITERIA AND COMMITMENTS
(CONTINUED)

Review Topic Number	Criteria/Commitment Numbers	Engineering Evaluation Number(s) for Review of Criteria & Commitments
II.7-1	1, 4, 44, 48, 52, 116	3201-001-009
II.8-1	1, 4, 17, 52, 116	3201-001-007
II.9-1	1, 4, 17, 44, 52, 116	3201-001-007
II.10-1	1, 4, 17, 44, 52, 116	3201-001-007
II.11-1	1, 4, 17, 52, 116	3201-001-007
II.12-1	1, 3, 52, 54, 116, 128, 129	3201-001-072
II.13-1	1, 4, 52, 115, 116, 123	3201-001-011
II.14-1	1, 2, 4, 47, 52, 116	3201-001-034
III.1-1	1, 2, 26, 29, 47, 52, 116, 117, 118, 121, 125	3201-001-042
III.2-1	1, 2, 4, 29, 52, 116, 119, 124	3201-001-042
III.3-1	1, 2, 29, 51, 52, 116, 122	3201-001-042
III.4-1	1, 4, 44, 48, 52, 116	3201-001-042
III.5-1	1, 52, 116, 126	3201-001-042
III.6-1	1, 52, 116, 126	3201-001-042
III.7-1	1, 52, 116, 126	3201-001-042