DIAGNOSTIC EVALUATION TEAM REPORT

FOR THE

PALO VERDE NUCLEAR GENERATING STATION UNITS 1, 2, AND 3

FEBRUARY 1990

U.S. Nuclear Regulatory Commission
Office for Analysis and Evaluation of Operational Data
Division of Operational Assessment
Diagnostic Evaluation and Incident Investigation Branch

Licensee: Arizona Public Service Company

Facility: Palo Verde Nuclear Generating Station Units 1, 2, and 3

Location: Maricopa County, Arizona
About 34 Miles West of Phoenix, Arizona

Docket Nos.: 50-528, 50-529, and 50-530

Evaluation Period: November 6, 1989 through December 8, 1989

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EXECUTIVE SUMMARY

During the Nuclear Regulatory Commission (NRC) Senior Management Meeting in May 1989, NRC senior managers recommended that a diagnostic evaluation (DE) be conducted at Palo Verde Nuclear Generating Station (Palo Verde). The recommendation was based upon an apparent decline in plant performance and questions regarding management effectiveness as reflected by operational events and responses to the NRC concerning problems and inspection findings. In addition, a number of organizational and management changes had recently occurred, the effect of which had not been evaluated and for which additional information was considered necessary to further assess Palo Verde's performance.

Based on these issues and concerns, and on the recommendations of the NRC senior managers, the Executive Director for Operations (EDO) directed the Office for Analysis and Evaluation of Operational Data (AEOD) to conduct a broad-based DE at Palo Verde to provide additional information regarding the quality and trend of plant performance, the effectiveness of improvement programs and recent changes in licensee management, and the root causes of any confirmed performance problems at Palo Verde.

A 21 member Diagnostic Evaluation Team (DET, the team) spent a total of three weeks at the Palo Verde site, and at the corporate and engineering offices in Phoenix, Arizona, during November and December 1989, evaluating the functional areas of management and organization, operations and training, maintenance, surveillance and testing, quality programs, and design and engineering support.

The team found that Palo Verde had several substantial management, organizational and technical problems that were caused by a number of longstanding deficiencies, which over a period of time became more evident. Subsequent to licensing, operational events and inadequate response to certain problems led to the manifestation of existing deficiencies in the areas of leadership, management involvement, teamwork, resource utilization, communications, accountability, creativity, technical expertise, ownership, motivation, work planning, work control, work prioritization, problem identification, problem resolution, and corrective action.

The team concluded that the root causes of Palo Verde's performance problems were: (1) insufficient technical and management depth to support startup and operation of a three-unit facility, (2) during startup, management and technical resources were focused on the next unit on line at the expense of the operational units, resulting in a backlog of technical and programmatic issues, and (3) the 1987 reorganization compounded management deficiencies rather than contributed towards improvement.

At the time of the diagnostic evaluation, Palo Verde was still in a period of organizational renewal and transition due in part to: (1) bringing in a senior site management team with prior operations experience, (2) reacting to findings of the NRC and industry groups, and (3) initiating improvements to achieve excellence. However, a number of functional areas, in particular maintenance and engineering, needed increased attention to foster greater emphasis on management, ownership, and urgen --

The team found positive attributes in engineering support including a quality staff in EED and strong support for the Engineering Excellence and other improvement programs. Strengths were noted to include the excellent document retrieval capabilities and the design of electrical components and systems. However, engineering support was often untimely and inadequate as a result of management instability and deficiencies, strained resources, and poor communications. The engineering departments had expanded over the last two years resulting in many of the current supervisory personnel having less than one year in their current position. Unclear and unrealistic guidance resulted in confused roles and responsibilities. The team found systems engineers had too broad a work scope and the anticipated work scope of the resident nuclear engineering group had overlapping responsibilities and authorities that were similar to those already provided by the on site and the corporate nuclear engineering departments.

Although it was the goal of the corporate Nuclear Engineering Department (NED) to reduce its reliance on contractor support, the licensee has had to greatly increase the number of contract personnel in an attempt to reduce the backlog of work which was recently discovered (July 1989) to require approximately 400,000 man-hours of effort to resolve. The engineering evaluation request (EER) system was ineffective and was "overwhelming" the system engineers with paperwork. The team also reviewed many open EERs and determined that much of the time spent by engineering personnel to resolve various issues was a misuse of resources. The licensee was not effective in screening out frivolous or irrelevant EERs or rerouting them to other organizations if they were not engineering related.

A new integrated, department-wide work prioritization system was being developed and implemented at the time of the DET site visit; however, it was not yet effective. Because of outages at all three units, most of EED's efforts involved reacting to whichever plant submitted the initial assistance request or whoever applied the most pressure to obtain engineering support.

While general housekeeping at the facility was noted by the team as a positive attribute, maintenance tasks were not always being performed in a timely, quality, and coordinated manner due to ineffective management, strained resources, and inadequate procedures and programs. A lack of coordination of maintenance activities resulted in delays in the performance of work and interfered with proper root cause analysis. Inadequate planning for and management of outages were factors in the refueling outages for Units 1 and 3 exceeding 230 days each. No central person or organization was responsible for managing the outages. In addition, there was little pre-staging of parts for outages, tangible plans to deal with emergent work, or a cutoff date for submission of maintenance or modification activities to the outage schedule.

Maintenance work orders were inconsistent in the level of detail and often contained errors. In addition, work packages and reference materials were inaccurate, cumbersome, and difficult to use, resulting in an increased probability of maintenance errors. Maintenance management also was not sufficiently aware of the personnel deficiency reporting systems and equipment failure data trending programs to effectively trend maintenance activities and initiate corrective actions as appropriate.

Motor-operated valve (MOV) setpoints were not being adequately controlled because trained technicians had trouble using the MOV data base drawing. Additional weaknesses were identified in the MOV program, including lack of baseline data for many MOVs, lack of detailed procedures for MOV disassembly and reassembly, and lack of proper documentation for MOV setpoints. Internal responses to industry experience reports in this area were incomplete and untimely.

In the area of quality programs, positive attributes were noted to include recent personnel and programmatic changes in QA and a good vendor quality assurance program. However, in some instances, the team found deficiencies that were not being identified and corrective actions that were ineffective or slowly implemented as a result of programmatic weaknesses and insufficient support from line organizations. The audit program was compliance based, thus limited in scope and effectiveness. Numerous examples were found illustrating the line organization was not identifying problems, actions were slow to determine root causes, and deficiencies were resolved without fully addressing root cause.

The Plant Review Board (PRB) was not functioning effectively, suffering from lack of direction and slow progress to develop its improvement program. Many of the team assessments of this group were similar to those identified by a contractor assessment of the PRB conducted during third quarter 1989, indicating weaknesses continue to exist.

In the operations area, positive attributes were noted to include knowledgeable and professional licensed and auxiliary operators, and communications within operations at the working level. A strength was noted in the use of mockups and computers in training. However, system misalignment events were being caused by programmatic weaknesses and inattention to detail, as evidenced by the independent verification process not working, system status prints and valve logs not being maintained, and operator inattention. Communications between operations management and the staff were not effective, as evidenced by inconsistent guidance and poor implementation among the three units of two policy letters issued to reemphasize normal practices. The team was concerned with the ability of Palo Verde to continue to apply resources necessary to develop, maintain, and improve the training programs because of the large use of contractors and their upcoming release from the facility.

In several instances, implementation of surveillance testing suffered from a lack of attention to detail during the planning, performance, and review activities. Adequate progress had not been made in response to industry guidance on check valve testing.

Overall, the team concluded that the new management team understands the major management, organizational, and technical issues that affected plant performance and had begun implementing improvement initiatives. At the time of the diagnostic evaluation, Arizona Public Service Company (APS, the licensee) had over 50 major initiatives in various stages of development and implementation. While some progress was evident in resolving the issues, many initiatives have not been in place long enough to achieve the desired results. In addition, the rate at which major issues were being resolved was being limited by a number of factors. These included: (1) insufficient top level improvement program integration, (2) a lack of systematic/complete programs plans and implementing strategies for all issues, (3) insufficient management oversight of improvement efforts, and (4) organizational instability, uncertainty, and insecurity.

Additional management attention was needed to resolve Engineering and Maintenance programmatic issues which continue to adversely affect adequate root cause analysis and timely corrective actions for problems. In particular, attention was needed for the Palo Verde MOV program and check valve program to ensure long-term reliability of these components. Finally, increased attention to the Plant Review Board was required to raise the overall effectiveness of this organization.

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ABBREVIATIONS

ADV	Atmospheric Dump Valve
AEOD	Office for Analysis and Evaluation of Operational Data
AFW	Auxiliary Feedwater
AIT	Augmented Inspection Team
ANPP	Arizona Nuclear Power Project
ANS	American Nuclear Standard
ANSI	American National Standards Institute
AO	Auxiliary Operator
APS	Arizona Public Service Company
ASME	American Society of Mechanical Engineers
BOP	Balance of Plant
BWR	Boiling Water Reactor
CAR	Corrective Action Request
CBT	Computer Based Training
CE	Combustion Engineering
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
CPC	Core Protection Calculator
COTS	Corrected-On-The-Spot
CRO	Control Room Operator
CVCS	Chemical and Volume Control System
DC	Direct Current
DCN	Document Change Notice
DCP	Design Change Package
DE	Diagnostic Evaluation
DET	Diagnostic Evaluation Team
DG	Diesel Generator
DNBR	Departure from Nuclear Boiling Ratio
dp	Differential Pressure
EAR	Engineering Action Request
ECE	Equipment Change Evaluation
ECP	Employee Concerns Program
EDG	Emergency Diesel Generator
EDO	Executive Director for Operations
EED	Engineering Evaluations Department
EER	Engineering Evaluation Request
EOP	Emergency Operating Procedure
EPRI	Electric Power Research Institute
ESF	Engineered Safety Features
^{o}F	Degrees Fahrenheit
FDT	Failure Data Trending
FSAR	Final Safety Analysis Report
GL	Generic Letter

HP	Health Physics
HPES	Human Performance Evaluation System
HPSI	High Pressure Safety Injection
HVAC	Heating, Ventilation and Air Conditioning
I&C	Instrumentation and Controls
ICR	Instruction Change Request
IE	Office of Inspection and Enforcement
IIP	Incident Investigation Program
IIR	Incident Investigation Report
IN	Information Notice
INPO	Institute of Nuclear Power Operations
IR	Inspection Report
ISEG	Independent Safety Engineering Group
IV	Independent Verification
JPM	Job Performance Measure
KV	Kilovolt
LADWP	Los Angeles Department of Water and Power
LCO	Limiting Condition for Operation
LCS	Linear Calibration Switch
LER	Licensee Event Report
LOCA	Loss of Coolant Accident
LRC	Locked Rotor Current
M&O	Management and Organization
MCR	Main Control Room
MIS	Management Information System
MMIS	Materials Management Information System
MNCR	Material Nonconformance Report
MODB	Motor Operator Data Base
MOP	Management Observation Program
MORT	Management Oversight and Risk Tree
MOV	Motor Operated Valve
MOVATS	Motor Operated Valve Automated Testing System
MRC	Management Review Committee
M&TE	Measurement and Test Equipment
N/A	Not Applicable
NATM	Nuclear Administrative and Technical Manual
NED	Nuclear Engineering Department
NOC	Nuclear Oversight Committee
NOVML	Nuclear Operators Valve Manipulation Log
NPRDS	Nuclear Plant Reliability Data System
NRC	Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
NSD	Nuclear Safety Department
NSSS	Nuclear Steam System Supplier
O&MR	Operations and Maintenance Reminders
OE	Office of Enforcement
OER	Operating Experience Review
OQAP	Operational Quality Assurance Program

PCN	Procedure Change Notice
PCP	Plant Change Package
PCR	Plant Change Request
PI	Pressure Indicator
PMC	Plant Modification Committee
PNM	Public Service of New Mexico
PM	Preventive Maintenance
PPS	Plant Protection System
PRB	Plant Review Board
PRS	Problem Resolution Sheet
PSAG	Project Self Assessment Group
PSI	Pounds per Square Inch
PSIG	Pounds per Square Inch Gage
PVNGS	Palo Verde Nuclear Generating Station
PWR	Pressurized Water Reactor
Q	Quality Related
QA	Quality Assurance
QC	Quality Control
QDR	Quality Deficiency Report
QE	Quality Engineering
RCF	Root Cause of Failure
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RG	Regulatory Guide
RNE	Resident Nuclear Engineering
RP	Radiation Protection
SALP	Systematic Assessment of Licensee Performance
SARCN	Safety Analysis Report Change Notice
SCE	Southern California Edison
SE	System Engineer
SER	Significant Event Report
SESS	Safety Equipment Status System
SFP	Spent Fuel Pool
SIL	Service Information Letter
SIMS	Station Information Management System
SOER	Significant Operating Experience Report
SRO	Senior Reactor Operator
SRP	Salt River Project Agricultural Improvement and Power District
SRR	Special Review Report
SRSS	Square Root Sum of the Squares
SS	Shift Supervisor
ST	Surveillance Test
STA	Shift Technical Advisor
Tc	Steam Generator Reactor Coolant System Outlet Temperature
Th	Steam Generator Reactor Coolant System Inlet Temperature
TI	Temperature Indicator
TS	Technical Specification
TSCCR	Technical Specification Component Condition Record

UFSAR	Updated Final Safety Analysis Report
V	Volt
WO	Work Order
WR	Work Request

1.0 INTRODUCTION

1.1 Background

The Systematic Assessment of Licensee Performance (SALP) Program results and supporting inspection reports document NRC's favorable view of the Palo Verde construction program. Throughout the construction and startup test program Arizona Public Service Company (APS, the licensee) had the services of a large number of contractors, vendors, and the architect-engineer, Bechtel, to assist its management team in solving problems. As preparations for Unit 1 operations were being made, the NRC raised concerns about APS management's lack of nuclear power plant operating experience. In response, the licensee added several new managers who had multi-unit facility operating experience to the team. Palo Verde Units 1, 2, and 3 subsequently achieved commercial operating status in January 1986, September 1986, and January 1988, respectively.

In October 1987, the company reorganized from a centralized control organization with one plant manager, one technical manager, one operations manager, and so forth, to a decentralized and diverse management scheme, with each unit having a plant manager, operations manager, maintenance manager, and so forth, and a nuclear production support organization was formed with certain centralized functions such as outage management and radwaste support. The licensee promoted this reorganization as a vehicle to improve performance.

Subsequent to the reorganization, significant inspection findings raised questions from NRC as to whether the licensee was effectively managing Palo Verde. It was believed that APS management had not established the proper working atmosphere, was not effectively using its oversight groups to identify and correct problems prior to the occurrence of preventable events, and was not consistently demanding thorough reviews of events once they occurred.

The licensee initiated a number of management and organizational changes between January and October 1989, creating and filling new positions, and replacing a number of top managers.

In view of the concerns regarding the performance problems at Palo Verde and the management and organizational changes, NRC senior managers recommended to NRC's Executive Director for Operations (EDO) during the May 1989 Senior Managers Meeting that the NRC staff conduct a Diagnostic Evaluation at Palo Verde. The EDO accepted the recommendation and in June 1989 directed NRC's Office for Analysis and Evaluation of Operational Data (AEOD) to develop an evaluation plan.

1.2 Scope and Objectives

The plan approved by the EDO directed the Diagnostic Evaluation Team (DET) to conduct a broadly structured evaluation to assess the current status of Palo Verde's performance, including the involvement of APS management and staff in safe plant operations, the effectiveness of improvement efforts, and the root causes for performance problems.

To provide the assessment of plant performance directed by the EDO, the DET evaluated several functional areas with the following specific goals:

- o Assess the effectiveness (including strengths, weaknesses, problems, and issues) of operations, operations training, maintenance, surveillance and testing. Identify the root causes for the identified problems and the areas in need of improvement.

- o Assess the effectiveness (including strengths, weaknesses, problems, and issues) of engineering and technical support provided by nuclear engineering and plant technical support groups. Identify any problem areas or issues impairing the delivery of support in these areas. Determine the root causes for any identified problems and issues and areas in need of improvement.

- o Assess the effectiveness (including weaknesses, problems, and issues) of the management oversight and quality assurance/verification functions provided for Palo Verde by the site and corporate management. Identify root causes for identified problems and the areas that need improvement.

- o Evaluate how licensee corporate and site management react to safety-related problems that affect plant operations. Relate findings to the adequacy of planning, staffing, organizing, directing, and controlling plant activities, including weaknesses and strengths. Evaluate organizational attitudes, values and beliefs influencing corporate and plant performance.

1.3 Methodology

Before arriving on site, the DET devoted several weeks to in-office document review and preparation that included team meetings and briefings by knowledgeable NRC regional and headquarters staff. On November 6, 1989, the DET began a 2-week evaluation at the facility, including corporate and engineering offices. The DET returned to the plant on December 4, 1989 for an additional week of evaluation. During the on site portion of the evaluation, the team met at the end of each day to discuss the evaluators' observations. The NRC resident inspectors frequently attended these meetings and functioned as technical advisors to the DET. In addition, designated representatives from the team met daily with their licensee counterparts to discuss the DET activities and findings in the technical areas. In the course of the evaluation process, the DET collected and reviewed more than 800 documents, conducted approximately 230 interviews with plant and corporate personnel at all levels, attended working-level meetings, witnessed work in progress, and observed plant operations.

The exit meeting with the licensee was held on January 24, 1990, at NRC' Region V office (See Section 4.0 for details).

1.4 Facility Description

The Palo Verde site is located in Maricopa County, approximately 34 miles west of the nearest boundary of the city of Phoenix, Arizona. The facility includes three identical, separate, pressurized-water-reactor plants with Combustion Engineering System 80 nuclear steam supply systems and reinforced-concrete steel-lined containments. Bechtel served as both architect-engineer and constructor for the facility. Each reactor is licensed by the NRC to operate at 3800 MWt and 1270 MWe. Palo Verde Units 1, 2, and 3 sequentially achieved commercial operating status in January 1986, September 1986, and January 1988.

1.5 Organization

The licensees for Palo Verde included Arizona Public Service Company (APS), Salt River Project Agricultural Improvement and Power District, El Paso Electric Company, Southern California Edison Company, Public Service Company of New Mexico, Los Angeles Department of Water and Power, and Southern California Public Power Authority. Pursuant to the operating license issued by NRC, APS was authorized to act as an agent for the licensees and had exclusive responsibility and control over the physical construction, operation, and maintenance of the facility. APS is a wholly owned subsidiary of Pinnacle West Capitol Corporation.

The APS corporate officer who had primary responsibility for Palo Verde was the Executive Vice President, Nuclear. He reports directly to the Chief Executive Officer. Key elements of the Palo Verde organization are shown in Figures 1.5-1 through 1.5-9.

Figure 1.5-1

PALO VERDE NUCLEAR

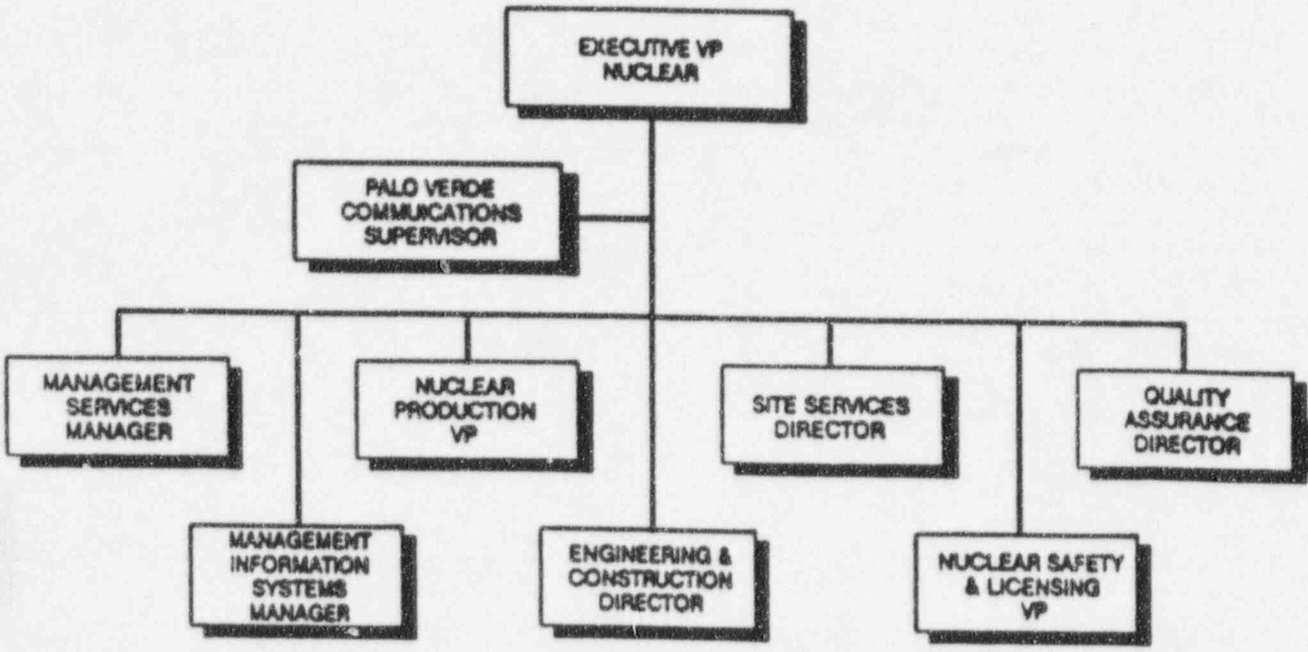


Figure 1.5-2

PALO VERDE
NUCLEAR PRODUCTION

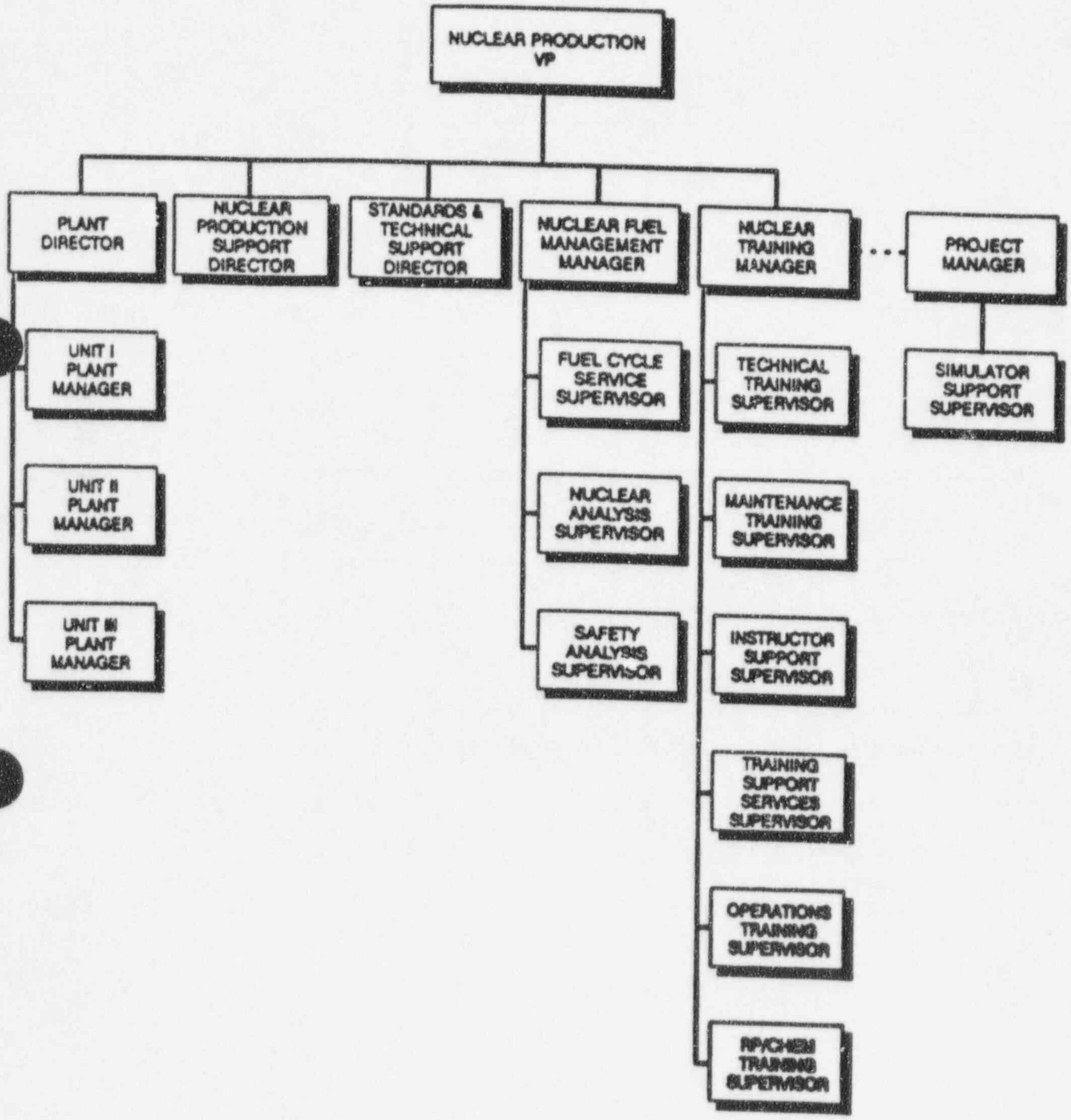


Figure 1.5-3

PALO VERDE
NUCLEAR PRODUCTION

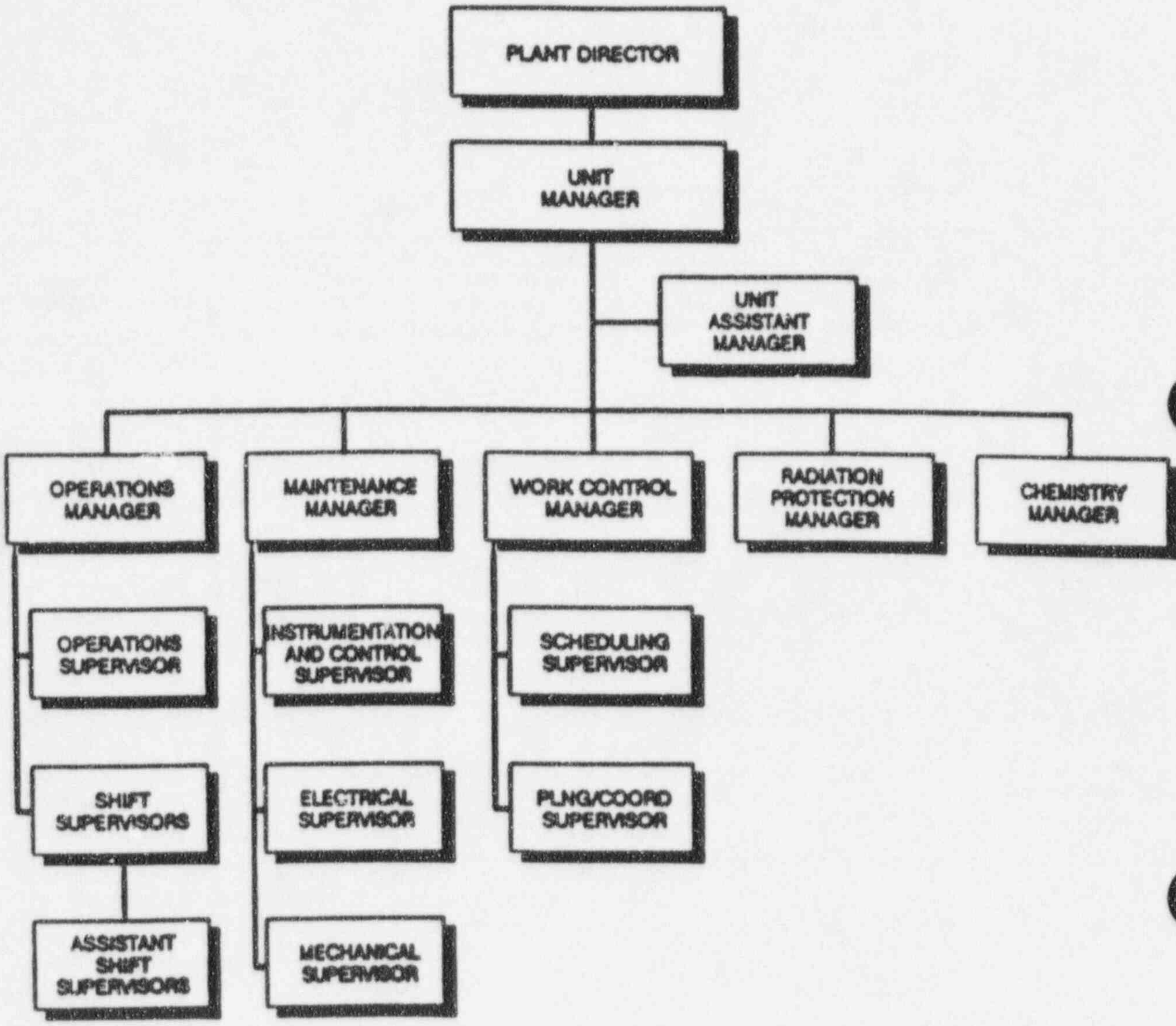


Figure 1.5-4

PALO VERDE
NUCLEAR PRODUCTION

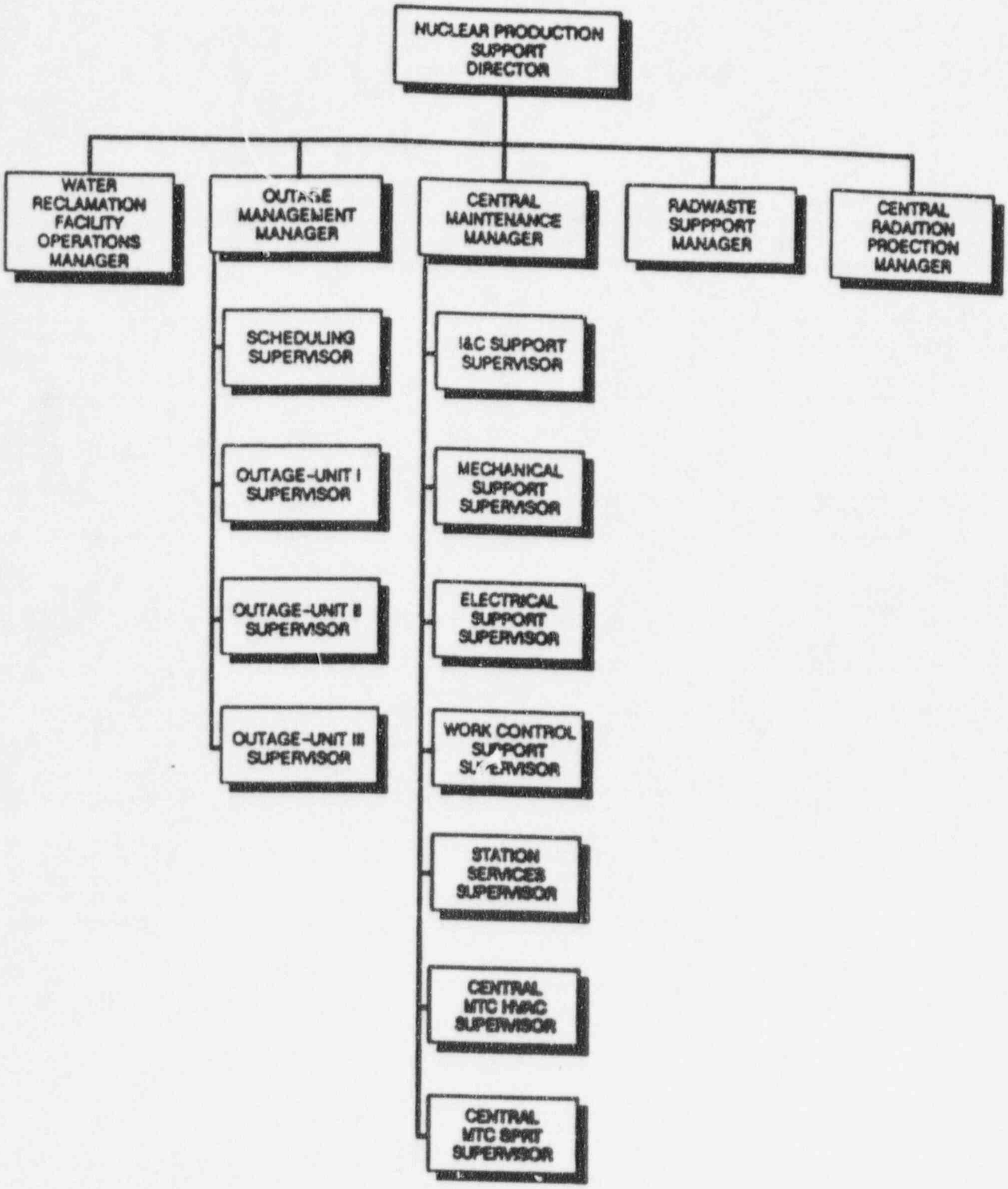


Figure 1.5-5

PALO VERDE
NUCLEAR PRODUCTION

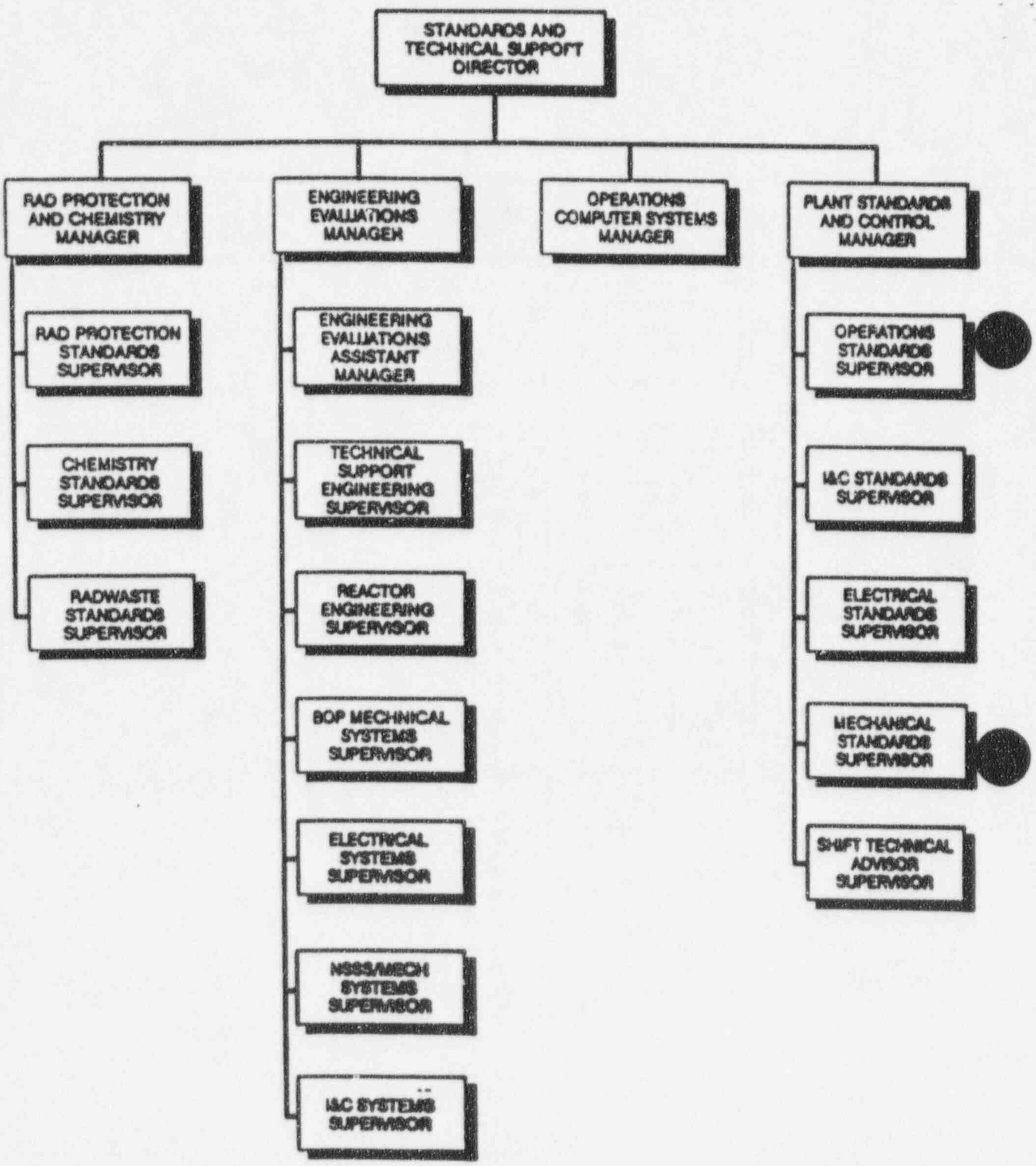


Figure 1.5-6

PALO VERDE
NUCLEAR ENGINEERING & CONSTRUCTION

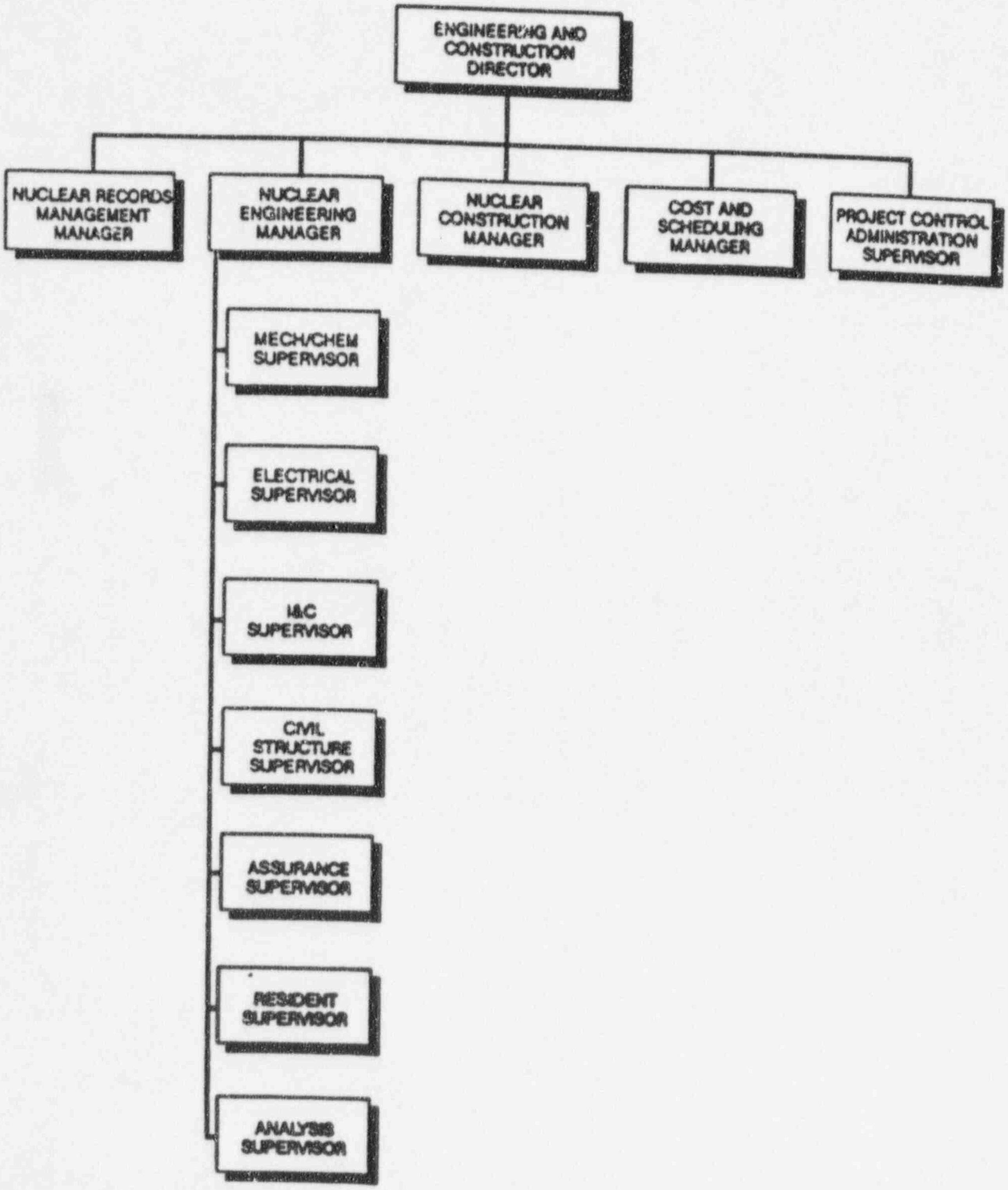


Figure 1.5-7

PALO VERDE
NUCLEAR SITE SERVICES

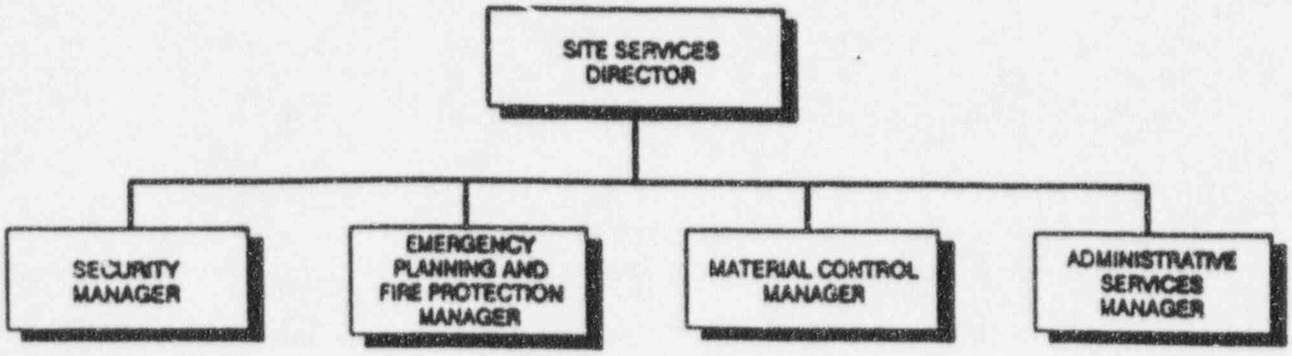


Figure 1.5-8

PALO VERDE
NUCLEAR SAFETY & LICENSING

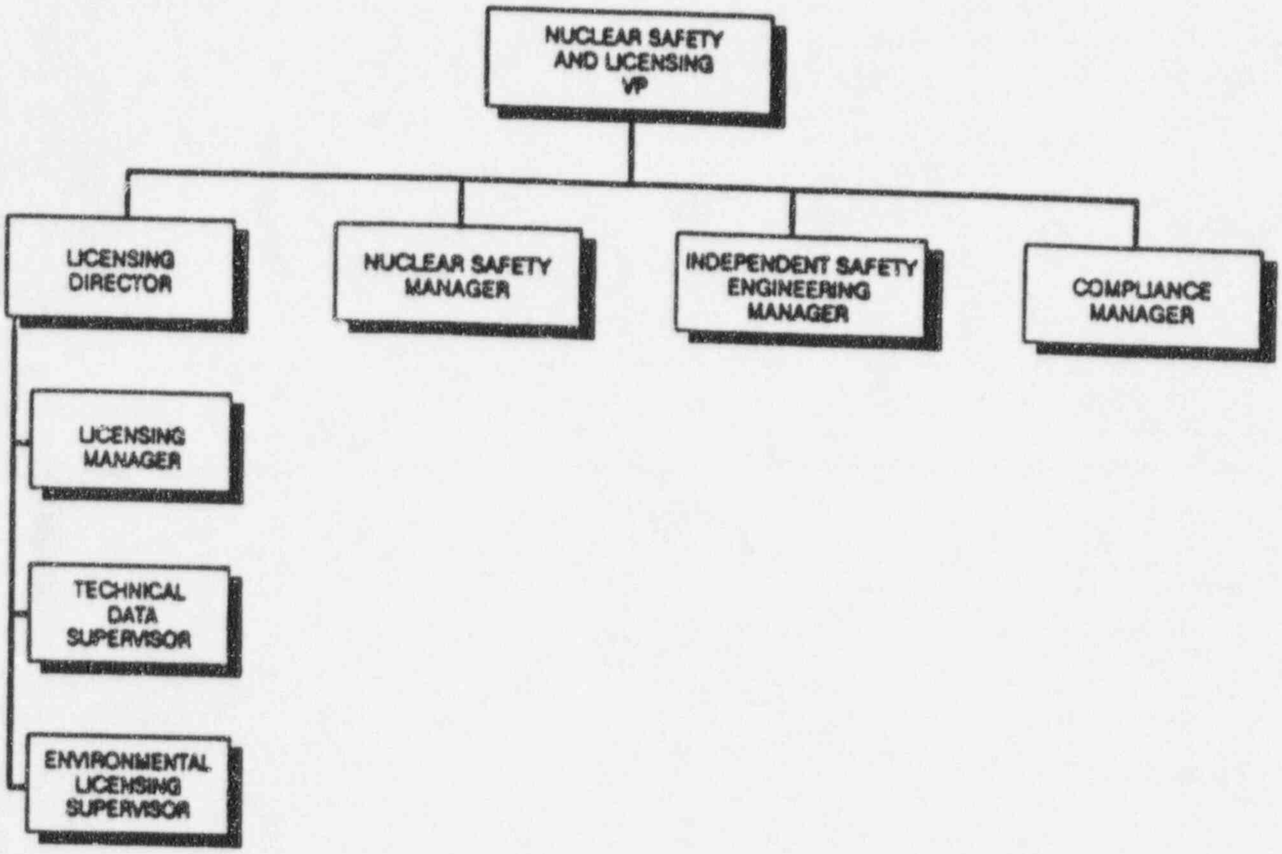
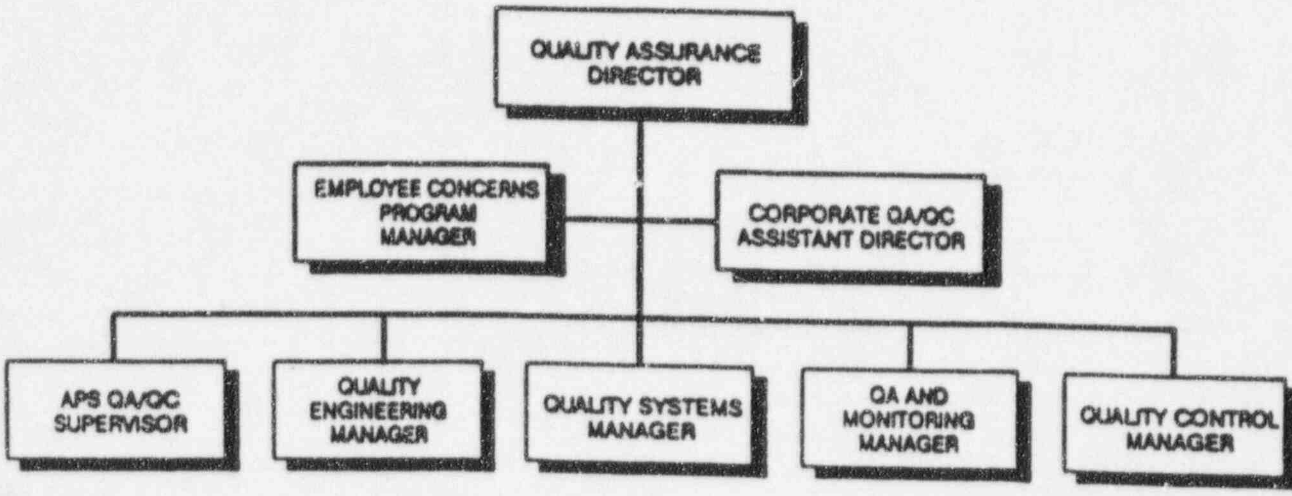


Figure 1.5-9

PALO VERDE
NUCLEAR QUALITY ASSURANCE



2.0 EVALUATION RESULTS

2.1 Findings and Conclusions

At the time of the diagnostic evaluation, Palo Verde was still in a period of organizational renewal and transition due in part to: (1) bringing in a senior site management team with prior operations experience, (2) reacting to findings of the NRC and industry groups, and (3) initiating improvements to achieve excellence. However, a number of functional areas, in particular maintenance and engineering, needed increased attention to foster greater emphasis on management, ownership, and urgency.

The team concluded that the new management team understands the major management, organizational, and technical issues that affected plant performance and had begun implementing improvement initiatives. At the time of the diagnostic evaluation, Arizona Public Service Company (APS) had over 50 major initiatives in various stages of development and implementation. While some progress was evident in resolving the issues, many initiatives have not been in place long enough to achieve the desired results. In addition, the rate at which major issues were being resolved was being limited by a number of factors. These included: (1) insufficient top level improvement program integration, (2) a lack of systematic/complete programs plans and implementing strategies for all issues, (3) insufficient management oversight of improvement efforts, and (4) organizational instability, uncertainty, and insecurity.

Additional management attention was needed to resolve Engineering and Maintenance programmatic issues which continue to adversely affect adequate root cause analysis and timely corrective actions for problems. In particular, attention was needed for the Palo Verde motor-operated valve (MOV) program and check valve program to ensure long-term reliability of these components. Finally, increased attention to the Plant Review Board was required to raise the overall effectiveness of this organization.

The findings and conclusions for each evaluated area are summarized below. A reference is made to the appropriate report section for additional details.

2.1.1 Management and Organization

(1) Existing plans did not describe strategies or provide schedules for correcting management issues. A statement addressing APS management's desired organizational attitudes, values and beliefs had not been written into personnel policies and communicated to employees. (Section 3.1.3)

(2) Because of limited strategies for achieving the various objectives of the Excellence Program plans, there was little assurance that the plans will be implemented on the established schedules. (Section 3.1.8)

(3) It was evident from the five-point plan that the Executive Vice President had a sound understanding of the problems and needs at Palo Verde. However, the plan lacked the emphasis which was needed to solve the most pressing management issues. (Section 3.1.3)

(4) The Management Information System (MIS) was not integrated into a network or centralized from an organizational standpoint. Patchwork systems or

pockets of information existed and had not been pulled together for total use by the organization. Palo Verde management had recognized the weaknesses associated with MIS and was committed to correct them. (Section 3.1.4)

(5) Some of the new managers had more nuclear plant operating experience than their predecessors but none had been in their new jobs long enough to serve as a role model. (Section 3.1.2)

(6) The new management team had not been in place long enough to adequately instill the desired characteristics and values. Therefore, many of the desired values were not represented in current behavior. (Section 3.1.1)

(7) The new management team was still not unified, and some managers were not always communicating philosophy and values consistent with that of the Executive Vice President. Verbal messages were filtered by managers and supervisors and written messages were not always fully explained nor clearly understood. Two-way communications were lacking. (Sections 3.1.3 and 3.1.5)

(8) Organizational instability, uncertainty, and insecurity were evident at Palo Verde due in part to the financial difficulties and declining stock values of the Pinnacle West Capital Corporation, whose assets included the Arizona Public Service Company (APS). However, no evidence suggested that financial difficulties at Pinnacle West or APS appropriation levels had jeopardized safety systems or the safe operation of the units. (Section 3.1.1)

(9) Many of the programs or initiatives ranged from conceptual to some written plans in various stages of completion or implementation. Of those programs implemented, many had been in place for less than six months prior to the diagnostic evaluation and consequently could not be fully evaluated to determine their overall effectiveness. (Section 3.1.2)

(10) Although the new management team had increased its level of involvement, management participation and involvement still needed greater emphasis. (Section 3.1.3)

(11) The Nuclear Oversight Committee had an excellent grasp of the management problems and issues that required attention. (Section 3.1.5)

(12) With the exception of identifying problems concerning management issues, problem identification was ineffective at Palo Verde. Plant personnel identified material and hardware deficiencies inadequately and in an untimely manner. (Section 3.1.5)

(13) Systems were ineffective for determining problems, analyzing root causes, making timely decisions concerning corrective actions, prioritizing corrective actions, and controlling the work to achieve the desired results on schedule. (Section 3.1.5)

(14) The licensee had made extensive commitments considering its resource base and it would be some time before the licensee could shift from a reactive to a proactive mode. The licensee was highly driven by external

organizations and there was too li ..'e effort devoted to advance planning. (Section 3.1.6)

(15) In total, the management initiatives could change the employee attitudes, values and beliefs at Palo Verde and achieve the changes desired by the new management. However, there was some doubt that the improvements would have the expected results because there was no unified or consolidated plan to bring all the individual initiatives together and no way of effectively measuring overall progress. Additionally, the resources for many of the initiatives had not been fully considered in budget documents. (Section 3.1.8)

(16) Standards and expectations had been developed and most employees knew about them. But many did not understand them or how they related to individual accountability and performance. Expectations for accountability were not being transmitted effectively and were not received in a consistent manner. (Sections 3.1.3 and 3.1.5)

(17) Standards of performance were inadequate in that job descriptions and group organizational plans lacked quantitative objectives for management and technical issues in terms of time, cost, quantity or quality. Management was well aware of these deficiencies and had planned or implemented various initiatives to correct them. (Section 3.1.4)

(18) Poor performance was often not recognized and development of individual performance improvement plans was inadequate. Training on the performance appraisal process was inadequate as was the understanding of performance accountability, particularly at lower levels in the organization. As a result, performance was inconsistent in some organizations. (Section 3.1.4)

(19) The decisionmaking process had improved to some extent, but more emphasis was needed to ensure that decisions were made on a timely basis at the proper level. (Section 3.1.5)

(20) The Management Review Committee (MRC) was set up to initially follow the Unit 3 restart issues and build teamwork. Failure to include representatives from Units 1 and 2 on the MRC, particularly when discussions involved programmatic issues that affected the whole site, was a weakness. (Section 3.1.9)

(21) There was a lack of praise and financial rewards for performance that exceeded expectations or for achieving the desired results. Greater emphasis and timeliness were required for implementing initiatives to instill commitment, reward competence, and maintain consistency. Management was well aware of the deficiencies regarding the recognition, rewards, and compensation programs and had increased its efforts to recognize good performance. (Sections 3.1.1 and 3.1.9)

2.1.2 Operations and Training

(1) A potentially critical staffing problem existed pertaining to licensed operators at the operating units. A present shortage of operators has caused the licensee to move from six-shift to five-shift operation. This has resulted in more overtime and decreased job satisfaction among the

remaining operators. Meetings between management and the operators are held less frequently and as a consequence a path for communications has been weakened. (Sections 3.2.2 and 3.2.4)

(2) Oversight exercised by senior reactor operators was generally good, but had occasional lapses. (Section 3.2.3)

(3) The assistant shift supervisor conducted a shift briefing with all the auxiliary operators (AOs) to discuss past and planned activities. These briefings were also attended by support groups such as radiation protection, chemistry, and operations support. Communications between all groups during the crew briefing were excellent. (Section 3.2.3)

(4) The licensed operators were knowledgeable and their performance generally satisfied the high standards established by the industry. (Section 3.2.3).

(5) Communications with AOs and other groups via two-way radios and pagers significantly reduced the number of personnel in the control rooms, and reduced the background noise created by use of the plant page system. This reduction in background noise contributed to a healthy operating environment. (Section 3.2.3)

(6) The AOs were knowledgeable of their assigned duties and plant equipment. (Section 3.2.3)

(7) A formal procedure to control required reading for the operating crews did not exist. An informal required reading program was in place, but time limits to complete the required reading were not established, it was not audited and criteria for determining the content of the required reading were not developed. (Section 3.2.3)

(8) During a walkdown of the control boards by the team, the suction valve to the spray addition pump, SIA-UV-603, was found incorrectly positioned. The valve should have been closed following completion of a surveillance test performed earlier that day. Failure to close the valve was determined to have been caused by inattention to detail by a licensed operator and a weakness in the programmatic controls associated with independent verification (IV). (Section 3.2.3)

(9) The Technical Specification Component Condition Record (TSCCR) which was used to track safety-related equipment and components that were out of service or declared inoperable was effective in assuring the unit was prepared for mode changes. (Section 3.2.3)

(10) System status configuration control was ineffective. There was a history of licensee identified problems with system status prints and these problems were still evident. (Section 3.2.3)

(11) Generally, operating procedures were weak from a human-factors standpoint in that they unnecessarily referred the operators to other documents for reference instead of including the necessary limits or steps derived from the reference documents. (Section 3.2.3)

(12) Several weaknesses were identified regarding independent verification (IV). IV was not consistently required following surveillance tests that involved repositioning critical components, not always performed in an independent manner, and not always performed in the sequence specified in surveillance procedures. (Section 3.2.3)

(13) Communications between operations and other groups were not always effective. The daily meetings were successfully keeping all groups up to date on job status and removing roadblocks encountered that hindered job progress. However, the failure to sample the secondary steam generators for a six-to-seven-week period at Unit 1 reflected a breakdown in communications and a need for a greater awareness and ownership of plant equipment during extended outages. (Section 3.2.4)

(14) Communications between operating crews were good; excellent communication was observed during plant activities. Communications between operations management and the operators were not always effective. Messages were not clearly communicated to the operator level. (Section 3.2.4)

(15) In June 1989, the Institute of Nuclear Power Operations (INPO) placed the training programs on probation. As a result, management has elevated training to a high place on the priority list. (Section 3.2.6)

(16) Generally, the level of knowledge and qualifications of the training staff was considered good and effective controls for maintaining staff qualifications were in place. (Section 3.2.6)

(17) The replacement and requalification program contained sufficient controls to ensure licensed operators were well trained and that they maintained the knowledge necessary to operate the plant safely. Controls have been established to ensure personnel meet the requirements of the license. (Section 3.2.6).

(18) The effective use of mockups was considered a training department strength. Mockups included a full-size reproduction of the steam generator Th and Tc bowls and interferences, three simulated work areas for advanced radiation work permit training and reactor protective system simulator. The computer-based training group was another strength of the training organization. (Section 3.2.6)

(19) Because of the heavy reliance on contractors and their upcoming release from the facility, there was a concern about the licensee's ability to continue applying the resources necessary to develop, maintain, and improve the current training programs. (Section 3.2.6)

2.1.3 Maintenance

(1) Although maintenance craft personnel were viewed as competent, a significant contributor to component failures was human error, including inattention to detail in the performance of maintenance activities. (Sections 3.3.1, 3.3.5, 3.3.10)

(2) Established maintenance procedures were adequate in scope and level of detail. However, work orders were utilized for most work activities and

some of these work orders were inadequate in detail while others contained errors. In addition, work packages and reference material were sometimes difficult to use. These conditions increased the probability of maintenance errors and represented a significant weakness in the maintenance program. (Sections 3.3.2 and 3.3.6)

(3) Inadequate outage planning and management contributed to the extension of refueling outages. These plans were simply compilations of the amounts of time required to perform certain "big ticket" activities in series, as opposed to being comprehensive work plans for outages. (Section 3.3.4)

(4) Maintenance management was not sufficiently aware of the quality deficiency reporting (QDR) system and the equipment failure data trending program to effectively use these to trend maintenance activities and to initiate corrective actions as appropriate. In addition, maintenance and work control center personnel did not understand or implement the QDR system. These constituted significant weaknesses in the maintenance program. (Section 3.3.5)

(5) A lack of coordination of activities during maintenance sometimes caused delays in the performance of work and interfered with proper root cause analysis. (Section 3.3.4)

(6) An increase in the participation of maintenance personnel in training programs was determined to be an improvement. (Section 3.3.6)

(7) In general, housekeeping at the facility was good. However, several examples of a lack of attention to equipment condition were identified. (Section 3.3.7)

(8) Because trained technicians could not properly use the MOV data base drawing, MOV setpoints were not adequately controlled. In addition, weaknesses in the MOV program included the lack of MOV automated testing system (MOVATS) baseline data for many MOVs, the lack of detailed disassembly and reassembly procedures, and the lack of proper documentation for MOV setpoints. Response to industry experience reports concerning MOVs was incomplete and untimely. These weaknesses were not directly correlated with the MOV problems noted in the failure data trending program. (Section 3.3.8)

(9) Equipment failure trending reports indicated a high number of personnel errors had occurred prior to the teams arrival onsite. Several maintenance errors occurred during the evaluation indicating that this unfavorable performance trend was continuing. (Sections 3.3.5 and 3.3.10)

(10) Inadequate parts availability was causing delays in the performance of maintenance. Some of the parts availability problems stemmed from previous inadequate communications and planning between the materials management group and the units and an inadequate [illegible]s for the available inventory. The licensee was in the process of implementing a program to improve materials management. (Section 3.3.9)

2.1.4. Surveillance and Testing

(1) The overall implementation of the surveillance and testing program activities appeared to be acceptable; however, in several cases, the implementation of surveillance testing suffered from a lack of attention to detail during the planning, performance, and review activities. (Section 3.4.3)

(2) The starting air check valves on the Unit 3 emergency diesel generator B (starting air receiver A) were not fully tested as required during the period from mid-July through mid-November 1989 due to improper test planning during an air compressor outage. (Section 3.4.3)

(3) Adequate progress had not been made in response to industry guidance on check valve testing because a comprehensive program and implementing procedures for the augmented inspection of designated check valves (213 per unit) had not been completed. (Section 3.4.6)

2.1.5 Quality Assurance/Quality Control and Other Oversight Groups

(1) Overall, performance of the oversight groups improved over the last 6 to 8 months in accordance with the expectations of the new management team, except for the Plant Review Board (PRB). (Sections 3.5.3, 3.5.10, and 3.5.11)

(2) Overall, the staffing, resources, organization, and expertise of the Quality Assurance/Quality Control (QA/QC) organization appeared to be adequate. (Section 3.5.2)

(3) The personnel and programmatic changes made in QA/QC were having a positive impact on the QA/QC organization and general licensee performance. (Section 3.5.3)

(4) The QA audit program was weak, in that audits were based primarily on Technical Specifications and were compliance oriented. Further, the audit program did not provide the flexibility to allow auditors to use their individual experience and expertise in investigating potential problems. Relatively few safety-significant items were identified during 1989. Additionally, many items were not properly managed (by both the QA and the line organizations) and corrective actions, in some cases, were not timely or appropriate. (Section 3.5.4)

(5) Overall, the monitoring (surveillance) program had improved, although one problem area was observed involving the use of corrected-on-the-spot methodology to resolve deficiencies. (Section 3.5.5)

(6) The vendor QA program, as a whole, was an area of strength. Notwithstanding, one area of weakness in the program concerned the availability and use of vendor rejection data from the site receipt inspection process. (Section 3.5.6)

(7) QA trending was an area that showed improvement. Trending reports were being issued in a more timely fashion and the format of the reports had been changed to highlight important problem areas. The new trending reports, however, did not identify significant new trends for management action and some quality deficiencies were omitted from the trending program. This caused the trending program to provide an inaccurate picture to management of the extent of some problem areas. (Section 3.5.7)

(8) The QC area was adequate, however, there was no "after completion of work" review of work requests by the QC organization or any of the QA organizations, and the 100-percent, in-line, "before work" review of work requests conducted by QC for the last 14 months continued to find a significant number of deficiencies. (Section 3.5.8)

(9) The new management team had implemented a number of initiatives to strengthen problem identification and corrective action. These efforts had resulted in improvement, although the following problems still persisted: problem identification was weak; significant backlogs of deficiencies still existed; problem resolution and implementation of corrective actions were slow; the urgency of problem resolution at the lower working level had not become a routine part of performance; and root-cause analysis was weak. (Section 3.5.9)

(10) The performance of the Plant Review Board was ineffective in that known weaknesses continued and an improvement plan had not been effectively implemented. (Section 3.5.10)

(11) Although the operating experience review program had improved greatly, much remained to be done. Numerous plant events or cases of degraded equipment occurred in the past year that might have been prevented or reduced in severity by benefitting from "lessons learned" or by performing adequate and timely evaluation and corrective action. (Section 3.5.11)

2.1.6 Design and Engineering Support

(1) Engineering personnel within the Engineering Evaluations Department (EED) and the Nuclear Engineering Department (NED) appeared to be qualified for their positions in terms of education and years of experience and compared favorably in this regard to technical support staffs of well-performing nuclear utilities. NED personnel, however, lacked actual nuclear design experience. (Section 3.6.1 and 3.6.2)

(2) Several weaknesses tended to diminish the quality, quantity, and timeliness of engineering support provided by engineering. These included: a large backlog of engineering evaluation requests (EERs) consisting of largely insignificant issues; inadequate control/screening of EERs forwarded to EED for resolution; realistic responsibilities and authorities had not been defined for the system engineers due in part to inadequate management control of work assignments; the anticipated workscope of the Resident Nuclear Engineering (RNE) section overlapped with the responsibilities and authorities of EED and the corporate NED resulting in confusion as to roles and responsibilities of groups providing engineering support to Palo Verde; unclear guidance as to what

function and authority an NED system engineer (responsible engineer and backup engineers) should have; lack of urgency and teamwork in addressing engineering problems and providing plant support; inadequate staff to handle the assumed workload; conflicting work priority systems between engineering (onsite and corporate) and site organizations; and lack of a stable management workforce, including stable policies, practices and direction. (Sections 3.6.1, 3.6.2 and 3.6.3)

(3) Because EED has been expanding over the last two years, one-half of the current supervisory personnel had less than one year in their current positions. Continual management changes seem to have impaired both morale and productivity. (Section 3.6.1)

(4) While it has been a goal of NED to reduce its reliance on contractor support and accomplish more work in-house, the licensee has had to greatly increase the number of contract personnel in an attempt to reduce the backlog of work, which was recently discovered (July 1989) to require 400,000 man-hours of effort to resolve. Over half of the NED workforce was supplied by contract support from at least 19 separate vendors. (Section 3.6.2)

(5) Although the engineering organizations had the capability to identify the causes of conditions adverse to quality, as evidenced by adequate responses to licensee event reports, there was an overall inability to take timely, effective corrective action to resolve component or system deficiencies or failures. This was considered a major programmatic weakness. (Section 3.6.4)

(6) In response to a mid-1988 evaluation of NED, the licensee had initiated an Engineering Excellence Program. There was strong enthusiasm and support for the program, and most saw it as having started NED on the way to achieving the level of competence required of a modern nuclear engineering organization. Although many of the elements of the program were far from complete, the overall effect on NED attitude and support capabilities was very positive. (Section 3.6.5)

(7) Overall the design bases reconstitution program was considered to be good when compared to the industry norm and considering that the licensee was in the early stages of the program. The documents themselves appeared to be well organized, and for the most part, thorough and complete. Direct employees rather than contractors were assigned to produce the documents, which ensured that the knowledge gained by the experience would remain within the organization. Weaknesses were observed with the program however, including procedure adequacies and implementation; design discrepancies identified in the NED open items summary list that were not promptly evaluated for operability/reportability; and operating, surveillance, and maintenance procedures, the FSAR and non-design-basis output documents that were not reviewed for adequacy and completeness. (Section 3.6.6)

(8) The team found several design issues associated with the emergency diesel generator (EDG) and support systems which were similar to design findings discovered by the licensee during its design bases reconstitution that had not been corrected. Most involved incorrect design information or utilization of design information in site process documents, and involved the

air-start system, engine lubrication system, combustion air and exhaust system, fuel oil system, HVAC, the EDG building and crankcase level instrumentation. (Section 3.6.7)

(9) Modification packages for the diesel generator system reviewed by the team were adequately designed, planned and executed with the exception of one which involved an inadequate materials review by engineering. (Section 3.6.12)

(10) Document retrieval capabilities were considered a strength. In a short period of time, the licensee was able to provide documentation on why certain modifications were not performed on all three units, many of which were related to the staggered construction and various systems used to make modifications. (Section 3.6.13)

(11) Numerous design change packages (DCPs) had been cancelled for no apparent reason or were not uniformly installed in all units, indicating poor initial modification screening by engineering. The licensee recognized that the modification process needed to be improved and was studying ways to streamline the controlling procedures and had developed a Plant Modification Committee. (Section 3.6.13)

(12) Virtually all design records requested were provided very quickly. This was considered a strong indicator that engineering was well organized and supported, an important consideration in the effectiveness of an organization. (Section 3.6.14)

(13) Overall, design calculations were generally clear and concise, although in some instances the licensee took a nonconservative approach. Several MOV design parameters were not well controlled or documented including set point caluclations that were not reviewed and approved, stem thrust values that could not easily be compared with actual switch settings, stem overthrusting was incorrectly allowed, and torque switch limiter plates were removed without formal engineering evaluations. As a result of these findings and recognized shortcomings, NED committed to reconstitute all MOV design-basis set points and to develop formal thrust calculations and documentation as part of their response to Generic Letter 89-10. (Section 3.6.15)

(14) There were several examples of ineffective implementation of the failure data trending (FDT) program which were similar to recent Quality Assurance and Nuclear Safety Department findings. Neither maintenance nor NED was on the distribution list for the FDT reports. Programmatic and EED implementation weaknesses associated with the FDT program resulted in its having very limited effectiveness on improving equipment reliability. (Section 3.6.16)

2.2 Root Cause Analysis

Palo Verde was the first Combustion Engineering (CE) System 80 facility to receive an operating license, presenting Palo Verde with unique and complex plant issues. During construction, the licensee relied on the architect/engineer and constructor for accountability and meeting schedules; the APS site organization functioned in more of a project management or monitoring role. As the units were completed, management attention and focus were directed toward the next unit to be completed. People were moved from unit to unit and startup personnel who had only limited operating experience were converted to operating personnel. As with most facilities nearing completion of construction, Palo Verde had a large number of contractors available to assist in solving problems during startup. But as each unit came on line, the operational workload increased and the available construction technical resources decreased, resulting in a backlog of technical and programmatic issues.

Before and during the transition stages from construction to operations, Palo Verde's senior management failed to plan and take appropriate actions to convert from a construction mode of operation to an effective nuclear operating environment. As a result of weaknesses in leadership and planning for the operations environment and the continuance of a significant construction environment up through 1988, management problems escalated. These organizational characteristics which had resulted in construction excellence in the early years at Palo Verde, such as a heavy emphasis on contractor construction management with the primary goal of getting well built plants, and less emphasis on direct management involvement, supervision, followup, or control on the part of APS personnel, became contributing influences to the primary root causes of operational management problems.

A major reorganization occurred in 1987 with the intent of placing the three units in friendly competition with each other to improve performance. However, the details of the proposed changes were not well structured at the time the reorganization was announced, and the actual implementation was also poorly handled and lacked sensitivity to individual employee needs. Also, the reorganization compounded management deficiencies because the decentralized organizational scheme not only diluted the experience within the units, but also resulted in some personnel with considerable experience leaving APS.

Subsequently, operational events and inadequate response to certain problems led to the manifestation of existing deficiencies in the areas of leadership, management involvement, teamwork, resource utilization, communications, accountability, creativity, technical expertise, ownership, motivation, work planning, work control, work prioritization, problem identification, problem resolution, and corrective action. This was a reflection that the development of a proper operations environment really began in earnest in 1989 when the licensee brought a new management team to Palo Verde, one that had technical expertise and nuclear plant experience more appropriate to the operations phase. However, the new team had not been in place long enough to adequately instill the desired characteristics and values. Therefore, many of the desired values were not represented in current behavior.

In summary, the team concluded that the root causes of Palo Verde's performance problems were: (1) insufficient technical and management depth to support startup and operation of a three-unit facility, (2) during startup, management and technical resources were focused on the next unit to go on line at the expense of the operational units, resulting in a backlog of technical and programmatic issues, and (3) the 1987 reorganization compounded management deficiencies rather than contributed towards improvement.

3.0 DETAILED EVALUATION RESULTS

3.1 Management and Organization

The objective of the management and organization (M&O) analysis was to evaluate the effectiveness of management in implementing and controlling activities involving Palo Verde Nuclear Generating Station (Palo Verde), including both on site and corporate management functions, associated with safe and efficient power generation. The evaluation was based on approximately 90 structured M&O interviews, extensive review of documents, licensee presentations, and direct observation of management and staff activities. A cross-section of personnel was interviewed from the Chief Executive Officer down to the operator/technician. Documents reviewed included Arizona Public Service Company (APS) policies, plans, reports, manuals, audits, survey results, newsletters, and memoranda.

3.1.1 Organizational Environment

The collective perceptions and attitudes about the work environment of those who work at Palo Verde have a demonstrable impact on individual and team motivation and behavior, and thus, a direct relationship to safety attitude. At a nuclear utility, the organizational values can change drastically between construction and startup and between startup and actual operations. Successful operations depend upon highly qualified technical individuals with varied nuclear industry experiences. The process of changing individuals and organizational values results in numerous human relations and people concerns. In addition, the need for utilities to become more competitive and change to performance-based accountability systems exacerbates personnel concerns. Effective managers, therefore, need to possess an excellent blend of human relations and technical skills.

Before and during the transition stages from construction to operations, Palo Verde's senior management failed to plan and take appropriate actions to convert from a construction mode of operation to an effective nuclear operating environment. As a result of weaknesses in leadership and planning for the operations environment, and the continuance of a significant construction environment up through 1988, management problems escalated. These organizational characteristics (values) which had resulted in construction excellence in the early years at Palo Verde, such as a heavy emphasis on contractor construction management with the primary goal of getting well built plants, and less emphasis on direct management involvement, supervision, followup, or control on the part of APS personnel, became contributing influences to the primary root causes of operational management problems. A major reorganization in 1987 did not significantly alter the overall employee attitudes and values at Palo Verde. Significant change from a construction environment toward an operations environment did not begin until 1989 when the licensee brought a new management team to Palo Verde, one that had technical expertise and nuclear plant operations experience more appropriate to the operations phase. In the past, managers at Palo Verde generally lacked a good balance of technical and people skills. The coexistence of old and new values further contributed to management problems.

The new management team identified to the Diagnostic Evaluation Team (DET, the team) a number of characteristics that exemplified the desired organizational values. Among the more significant desired organizational characteristics were: greater emphasis on accountability and teamwork, participative management or greater involvement in the decisionmaking process, an open problem-solving atmosphere, and attention to people concerns. Other important desired organizational characteristics were: greater professionalism and self-discipline, greater sense of plant ownership, doing the job right the first time, risk-taking not risk-avoidance, decisiveness, and dealing with regulatory agencies in an open, cooperative manner.

The team analyzed the past and present organizational characteristics in relation to current management issues and improvement initiatives. The status of these is discussed throughout this report. The new management team had not been in place long enough to adequately instill the desired characteristics and values. Therefore, many of the desired values were not represented in current behavior.

The new managers at Palo Verde tended not to concern themselves about history and outdated business practices. They knew that the past practices and values were unacceptable and had to be changed in order for the organization to improve. These individuals were creating new organizational values according to their own philosophies and management styles. It was evident that the new managers had still not worked together long enough to have formed a highly effective team. Generally, employees imbued with the past organizational practices and values were having difficulty adjusting to the new philosophies and values and delineating between "the way things were then" and "the way things are now.' New values as well as changed relationships were still unclear. Additionally, many individuals believed that the right behaviors were not currently being rewarded. Organizational instability, uncertainty, and insecurity were evident at Palo Verde due in part to the financial difficulties and declining stock values of Pinnacle West Capital Corporation, whose assets included APS. Personnel, as members of the employee savings plan, received matching funds in the form of Pinnacle West common stock. Additionally, personnel could increase their holdings by participating in the stock purchase plan. As the Pinnacle West stock values declined, so did the net worth of these plans, especially to longstanding members. Many individuals believed that Palo Verde was the most successful operation among the Pinnacle West subsidiaries, and that if financial difficulties lowered their stock values, their programs and future salary increases could also be impaired.

Despite these conditions, the team found no evidence to suggest that financial difficulties at Pinnacle West or APS appropriation levels had jeopardized safety systems or the safe operation of the units. Interviews and documents revealed that the resources (money, people, equipment, materials, and facilities) provided to Palo Verde by APS were generally adequate to meet needs. There had been significant overruns in past Operations and Maintenance (O&M) budgets. Senior management at both the site and corporate offices indicated a strong commitment of resources to operate the plant safely and reliably.

Success at Palo Verde will depend greatly upon the new managers' abilities to establish a good record and reputation, gain knowledge, and develop networks or relationships throughout all levels of the organization. It will take time to develop the teamwork and trust essential for getting the job done. With managers and supervisors constantly changing, individuals had to determine who held the position of authority in order to get a job done. The fear of additional changes, linked to an overactive "grapevine" had resulted in some individuals spending an inordinate amount of their time on office politics, figuring out who had the power and who would be the next to go. Under these conditions, it was only natural for employees to fight the system, filter information, and resist change.

Initiatives at Palo Verde still lacked the necessary continuity and clarity to effectively reduce the anxiety people have about their careers and future with the company. Some individuals, particularly at lower levels of management, did not feel a part of the management team, and they feared additional changes. The frequency of organizational and personnel changes as well as the drastic change in values made employees aware that they would no longer be rewarded with promotions at predictable intervals, but that promotion and job security would now be more dependent on individual accountability and results.

The new management team recognized the importance of building the necessary conditions for an effective operations organization. Many of the improvement initiatives were directed toward stabilizing the organization (e.g., to carefully plan and sequence changes, to fill key positions with full-time APS employees, to evaluate managers and supervisors at lower levels, and to replace, retrain, or transfer personnel to positions where they could become more productive). However, greater management emphasis and timeliness were required for implementing initiatives to instill commitment, reward competence, and maintain consistency. At the time of the onsite evaluation, the team did not find a policy statement covering organizational attitudes and values communicated through the personnel policies or as a component of a supervisor's handbook. Senior level managers recognized the need to more fully communicate the desired organizational values. Such a statement was being developed.

3.1.2 Organization

3.1.2.1 Management Changes/Organization Changes

A major reorganization had taken place in 1987 at Palo Verde with the intent of placing the three units in friendly competition with each other to improve performance. However, the details of the proposed changes were not well structured at the time the reorganization was announced, and the actual implementation was also poorly handled and lacked sensitivity to individual employee needs. Many individuals who were placed in new positions had neither adequate skills to carry out their responsibilities nor adequate backup from individuals experienced in nuclear plant operations, QA, and so forth. The individuals in key positions tended to have either strong technical backgrounds or good human relations skills, but seldom had a good balance of both.

APS and the Palo Verde site were in a period of organizational renewal and transition due in part to: (1) bringing in a senior site management team with prior operations experience, (2) reacting to adverse findings of the NRC and industry groups, and (3) initiating improvements to achieve excellence. Substantial changes had occurred in Palo Verde site management within the last nine months.

The new management team had implemented a large number of activities intended to address the desired changes in organizational values and the methodology for managing the day-to-day activities at Palo Verde. Findings in this and subsequent sections reflect both the performance and management issues of the past, as well as the current corporate and site management efforts to implement corrective actions. Many of the programs or initiatives ranged from conceptual to some written plans in various stages of completion or implementation. Of those programs implemented, many had been in place for less than six months prior to the diagnostic evaluation and consequently could not be fully evaluated to determine their overall effectiveness.

Palo Verde lacked a process for managing change that allowed organizational and programmatic change with minimum disruption of people while enhancing their understanding and acceptance of change. In general, the team found that although Palo Verde personnel had positive views toward the management changes that had been made during the previous 6-9 months, some uncertainty was associated with the changes. Many individuals had adopted a wait-and-see attitude and were withholding endorsement of the changes until they could see some positive results. The full impact of the restructured management team would not be apparent for some time. The new management team's effectiveness will be critically dependent upon its ability to meld the varying backgrounds and viewpoints of the individual members into a coherent, workable program for Palo Verde.

3.1.2.2 Roles and Responsibilities (Changes)

Palo Verde Unit 1 was the first Combustion Engineering (CE) System 80 facility to receive an operating license, presenting Palo Verde with unique and complex plant issues. During construction, the licensee relied on the architect/engineer and constructor for accountability and meeting schedules; the APS site organization functioned in more of a project management or monitoring role. As the units were completed, management attention and focus were directed toward the next unit to be completed. People were moved from unit to unit and startup personnel who had only limited operating experience were converted to operating personnel. As with most facilities nearing completion of construction, Palo Verde had a large number of contractors available to assist in solving problems during startup. But as each unit came on line, the operational workload increased and the available construction technical resources decreased, resulting in a backlog of technical and programmatic issues. The 1987 reorganization compounded management deficiencies because the decentralized organizational scheme not only diluted the experience within the units, but also resulted in some personnel with considerable experience leaving APS.

Some of the new managers had more nuclear plant operating experience than their predecessors but none had been in their new jobs long enough to serve as a role model. The team did not find any significant problems which had arisen because individuals did not know their roles and responsibilities. New positions, such as the Plant Director and the unit Assistant Plant Manager positions, had been created within the past year to increase nuclear plant operations experience in the direct management support for the plant operations. Additionally, technical assistants to each Plant Manager were authorized in the 1990 budget.

Overall, there did not appear to be excessive duplication of services or functions between organizational units except for the Resident Nuclear Engineering (RNE) group. Envisioned responsibilities in RNE overlap other groups (see Section 3.6.1.2). Additionally, the roles and responsibilities of the systems engineers were too broad and detracted from their primary responsibilities (see Section 3.6.1.1). Management had recognized this problem and had developed corrective action plans within the Engineering Excellence Program to address this issue.

3.1.3 Leadership and Direction

Within the last nine months, the new management team had established itself at the site and was attempting to improve overall management. The Executive Vice President had developed a five-point plan to achieve his long-term goal of making Palo Verde the best facility in the industry. These five points were: (1) obtain additional nuclear plant operating experience, (2) improve investigation of plant events, (3) improve effectiveness of self-assessment organizations, (4) establish and communicate higher standards of performance, and (5) increase the sense of urgency in the implementation of corrective actions.

The team concluded from the five-point plan that the Executive Vice President had a sound understanding of the problems and needs at Palo Verde. However, the plan lacked the emphasis which was needed to solve the most pressing management issues (most of which were related to human resources). The licensee lacked a process that would systematically monitor the progress of these issues and redirect efforts to those actions that failed to achieve the desired results.

The team found that existing plans did not describe strategies or provide schedules for correcting management issues. A strategic plan was lacking which addressed the management issues in relation to nuclear plant operations, assigned responsibilities for executing the plan, allocated resources to effectively implement the plan, and then held people accountable for the results. Current activities are scattered over several functional areas. A statement addressing APS management's desired organizational attitudes, values and beliefs had not been written into personnel policies and communicated to employees. The new managers were aware of the issues even though there was no formalized planning and control system for dealing with these management issues.

The team found that the new management team was still not unified, and some managers were not always communicating philosophy and values consistent with the Executive Vice President's plan. The new management team had developed distributed standards and expectations throughout the organization. Although most employees knew about these standards and expectations, many did not understand them or how they related to individual accountability and performance.

There was an increase in direct involvement by top managers, a sharper focus on specific problems, and better prioritization in some areas. Top management was promoting a more participative style of management and greater teamwork. A new Management Observation Program (MOP) had been developed to address the issue of management's lack of involvement. The MOP had been established to require managers to take scheduled plant tours on a monthly basis and report the results of the tour. Although not required by the procedure, supervisors and foremen toured on a weekly basis. Maintenance personnel reported favorably on the benefits of this program.

Although the new management team had increased its level of involvement, the team concluded that management participation and involvement still needed greater emphasis. Many people were so immersed in other issues, including plant operation and administration, that they had little time left to "stop, look, and listen." Supervisory coaching and praising were lacking (see

Section 3.1.8). Greater attention was needed at all organizational levels to assure that management was more directly involved in work by walking around, observation, listening, and discussing issues with subordinates on a daily basis.

3.1.4 Management Information and Control Systems

3.1.4.1 Management Information Systems

The team found that the Management Information System (MIS) was not integrated into a network or centralized from an organizational standpoint. Patchwork systems or pockets of information existed and had not been pulled together for total use by the organization. As indicated by the licensee, duplications, overlaps, omissions, and redundancies occurred in the APS and Palo Verde information systems. Other issues identified by the team included: (1) a system was not in place to supply all the facts needed for sound operation as well as for forecasting and planning, (2) information was not available in a timely manner nor in the form needed for decisionmaking, (3) some important performance indicators, standards, or quantifiable objectives had not been developed for groups and individuals to use in tracking progress, (4) some information was not easily accessible for managers, necessitating requests for special reports (e.g., related to human resources), (5) it was difficult to use existing information in a proactive manner, (6) some individuals lacked adequate training on the MIS equipment, and (7) there was no data base control program or centralized control over what was added to the data base.

Palo Verde management had recognized the weaknesses associated with MIS and was committed to correct them (e.g., improvements in the area of computer systems to process and display plant status information). Management has proposed to spend between $30 million and $50 million on MIS during the next 3 to 5 years.

An information exchange study had been completed in the Spring of 1989 and this resulted in the development of a new 5-year strategic information plan. The goal of this plan was to turn data into information for use by decisionmakers at the right time and in the right form. To improve integration and centralization, the MIS function was being moved from APS corporate offices to the Management System group on site under the Director of Site Services. This new group would assist organizational units on site with developing and tracking of management initiatives.

Initially, the MIS function priorities will go toward improving the Station Information Management System (SIMS), maintenance, and work activities of the units. The licensee used SIMS to integrate work planning and scheduling activities. The SIMS and its sister computer system, the Materials Management Information System (MMIS) were used together to plan work and track it to completion. Additionally, the SIMS also contained an extensive plant component data base. The licensee had instituted a program to improve the accuracy of the equipment data base and to increase plant personnel awareness of the features offered by SIMS.

3.1.4.2 Performance Standards, Measures, and Reporting

The team found deficiencies with performance standards, measures, and reporting. Standards of performance were inadequate in that job descriptions and group organizational plans lacked quantitative objectives for management and technical issues in terms of time, cost, quantity or quality.

There was a lack of regular feedback to individuals about their performance in meeting existing standards and management recognized this deficiency. The team also found that poor performance was often not recognized and development of individual performance improvement plans was inadequate. Performance targets were not always known, understood, and accepted by the employees and their immediate supervisors. The licensee indicated that supervisors needed to be taught how to write results-oriented performance standards. Some managers indicated that the lack of effective performance measures and the ability to effectively measure performance in the past had resulted in assigning people to the wrong jobs. The team found that training on the performance appraisal process was inadequate, as was the understanding of performance accountability, particularly at lower levels in the organization. As a result, in some organizations, performance was inconsistent.

Management was well aware of these deficiencies and had planned or implemented various initiatives to correct them. For example, standards and expectations had been distributed and discussed with employees; however, focus meetings were insufficient to help employees understand these expectations in relation to their jobs. Communications skills were also inadequate for improving how supervisors and their employees understand job expectations. Although performance indicators existed for plant operations and progress was being tracked and communicated through monthly reports, the new management team recognized the need to improve performance indicators and to strengthen the methods being used for tracking and reporting progress. Many of the improvement initiatives have not been implemented long enough to accurately determine their effectiveness.

3.1.4.3 Policies and Procedures

There were some weaknesses related to procedures. Most problems revealed to the team related to their inadequacy for work orders, predictable failures, and maintenance (see Section 3.3.2). Some individuals said procedures were too complicated, detailed and restrictive, and required simplification (see Section 3.2.3.8). Other procedures were not tailored to the task, covering a broader scope of work than was to be performed (see Sections 3.2.3.5 and 3.4.3.3). Change requests often took months to result in procedure revisions (see Section 3.4.3.1). Some individuals indicated that procedures lacked consistency among units. The team also found that although procedures were communicated, employees did not always follow or understand them (see Sections 3.2.3.7, 3.3.5.1, 3.3.5.2, and 3.4.3.3).

3.1.5 Problem Solving, Decisionmaking, and Communications

Systems were ineffective for determining problems, analyzing root causes, making timely decisions concerning corrective actions, prioritizing corrective actions, and controlling the work to achieve the desired results on schedule. Although communications both horizontally and vertically were improving, some barriers and gaps still needed management attention.

3.1.5.1 Problem Identification

With the exception of identifying problems concerning management issues, problem identification was ineffective at Palo Verde. Plant personnel identified material and hardware deficiencies inadequately and in an untimely manner (see Sections 3.2.3, 3.3.4, 3.3.6, 3.4.2, 3.4.3, 3.4.6, 3.5.9, 3.6.6, and 3.6.7). Although no hesitancy was indicated by individuals during interviews to report problems they found, there appeared to be some lack of attentiveness in seeing some problems and in identifying cumbersome processes which inhibited the quick resolution of those problems that were found. In many cases, outside organizations were more effective than internal organizations in identifying deficiencies. Management was aware of this issue and had recently reorganized the QA/QC group to improve the effectiveness of self-assessment (see Section 3.5.3).

The Nuclear Oversight Committee (NOC) had an excellent grasp of the management problems and issues that required attention. These issues were well documented in NOC meeting minutes and have addressed a broad range of topics including accountability, self-assessment, personnel errors, review committees, enhanced root cause analysis, backlogs, support for Systems Engineers and strengthening of Quality Assurance and Radiation Protection areas.

3.1.5.2 Problem Solving

Palo Verde was ineffective in reaching final resolution once a problem was identified. The new management team indicated its strong desire to establish an open problem-solving environment and conveyed to the plant staff that it wanted to "kill problems dead" and "fix things right the first time." The plant staff had adopted this attitude, but the problem solving processes used (which included the EER system [see Section 3.6.3] and Work Control system [see Section 3.3.2]) were cumbersome.

Root cause analysis was also ineffective. The analysis performed on failed equipment tended to attribute failures to normal wear and tear. In some cases, failed equipment was repaired but the reasons for the failure were not analyzed completely (see Sections 3.3.4.1 and 3.6.4). In the area of procedural errors and deficiencies, root cause analysis was weak (see Sections 3.3.5.2, 3.5.3, 3.5.9 and 3.6.16). Plant management was attempting to effect changes in this area through increased training and by developing a more formal process for performing root cause analysis.

One of these processes was the Human Performance Evaluation System (HPES) which had been recently implemented to evaluate potential personnel errors. The system was receiving wide coverage on site through monthly articles specific to HPES appearing in the plant publication "New ERA." The initial article included a breakdown of the various criteria called "causal factor categories" and served to make personnel more aware of problems and corrective actions taken.

The Shift Technical Advisors (STAs) were assigned HPES responsibilities as a collateral duty. Various managers and supervisors have also been trained in basic human performance issues to help them evaluate reports. The program, while only in the early stages of development, appeared promising. A review of some of the recent HPES reports showed improvement in the timeliness of finding the root cause and recommending a valid solution.

3.1.5.3 Decisionmaking

The new management team recognized that past decisionmaking was neither clear nor timely. The indecision associated with beginning the refueling outage after Unit 1 tripped in March 1989 was such a case. A contractor was mobilized to perform some of the major outage evolutions and was ready to begin work when the unit shut down. The plant still had one-month worth of burnable fuel in the core and management decided to demobilize the contractor in preparation for restart of the unit. A week later management decided to recall the contractor and begin the refueling outage. The team found that the decisionmaking process had improved to some extent but that more emphasis was needed to ensure that decisions were made on a timely basis at the proper level.

Some individuals expressed a concern that some decisions were being made at too high a level in the organization. This reverse delegation is typical in an organization that lacks stability and is undergoing transition. As a result upper-level managers were overburdened with decisions that should more proper be made at a lower level. Two factors were involved:

(1) New managers were being brought in to help "straighten things out" and these new personnel felt it was incumbent on them to step in and make decisions that the lower-level personnel had previously been making.

(2) Because of the new emphasis on accountability and the resulting disciplinary actions, personnel were hesitant to take responsibility for making the decisions they should normally be involved in and were deferring to their superiors.

Management indicated a commitment to increase employee involvement in the decisionmaking process at all levels of the organization. Some surveys had been conducted and some quality circle type efforts were being implemented.

3.1.5.4 Communications

No formalized communications improvement plan existed to ensure that site goals and management expectations were consistently communicated and reinforced at all levels of the organization. Although vertical communications from the top down had increased, two other problems were noted: (1) filtering of the message as it passed through middle management and (2) lack of two-way communications. Senior-level management expressed the need for a plan to address honesty and openness in communications in order to resolve these problems.

The primary message from the new management team concerning accountability seemed to be getting through to the plant staff. The lower-level staff personnel knew that management was going to hold them accountable for their job performance. However, the expectations for that accountability were not being transmitted effectively and were not received in a consistent manner by these personnel.

Two main methods were used to transmit messages through the organization: (1) verbally down through the chain of command and (2) through written memoranda from upper management directly to the plant personnel. Neither of these methods appeared to convey specific expectations effectively since the verbal message was filtered by managers and supervisors and the written messages were not always fully explained nor clearly understood.

Some managers were communicating to their workers but were not receptive to comments and complaints. This one-way communication impaired trust and team building. Although the new managers were getting out in the plant on occasion, their direct face-to-face communications with the plant staff appeared very limited.

Management used several other mechanisms to provide information to the plant staff. These included video, telephone newslines, monthly and quarterly publications, employee news bulletins, and scheduled staff meetings. In spite of all of these established methods, one of the most prevalent means of communication was the unofficial and informal "grapevine." In a recent APS survey, employees identified this "grapevine" as their primary source of information. Plant staff also expressed a concern that they were able to learn more about Palo Verde from the news media than from their own management.

In the area of horizontal communications, efforts were being made to improve the interfaces between the three units and between the operating departments and their support organizations; however, gaps still existed. Shortly after the 1987 reorganization, a deep communications gap developed between the three units and they were described at that time by staff members as "islands in the sea." Recently, efforts were made to close this gap through weekly meetings of staff peers in the Maintenance and Operations organizations and at the Plant Manager level. Despite these efforts, the DET found agreement lacking between the units on such issues as control of valve manipulations (see Section 3.2.4.2), indicating deficient communications and ineffective centralized management.

3.1.6 Planning and Scheduling

A site-wide, integrated, accessible planning and scheduling system was lacking. Planning and scheduling were inadequate for outage management (see Section 3.3.4.3) and for other management issues (see Sections 3.1.3 and 3.1.8). Long outages at Units 1 and 3 have raised concerns for the Unit 2 refueling outage scheduled for February 1990. The Plant Director recognized this problem and was developing plans to deal with it, but it was doubtful that an effective outage management program would be in place by the start of the Unit 2 refueling.

The licensee had made extensive commitments considering its resource base and it would be some time before the licensee could shift from a reactive to a proactive mode. The licensee was highly driven by external organizations and there was too little effort devoted to advance planning. Management had not acted early enough to change its processes and business practices to become more performance based. Other barriers to becoming more responsive included excessive "fire fighting," delays in decisions and corrective actions, poor planning and work control, and excessive workload and administrative burden. There were also delays in hiring or bringing in people when they were needed to help reduce the workload or backlog.

An attitude prevailed that management had simply dumped excessive numbers of people and amounts of money into solving problems without careful planning. Many individuals did not understand or could not adequately explain budget and corporate planning processes or the basis from which priorities and resources were determined. Many individuals believed the current situation stemmed from poor human resource and financial planning.

APS was aware that improvements were needed in this area and was in the process of developing a long-term business plan for the corporate and plant organizations. Part of this plan will strengthen the goals and objectives of the various APS business units.

3.1.7 Prioritization

Management issue priorities were set in accordance with top management's perception of the needs of the site. Of highest priority was establishing a sense of accountability in the site personnel. The next priority was to build teamwork among the site forces. The third priority was to succeed in getting the three units back to a stabilized operating condition, which management felt should follow naturally once the first two priorities were accomplished.

Although prioritization of day-to-day work activities in the area of corrective maintenance appeared adequate due to good interfaces between the Operations and Maintenance groups, an integrated priority system for allocating work-related resources did not exist. Safety-related and other top priority items appeared to receive adequate attention, but some work requests that entered the work control system took a long time to reach resolution, especially if the Engineering Department became involved (see Section 3.6.2). Engineering expertise was solicited to solve plant problems by the use of the EER system. It appeared that the licensee used this system excessively since an EER could be generated for almost any perceived problem without undergoing a proper screening to set priorities prior to being sent to EED. The licensee described the number of EERs as "overwhelming" and the engineers in EED were required to establish their own priorities using a ranking system which they described as not fitting their needs.

Priorities among the three units were being set at the Plant Director level and it was clear that all managers at the units knew where they stood on access to site resources.

3.1.8 Management Initiatives and Improvement Programs

The number one challenge to the new management was solving management issues. A statement heard frequently was, "We cannot fix our hardware or technical problems until we fix the soft management issues." Some of the major management issues included: accountability, teamwork, instability, communication, work processes, prioritization, planning, training, people concerns, participative management, open problem-solving environment, morale, discipline, and rewards. The overall effectiveness of the new managers was highly dependent upon their ability to serve as change agents.

Many management initiatives and improvement programs were aimed at resolving various parts of the problems that had been identified. These initiatives included programs to adjust staffing levels, to respond to employee concerns, to improve communications, to achieve better control over work and modifications, to improve performance of the various subgroups, to improve the process of root cause evaluation and self-assessment of organizational performance, and to achieve better management control through improved reporting and information systems. These initiatives were relatively new and their status ranged from concepts to written plans in various stages of development and implementation. In total, the management initiatives could change employee attitudes, values and beliefs at Palo Verde and achieve the changes desired by the new management. However, the team was not convinced that the improvement would have the expected results. There was no unified or consolidated plan to bring all the individual initiatives together and no way of effectively measuring overall progress. Very few individuals could explain many of the initiatives and many indicated they were not sure that the time necessary to devote to these issues was available. Additionally, it did not appear to the team that the resources for many initiatives had been fully considered in budget documents.

At the time of the on site evaluation, no central person or entity had responsibility for tracking and reporting progress on the soft management issues. Since that time, Palo Verde management has reorganized and transferred the MIS function for tracking and reporting of progress on management issues to the Palo Verde site.

Three Excellence Program plans had been developed: Engineering, Systems Engineering, and Material Control. These plans were aimed at correcting identified problems in these functional areas; however, portions of the Excellence Programs, such as those addressing management issues, were statements assigning an action to individuals for development of other plans, thereby providing only a limited scope of what was to be accomplished. In some cases, the specific strategies for how to improve teamwork and communications had not been developed. Because of the limited strategies for achieving the various objectives of the plans, the DET had little assurance that the plans will be implemented on the established schedules, particularly considering that in the past, there has been little sense of urgency at Palo Verde to meet schedules. Excellence Program plans were not currently under development for Maintenance and Operations.

An Employee Concerns Program (ECP) was managed by QA and coordinated by line units, as appropriate, with the support of the Human Resource group on site. Individuals were encouraged to take problems directly to immediate supervisors. However, they could go through the ECP with anonymity, if they were reluctant to approach their supervisors or not satisfied with a supervisor's resolution. This newly implemented program could help management learn about problems at an early stage and deal constructively with them on a timely basis before they become crises and impaired safe plant operations.

In the past, the QA/QC program had received inadequate management attention which limited its effectiveness. However, a new Director for QA had been hired and a number of supervisory changes were made recently that demonstrate a greater commitment by the new management team to improve the QA/QC program. Considerable progress has been made toward this goal (see Section 3.5.3).

3.1.9 Human Resources, Utilization and Development

3.1.9.1 Staffing

Total staffing at the time of the DET visit was about 2500 APS employees and 1250 contract employees. Average overtime was in the neighborhood of 20 percent, which produced a full-time-equivalent staffing level of about 4500. At the time of the on site evaluation, two of the three units were in extended outages. Normal plant staffing before the start of the outage activities (January-February 1989) consisted of about 2450 APS employees plus about 350 contract employees, for a total work force of about 2800.

Notwithstanding the current staffing levels, many organizational units were understaffed according to their approved (1990) staffing levels. The maintenance and work control activities at the unit level were scheduled for manpower increases, as were other organizational units such as the Systems Engineers and the Outage Planners. A consultant was studying the situation to determine the expected staffing level for normal plant operations and support, and to ascertain the reasons for the differences between the expected and the actual staffing levels for steady-state (non-outage) operation.

Most utilities rely on contract employees to supplement their craft personnel or to handle projects requiring special expertise. From the total numbers, it does not appear that the licensee has relied too heavily on contract support. However, many critical plant positions (managers, engineers, schedulers) were occupied by contract employees. Should the turnover rate of these contract employees be large, inconsistency in implementing management initiatives could result. For example, the inability to hire a full-time APS employee as Director for the Standards and Technical Support group has led to three different contract directors being assigned during the last few years, each with a different approach to resolving the problems of that group.

Training currently receives a high priority in an effort to correct previous deficiencies. In the unit maintenance groups, this has resulted in about 30 percent of the maintenance personnel attending training, leading to some schedule slippage for other work at the station. A similar, but lesser, impact was reported for the Central Maintenance staff. The units were struggling to keep up with maintenance needs by supplementing their work forces with contract personnel while the assigned personnel were in training.

3.1.9.2 Personnel Qualifications

Key management positions have been filled with individuals having varied nuclear plant operating experience. In time, the synergism of these varied backgrounds should work to the advantage of the licensee. However, at the time of the DET visit, these key individuals were still learning about each other and about the plant. Middle and lower level managers had ample nuclear experience, although such experience was not necessarily directly related to the jobs they were performing. As an example, the systems engineers appeared to have appropriate educational backgrounds, but many had little practical experience and little detailed knowledge of the systems for which they were responsible. As a result, Operations and Work Control personnel tended to consult those few systems engineers who were known to be well qualified and responsive, overloading the experienced systems engineers and not giving less-experienced engineers a chance to become fully involved (see Section 3.6.1). Time and organizational stability should alleviate this concern and result in the units having more faith in the abilities of the systems engineers.

3.1.9.3 Selection and Promotion

In the past, Palo Verde had given priority for most selections for promotion to its own people; however, with changing needs of the industry and increased emphasis on operation experience, it became necessary to look outside the organization for the talent and experience that was lacking.

The Human Resources group was attempting to establish a new improved performance appraisal system that was expected to result in more effective evaluations of individuals and, hence, better data upon which to base selections for promotion. Selections in the future were to be made after consideration of all eligible personnel site-wide, rather than just within the particular unit, as well as consideration of personnel from outside the organization. The proposed performance appraisal system included elements relating to career development of employees as well as the development of the individual preparing the employee appraisal. The result expected was better qualified personnel in supervisory and management positions.

3.1.9.4 Personnel Development

In the past, Palo Verde had limited supervisory and management development training. As one result, foremen and supervisors did a generally poor job of providing counseling and feedback to employees on their performance, and were reluctant to discipline employees for not performing well. The Human Resources group conducted a survey and determined that the greatest needs for supervisors were in the areas of team building, involving the staff in decisionmaking, using effective discipline, coaching employees, identifying and solving problems, and understanding the licensee's organization and the business process. The target group for training included foremen, leads, supervisors, administrators, shift supervisors, and assistant shift supervisors. A total of 379 positions, site-wide, were identified for the training, of which 219 were supervisors already in position and 160 were proposed additions over the next 18 months after the survey was completed. As a result of the survey, a new six-part course has been established for supervisory training.

The DET found a Management Development System in place which included a management succession plan that extended down to the supervisor level. However, the detailed planning is out of date because so many new managers were hired and because of the continuing instability of the organization. Training needs were identified for some positions, but actual training needs cannot be established until valid job descriptions and a sound performance appraisal system have been put in place. APS has a Management Academy for selected higher level managers.

No formalized policy was in place for rotational assignments of personnel. In fact, the present lack of such a program probably is not meaningful since a large proportion of the managers and supervisors are relatively new to their jobs. For the future, development and implementation of a rotational assignment program will take on added importance. Senior management indicated that it is considering moving employees from one unit or work station to another as a means to increase overall performance by promoting a greater understanding of multiple tasks in the organization. Recent moves of several licensed operators was a tentative step in this direction. The team considered rotational assignments of station personnel to be a positive contribution toward enhancing overall station operations.

3.1.9.5 Attitudes and Morale

Attitudes and morale ranged from poor to good in various places throughout the organization; in Systems Engineering, Radiation Protection, and among Unit 1 employees, attitudes and morale were poor. This state in Systems Engineering and Radiation Protection was attributed to long delays in making improvements to these areas. Unit 1 morale suffered from the extended outage and the low priority assigned to the unit activities in relationship to activities at Units 2 and 3. During interviews, numerous reasons for poor attitudes and morale were given; among these were too few successes caused by extended outages; and instability, uncertainty, and insecurity caused by changes in site management; and Pinnacle West's financial difficulties and declining stock values.

Among operators, morale varied between the units. In addition to the impact of all three units being shut down at the initial DET onsite evaluation period, other reasons stated for below-average morale included: (1) the new qualification card for Auxiliary Operators and (2) the effects of being in a five-shift rotation rather than a six-shift rotation. The new qualification card required a percentage of the tasks to actually be performed rather than to be completed by walkthrough or discussion. With the units shut down, many of the tasks could not be performed. With respect to shift rotation, some Auxiliary Operators had been required to work overtime on their scheduled days off because there was no sixth or relief shift.

The new accountability system was not fully understood or accepted and increased emphasis was being placed on disciplinary action. Priorities were ever changing and there were conflicting demands. The administrative burden or excessive workload was blamed on regulatory demands. There were delays in hiring people when they were needed to help reduce backlogs or workloads. Employee trust and loyalty toward management had declined because of problems associated with the reorganization in 1987. Low morale hampered team building and communications. In addition, many individuals had not yet been made to feel an important part of the management team.

The new management team was aware of these problems and had many new initiatives planned or implemented to correct them. The new management team thought that attitudes and morale would improve with more successful plant operation and greater attention to management issues. The DET found areas in which attitudes and morale had improved.

3.1.9.6 Teamwork

In the past, strong emphasis was not placed on teamwork. As a result, there were many pockets in which individuals worked alone. It was much easier for people to blame others when something went wrong. When one did not want the responsibility, the problem was shifted to another individual or area. "We versus them" or "they versus us" attitudes were indicated during interviews as still existing. Many of those interviewed indicated that the lack of teamwork was a significant management problem. Adequate recognition for teamwork was not evident.

The new management team indicated its commitment to have all employees work together to achieve common goals. Teamwork meetings and training sessions have been held and there were plans for more. Senior-level management is trying to structure work and the organization to encourage cooperation.

One of the team-building actions taken by senior-level management was the formation of the Management Review Committee (MRC). This committee served a useful function as a team-building mechanism since many of the new managers were members of the committee. While the MRC served a team-building function, it also served as a training ground for the new managers who were still in the learning phase at Palo Verde. The usefulness of the MRC as a "review committee" was not apparent from the limited exposure the DET had at the MRC meeting. Many details of the various programs were discussed, but very little "big picture" review was done. The MRC was set up to initially follow the Unit 3 restart issues and build teamwork. Failure to include representatives from Units 1 and 2 on the MRC, particularly when discussions involved programmatic issues that affected the whole site, was a weakness.

3.1.9.7 Recognition

There was a lack of praise and financial rewards for performance that exceeded expectations or for achieving the desired results. Numerous individuals indicated that they seldom were praised for a job well done. Because of limited successes, partially caused by extended outages, workers lacked pride. Some people lacked positive feelings and confidence that comes with the success of mastering a job and doing it well. Many individuals felt that the new management team was not adequately rewarding the behaviors that it was promoting. For example, numerous individuals said that they knew of no one who had been rewarded for taking problems to their superiors, recommending solid long-term solutions over short-term quick fixes, and doing the job right the first time. Taking the initiative or being proactive to solve the problem involved risk-taking because the employees were not certain how the new managers would react. Although most individuals thought that they were paid adequately, some pay inequities were recognized and those affected believed that they were not being adequately recognized for their contributions in comparison to others. Incentives were lacking to motivate people or encourage them to increase their productivity and perform well.

Management was well aware of the deficiencies regarding the recognition, rewards, and compensation programs and had increased its efforts to recognize good performance. The increased effort included publicizing good work as well as arranging more convenient parking spaces, awarding plaques, designating an employee of the month, and giving special praise and attention to good workers. Some individuals had received congratulatory letters from the Executive Vice President. In response to specific deficiencies, a new compensation/reward program had been developed and was ready for implementation.

3.1.9.8 Working Conditions

Job satisfaction varied among areas. Most individuals indicated that they were receiving fair and equal treatment. Concerns expressed dealt with physical location, space, discipline, pay inequities, excessive overtime and workload, burnout, and stress. Some people had not been housed or grouped for effective work.

Management was working on new initiatives to correct deficient work conditions. It was consolidating staff into fewer buildings and constructing new facilities inside the protected area. The provisions for personal health and safety were good. Management was making improvements to the overtime policy and compensation program, and it had developed a stress management course.

3.1.9.9 Discipline

The new emphasis on accountability had brought about an increase in disciplinary action. Some of the disciplinary actions taken had caused individuals to review their performance or work quality. In contrast to the past, individuals now felt that the new management team would not hesitate to discipline them for such reasons as carelessness, laziness, dishonesty, lack of cooperation, lateness, lack of effort, and lack of initiative. This new emphasis on discipline had increased employee concern about the immediacy and consistency in management's administration of the program. Employees indicated their desire for just and equal treatment, and an assurance that the same penalty would be given for the same offense.

Management recognized the need to improve its disciplinary process and had developed a new, positive, progressive discipline policy. The team analyzed the new policy and felt that it represented a solid solution for shaping long-term behavior.

3.2 Operations and Training

For the evaluation of plant operations, the Diagnostic Evaluation Team (DET, the team) observed control room and in-plant activities of both licensed and non-licensed operators, conducted tours of all accessible areas of the plant, observed communications with other departments, assessed management involvement, interviewed operators and unit management, examined records and logs, and conducted round-the-clock observations of selected units. The team assessed the operations training program by interviewing approximately 25 training personnel, reviewing documents, observing video classroom presentations, observing classroom and simulator sessions, reviewing initial and requalification training programs, observing training and simulator facilities, reviewing training staff qualifications, and observing management oversight and support for the program. Documents reviewed included Arizona Public Service (APS) policies, procedures, reports, audits, and memoranda.

3.2.1 Organization

Each of the three units is organized identically (reference Section 1.5). Each unit has a plant manager and an assistant plant manager. The operations manager reported to the plant manager and had an operations supervisor reporting to him as an assistant. Each unit typically has six crews reporting through this chain; however, while the DET was on site, all units were utilizing five-crew rotation. This organization appeared adequate to support plant operations.

3.2.2 Staffing

Staffing for all three units was adequate to provide for safe plant operation and comply with the Technical Specifications (TS). Normal operations crew manning level was one senior reactor operator (SRO) as the shift supervisor (SS), one SRO as the assistant shift supervisor, three reactor operators, five auxiliary operators, and a shift administrative assistant. The administrative assistant significantly reduced the administrative burden on the shift supervisor providing additional time for direct supervision of the operating crew. A shift technical advisor (STA) was assigned to a 24-hour shift in support of each unit. The STA provided routine operability and reportability reviews when needed. In general, operability and reportability determinations made by the operations organization were found to be correct and conservative. Each unit also had additional licensed personnel assisting in the administration of the shift.

A potentially critical staffing problem existed pertaining to licensed operators at the operating units. A present shortage of operators has caused the licensee to move from a six-shift to a five-shift operation. This has resulted in more overtime and decreased job satisfaction among the remaining operators. Further, other groups at the station (e.g., Work Control, QA, Plant Standards) recognize the value of having licensed personnel on their staffs, which tends to exacerbate the problem. The units have proposed that management provide incentives for licensed operators to remain on shift duty. If adopted, this may help, but it only represents a short-term fix. The licensee has plans to develop an operator licensing program that provides a steady source of new licensed operators for the station. A new class for license training is now in process, but it will be at least 18 months before new licensed operators will be available.

3.2.3 Conduct of Operations

3.2.3.1 Shift Leadership

The shift supervisor was charged with overall responsibility for coordination and control of activities within the unit in accordance with approved procedures and Technical Specifications. The assistant shift supervisor provided direction and coordination of the activities of the operating crew. The oversight exercised by SROs was generally good, but had occasional lapses. For example, the shift supervisors exercised strong leadership and control of the shift crews during all plant activities. During performance of a surveillance test on emergency diesel generator (EDG) A, an auxiliary operator heard unusual noises coming from the EDG room. The shift supervisor responded to the EDG room and immediately had the EDG secured. Investigation revealed an open head vent petcock on the #6 cylinder; the noise was air issuing from the vent. The petcock was closed and the EDG was restarted. The surveillance test continued without incident. The shift supervisor exhibited a conservative attitude toward equipment and personnel safety. He ensured the event was properly documented and an investigation process was initiated. Observations of the control room and simulator sessions typically showed good leadership skills being exhibited by the shift supervisor and assistant shift supervisor.

On December 2, 1989, during a heatup of Unit 2, the Technical Specification (TS) heatup rate was exceeded, indicating that the oversight exhibited by the senior licensed personnel on shift was insufficient. An assistant shift supervisor did not provide sufficient direction to an inexperienced operator assigned to perform the heatup. At one point the heatup rate exceeded the TS's limit of 40°(F) per hour. Plant procedures required logging the heatup rate at half-hour intervals. Action was taken to slow the heatup rate and the next recorded value was at the TS limit. The licensee's evaluation of this event indicated that greater oversight by the assistant shift supervisor was required as well as more frequent heatup rate determinations. The team concurred with the licensee's evaluation.

3.2.3.2 Shift Relief

Shift turnovers were thorough and complete. Oncoming crews reviewed logs, performed panel walkdowns, reviewed active Technical Specification Component Condition Records (TSCCRs), reviewed major work and activities in progress, and then conducted a turnover with their counterpart. The assistant shift supervisor conducted a shift briefing with all the auxiliary operators to discuss past and planned activities. These briefings were also attended by such support groups as Radiation Protection, Chemistry, and Operations Support. Communications between all groups during the crew briefing were excellent.

One area was identified that detracted from an otherwise good turnover process. The team identified that the "locked valve and breaker alignment" lists were not reviewed during shift turnover. A review of the out-of-normal positions of locked valves may have prevented the Unit 3 inadvertent transfer of water from the spent fuel pool in May 1989. A review of the outstanding "locked valve and breaker alignment" lists would have identified the fact that spent fuel pool valves PCN-V070, PCN-V071, and PCN-V123 were out of their normal position after their lineup requirement was complete.

Short-term reliefs to leave the control room to perform functions in the plant were adequate and well controlled, and provided in-plant time to control room operators to maintain familiarity with plant equipment. Crew staffing was sufficient to provide for these reliefs.

3.2.3.3 Logs and Records

The type and level of detail of information recorded in Operations Department logs varied with each unit. Units 1 and 3 were adequate in that logs provided enough information about normal unit operations, abnormal plant conditions, and operating events to evaluate unit performance and reconstruct operational events. Unit 2 logs were not written with sufficient detail to accomplish reconstruction of a near chemical and volume control system overpressurization event. To communicate the desired standards of logkeeping, a guideline was developed and sent to all operations personnel. The guideline was developed by Unit 2 for use of all three units. The DET concurred with the licensee's finding and noted, upon issuance of the guideline, an improvement in the content of the Unit 2 logs. The DET observed a weakness with respect to the nuclear operator valve manipulation log (NOVML). This is discussed in Section 3.2.3.7.

While observing the AOs on their rounds, the Unit 2 AOs were found to be recording emergency diesel generator (EDG) starting air receiver pressure from a gauge different from the instrument listed on the logs. The area 5 auxiliary operator log sheets required that EDG starting air pressure be recorded from a local gauge on the EDG control panel. The EDG air receiver pressure root stop valves for indication on the gauge board were isolated due to seismic concerns of the excess flow check valves (EER 88 DG 075). Differences were found between the three units' interim control measures with the root stop valves isolated. The Unit 3 AOs were opening the root stop valves long enough to take readings and then shutting them. The Units 1 and 2 AOs were taking readings at the local gauges located at the starting air receiver tanks. Unit 1 AOs logs identified and documented the fact that the readings were not being taken at the correct instrument. Unit 2 AOs logs were not annotated to reflect the instrument change. The licensee corrected this deficiency when informed of the annotation error. The AO logs also indicated the high limit for the starting air receiver tanks air pressure to be 260 psi, but the Final Safety Analysis Report (FSAR) described the limit to be 250 psi. (See Section 3.6.7.2.) While the deficiencies observed in the logs were not significant from an operations standpoint, the deficiencies indicated a weakness in attention to detail and inconsistent application of interim controls among the units.

3.2.3.4 Conduct of Licensed Operators

The DET observed control room activities during dayshift, backshift, and on the weekend. The control room staff conducted itself in a professional manner. The licensed operators observed were knowledgeable and their performance generally satisfied the high standards established by the industry. A board posted outside the control room clearly identified personnel responsible for each organizational position by a color-coded name plate. The color-coded name plate corresponded to the color of the person's name tag which was worn with the access control badge. Although personnel did not wear uniforms, organizational positions were easily distinguishable.

Communications with AOs and other groups via two-way radios and pagers significantly decreased the number of personnel in the control room, as well as reduced the background noise created by the use of the plant page system. This reduction in background noise contributed to a healthy operating environment. Only one person at a time was allowed to enter the control room and approach the assistant shift supervisor's desk. The units also limited access to the control board area by placing lines on the floor around an area into which permission must be granted prior to entry. Very few distractions were noted during the observation period. The combination of these controls leads to an environment conducive to safe plant operations.

Alarm annunciator acknowledgement was prompt and efficient. However, while the plant was in a shutdown condition, nuisance alarms were often left unacknowledged for extended periods of time. During normal power operations on Unit 2, the number of alarms and response to those alarms were observed to be good.

3.2.3.5 Conduct of Auxiliary Operators

The team accompanied various auxiliary operators (AOs) from all three units on their rounds. The AOs were knowledgeable of their assigned duties and plant equipment. Communications with the control room was observed to be good. The operators were observed checking equipment for vibrations, oil levels, and temperature. They checked indicating lights on switchgear and alarm annunciators and examined valves and pipes for leaks. All areas of the watch stations were thoroughly covered.

Prior to performance of an engineered safety features (ESFs) start of the B EDG, a procedure briefing was held to ensure all personnel involved in the surveillance test knew their responsibilities and actions required of them. The surveillance test contained both the A and B EDG ESF start procedures, but only the B EDG ESF start was to be performed. The "not applicable" (N/A) portions of the procedure were not marked nor annotated on a deviation sheet as is required by the Conduct of Operations administrative procedure. Consequently, the AO performing the surveillance test commenced signing off steps he completed in the procedure related to the A EDG while performing the steps on the B EDG. When questioned, the AO signed the correct portion of the procedure. Although no equipment was affected, a weakness was identified relating to the appropriate use of "N/A" and to procedural compliance with the Conduct of Operations procedure.

3.2.3.6 Administrative Controls/Attention to Detail

A written procedure to control required reading for the operating crews did not exist. An informal required reading program was in place, but time limits to complete the required reading were not established, it was not audited, and criteria to determine content of required reading were not developed.

During a walkdown of the control boards in Unit 3 on December 5, 1989, the DET noted the suction valve to the spray chemical addition pump A, SIA-UV-603, was in the open position. The normal position for this valve was closed. The licensee evaluated the condition and closed the valve. Document reviews and interviews with licensee personnel revealed that the valve should have been closed following the completion of surveillance test procedure 43ST-3ST06 performed earlier that day. Investigation also revealed the valve was signed off as being closed in the surveillance test, but was inadvertently left open by the operator performing the surveillance test. The operator performing the surveillance test was transferring the information from the rough copy of the surveillance test to the smooth copy and although the step was not signed off as complete on the rough copy, the operator inadvertently signed the step off in the smooth copy of the procedure based upon the assumption he had performed the step. The valve was not observed to be out of position by the operating crew or during shift turnover. Based on document reviews and interviews, the DET expected an independent verification (IV) during or immediately following the surveillance test. IV was not required or performed. Failure to close the spray chemical addition pump suction valve was identified as a weakness in attention to detail by a licensed operator, and a weakness in programmatic controls associated with the IV process.

One positive attribute noted by the DET was that a preventive maintenance procedure existed to check all operator aids throughout the plant on a routine basis. The check verified the proper revision was in place and proved the necessity of the aid.

The DET evaluated the Operations group's overtime policies, procedures, and practices. All overtime in excess of Technical Specification requirements involving licensed personnel had been authorized and approved prior to exceeding the requirements. One case involving licensed personnel exceeding the overtime limit that occurred between May and November 1989 resulted from an operator who had a change in shift/unit (the person worked more than 72 hours in 7 days). The overtime policies, practices, and procedures at Palo Verde are adequate to minimize excessive overtime.

3.2.3.7 Systems Configuration Control

The licensee used a variety of administrative systems to control the status of equipment in the plant. The Technical Specification Component Condition Record (TSCCR) was used to track safety-related equipment or components which were out of service or declared inoperable. When a determination was made to remove a system from service or declare it inoperable, a TSCCR was written and entered into a log in the control room. The log was frequently referenced during preparations for mode changes to assure equipment operability. The TSCCR was effective in assuring the unit was prepared for mode changes. The DET noted the effective use of personal computers to control adherence to the Technical Specifications (TS) action statements. When the TS action statements became effective, entries were made into the computer and alarm limits were established to warn the operators of the impending expiration date and time of the action statement. A hard copy was also developed for review during shift turnover.

While the DET was on site, the licensee was attempting to resolve problems with maintaining the accuracy of the system status prints. System status prints were a set of controlled prints maintained in the control room which reflected the status of valves and equipment. Before the DET arrived, the licensee had identified problems with the use of system status prints for verifying the initial conditions for plant procedures. The Quality Assurance organization had similarly identified a number of continuing problems with maintaining the system up to date and accurate. The prints were maintained by the shift administrative assistant. The prints were updated through the use of the nuclear operator valve manipulation log (NOVML), surveillance test procedures, and safety tag-outs. As operators manipulated valves, log sheets were completed and returned to the control room where they were reviewed, and status prints were updated.

Late in November 1989, Unit 2 experienced a valve alignment problem in the chemical and volume control system (CVCS). Two valves were found out of position for the activity and resulted in a near overpressurization of a portion of the system. Had the valve positions been properly logged, the event may have been avoided. As a corrective action to that issue and to continuing problems with the system status prints, Unit 2 management issued two policy letters on November 28, 1989, that reiterated plant policies on the use of logs and operations procedures. The intent of these letters was to improve updating the status of equipment at all three units. During a startup of Unit 2 one week later, the main turbine exhaust hood temperature increased to the alarm limit. When the alarm annunciated, the operator took proper action by opening the exhaust hood spray bypass valve. Opening the valve was logged on the control room operators (CRO) log, but not on a nuclear operator valve manipulation log (NOVML). The turbine subsequently tripped on high exhaust hood temperature despite the efforts to correct the high temperature. The closing of the exhaust hood spray bypass valve was not logged in the control room operator (CRO) log or on an NOVML as required by procedure and reiterated by the two policy letters. After the DET identified this error, the valve was verified in its correct position and logged in the CRO log and on an NOVML. A review of the controls in place identified that the corrective actions specified in the two policy letters of November 28 were not implemented in this instance. This was considered an example of ineffective implementation of a corrective action, and a weakness with respect to procedural adherence. Section 3.2.4.2 discusses the interdepartment communications problems identified with this event. On the basis of the licensee's identified problems with system status prints prior to the team's arrival on site and continued problems with effective corrective action, system status configuration control was considered ineffective.

3.2.3.8 Procedural Adequacy and Compliance

During the Unit 2 startup on December 2, 1989, the TS heatup rate limit of 40°(F) per hour was exceeded. The surveillance test procedure used to record the heatup only required reactor coolant system (RCS) temperature to be logged once every 30 minutes. The licensee determined that 30 minutes provided insufficient response time. The procedure was changed to require logging the RCS temperature every 10 minutes.

The team found some operating procedures to be weak from a human factors standpoint in that they unnecessarily referred the operators to other documents for reference instead of including the necessary limits or steps derived from these reference documents. Where appropriate, incorporating references minimizes the number of documents used to perform activities, increasing the time that operations personnel can monitor the control boards. Examples were:

- Operating procedure 41OP-1ZZ03, "Reactor Startup," Step 4.2.16, states in part that "RCS cold leg temperature is greater than minimum temperature for criticality per L.C.O. 3.1.1.4."
- Operating procedure 41RO-1ZZ08, "Small Loss of Coolant Accident," Step 5.1.4.2, states in part that "With no RCPs operating, verify compliance with T.S. 3.4.1.2."

In some cases, operating procedures did not provide conservative guidance for operating limitations for equipment. Operating procedure 41OP-1ZZ04, "Plant Startup Mode 2 to Mode 1," Step 3.10, states: "Reactor power shall be maintained within the capabilities of the Auxiliary Feedwater system until a Main Feedwater pump is placed in service." No power limit was succinctly stated. Although no specific cases were identified, the lack of conservative guidance in procedures and the excessive use of references that could interfere with the operators performing their duties were considered weaknesses.

The independent verification (IV) program documents were reviewed and IV was witnessed. During one IV, the assistant shift supervisor, a senior licensed operator, performed the positioning of a control board operated valve per a surveillance test procedure. When a non-licensed auxiliary operator (AO) entered the control board area, the assistant shift supervisor, identified the valve, SIA-UV-681, its position indication, and its location to the AO. The AO then signed the surveillance test as the "independent verifier." This activity revealed a number of weaknesses in the IV process. The AO was not qualified on the main control board and, therefore, had to be shown the indication he was verifying. This was not independent. Procedure 02AC-0ZZ01, "Independent Verification of Valves, Breakers, and Components," requires that, if possible, one check be performed locally at the component to avoid common failure problems. This valve met the requirement for both local and remote verification, yet both operators verified the position of the valve at the control board indicator. The senior licensed operator and the AO were not separated in time which is a characteristic of good IV practice. Additionally, problems were noted with IV during the performance of surveillance tests by AOs. IV was to ensure systems were properly returned to their normal lineup following system manipulations required by tests or procedures. The Unit 2 essential chilled water pump B operability surveillance test (42ST-2EC02) was witnessed. Independent verification signoffs were included in the body of the surveillance test procedure. The IV procedure allowed the IV to be performed at any time during performance of the procedure; however, the programmatic controls governing the surveillance test program, require each step to be performed in sequence. In spite of the conflicts with these procedures, the AOs were observed to perform timely IV of this surveillance test. On the basis of observations in this area, the independent verification program was considered weak.

A good practice established by the operations staff was the startup procedure checklists. Startup procedure checklists were available to verify individual pieces of equipment were ready for operation. The checklists were thorough and eliminated the chance of error by requiring signoffs for specific items. As an example, the checklists for pumps include suction and discharge valves position, oil levels, and normal operating noises.

3.2.4 Communications

3.2.4.1 Interdepartment

Communications between operations and other groups were not always effective. Communications among groups interfacing with the Operations group at the daily meetings were effective. Discussions during these meetings kept all groups up to date on job status and helped remove road blocks that were hindering job progress. Prior to starting maintenance, the work packages were cleared through either the shift supervisor or the assistant shift supervisor to ensure systems were ready for the work to begin and the Operations group was aware that the work was in progress. The maintenance groups kept the control room informed of their progress and problems, particularly when causing alarms and affecting other plant indications.

Communications between Unit 1 operators and the Work Control group were poor. Unit 1 operators received very little feedback regarding deficiencies they identified, while Unit 2 and Unit 3 received timely feedback.

A notable breakdown in interdepartment communications was the failure to sample the secondary steam generators for a 6-to-7-week period at Unit 1 (Section 3.6.4.2). Despite the sample results which, when taken, were within specifications, greater awareness of plant equipment during extended outages was needed.

3.2.4.2 Intradepartment

Communications between operating crews were good. The operators were working 12-hour rotating shifts and, for the most part, each crew relieved the crew that had relieved it. The exchange of information between two crews was effective. Within crews, the team observed excellent communications during plant activities. Examples were:

- Repeatbacks were consistently used throughout all activities.
- The auxiliary operators worked well with the reactor and senior reactor operators during a search for the source of steam causing a drain trough and sump to become hot and steam.
- The control room was kept abreast of the emergency diesel generator problem during the initial investigation.

An isolated case of poor communications within crews was identified during the excessive heatup rate event discussed in Section 3.2.3.1.

Downward communications between operations management and the operators were not fully effective. Messages were not clearly communicated to the operator level. Ineffective communication was evidenced by the poor implementation of the two policy letters issued to reemphasize normal practices for logkeeping and configuration control on all three units. The emphasis placed on these guidelines by management in each of the three units was inconsistent. Unit 1 placed the letters in required reading; Unit 2 personnel were briefed on the letters during shift turnover; Unit 3 had not received the letter 1 week after it had been issued.

Upward communications between the operators and operations management was also poor. An open forum had been used earlier in the year to allow the operators and others who had concerns about long-term problems to identify their concerns to management. Each of the concerns was first addressed to determine if it would impact restart. The restart items were taken care of rapidly. The remaining issues were addressed and feedback was given to the person who submitted the item. This relieved most of the concerns, but there was no followup to ensure that the stated fixes or planned fixes actually existed for those items not considered restart concerns.

Meetings between operations management and the operating crews were held regularly while the crews were in six sections. These meetings enhanced communication between operations management and the operating crews. Since the advent of five-section rotation, the extra/relief week is no longer available for holding these meetings. Meetings were held much less frequently and the regular communication path between management and the operators has been weakened.

Communications between Training and Operations has improved dramatically since the creation of the training coordinator position. There was consistency in training development/modification.

3.2.5 Root-Cause Determinations

The shift technical advisors (STAs), were assigned as human-performance evaluation system (HPES) investigators as a collateral duty. Various managers and supervisors had been trained in basic human-performance issues to help them in evaluation of the reports. The program appeared to be good and held promise for the future. A review of some of the more recent HPES reports demonstrated better root-cause analysis. The success of the HPES program hinged on the commitments to continued training and the ability of the organization to implement HPES at the near-miss level. Neither of these initiatives had been implemented; therefore, the effectiveness of HPES could not be evaluated.

In the past, other programs, such as post-trip review, had not been complete or timely in the determination of root cause. The DET attended a post-trip review meeting addressing a recent plant trip. The root cause of the trip had been identified as a switch (Section 3.6.4.4) whose design was not adequate for the function in which it was used and for which a substitute was required. This meeting, the most recent in a series of meetings, seemed more involved with the wording of the report than with ensuring the problem was finally resolved. The unit manager asked the review group questions to prompt correct wording and resolution; it appeared that without the prodding the problem would have been written off without a sound documented evaluation. The new management team was observed to emphasize root-cause determinations throughout this meeting.

3.2.6 Training

3.2.6.1 Organization

The Nuclear Training group was led by the Nuclear Training Manager, who reported to the Vice President, Nuclear Production. The Training organization was organized into 4 functional areas: general training (85 people reporting to 1 supervisor), licensed training (28 people reporting to 1 supervisor), training support (18 people reporting to 1 supervisor), and training analysis (14 people reporting to 1 supervisor). The simulator upgrade project (6 people reporting to the project manager) was not part of the Nuclear Training organization.

In the December 1, 1989 reorganization, general training, training analysis, and licensed training personnel were distributed among five new work centers: technical training, operations training, maintenance training, radiation protection/chemistry/radiation worker/general employee training, and instructor support. The new organization retained the current training support services group. The Project Manager for the simulator upgrade project, reported directly to the Executive Vice President, Nuclear, and functionally to the Nuclear Training Manager. To prevent a recurrence of the simulator fidelity problems, a proposed simulator support group will eventually replace the simulator upgrade project and at that time will become part of the Nuclear Training organization. Since this reorganization took place late in this evaluation, the new organization was not assessed; however, it appeared adequate for addressing current training needs.

Core training programs for unit personnel were accredited by the Institute for Nuclear Power Operations (INPO). However, training was not emphasized and generally was poorly attended. In June 1989, INPO placed the training programs at Palo Verde on probation. The result has been a revision of management emphasis that has placed training high on the priority list. Scheduled training was being attended, even at the expense of slipping work schedules at the units. The names of persons who missed scheduled training were reported to the Executive Vice President on a weekly basis.

As part of the renewed emphasis on training, the units had assumed responsibility for the training. For example, each unit maintenance group now has a training coordinator who works with the Training Department to arrange the type and amount of training needed. Responsibility for the electrical, instrumentation and control (I&C), and mechanical disciplines was split: Unit 1 was responsible for electrical training, while Unit 2 handled I&C training and Unit 3 handled mechanical training. There were quarterly meetings with the Training Department. This training also was provided to central maintenance personnel. The unit maintenance groups had about 30 percent of their people in training at the time of the DET visit.

Prior management had made a decision to cut back on licensed operator training. The result was the present shortage of licensed operators, requiring the units to adopt a five-shift rotation scheme replacing the six shifts they had previously. A new licensed training class was in progress, but it will be about 18 months before additional operators become available.

Non-licensed operator training, which was the main pipeline for license candidates, had become part of the general training group. Training provided to auxiliary operators was not adequate to meet their needs. With the implementation of the new training organization, non-licensed operator training had become part of operations training. This reorganization coupled with the increased emphasis on auxiliary operator training, appeared to address the problem.

3.2.6.2 Level of Knowledge

Nuclear Training group personnel were well qualified for the positions they held. Licensed operator instructors either hold or have held valid licenses or were degreed and certified by an independent, outside evaluator. Licensed operator instructors were required to spend eight hours per month in the plant. Instructors worked with the on-shift crew and completed on-the-job requirements, accompanied the crew on their rounds, or observed any in-process work. This required plant time allowed the instructors to remain current in plant operations and helped to improve their credibility with the staff.

Contract trainers were required to have the same qualifications as the Palo Verde training staff. Instructor qualifications were verified by reviews of the person's resume, interviews with the individual, and practice instruction sessions. Contract trainers were required to complete/participate in the same continuing training and were evaluated/monitored in the same ways as the Palo Verde instructors.

Personnel in the instructor support group (instructional technologists) all had education degrees, up to and including the doctorate level, and had education/training experience prior to joining the Nuclear Training group. The six job analysts, two each from Operations, Radiation Protection, and Maintenance, were selected from plant-certified technicians and had sufficient experience to conduct functional area job/task analysis.

Morale among the training staff was high, although there was a large amount of overtime (from 25 percent to 70 percent). The size of the old general training group (85 people reporting to 1 supervisor) was perceived as a contributing factor to the overtime that training supervisors worked. Generally, the level of knowledge and qualifications of the training staff were considered good. Effective controls for maintaining qualifications were in place. Some concerns raised during interviews included: (1) uncertainty over the proposed reorganization, (2) training staff ability to develop and maintain the training programs after contractor support is removed, and (3) qualifications of new managers and training supervisors. Overall, the training staff was dedicated to quality training.

3.2.6.3 Licensed Operator Training

The replacement and requalification training programs were removed from INPO probation on October 19, 1989. The DET observed operator training in both classroom and simulator situations. All presentations were given in a professional, relaxed manner that was conducive to learning. The presentations contained a mix of lecture, questions, and positive individual reinforcement for correct answers. When students gave incorrect information, they were corrected in a manner that saved their dignity, but still reinforced learning.

The requalification program was set up in a continuing training format. Each operating crew was rotated into training on a 6-week cycle. A typical training segment included (1) classroom training on recent industry events (e.g., licensee event reports, significant operating experience reports), as well as on system design and operations, and job performance measure (JPM) accomplishment and (2) simulator team-training sessions. Licensed operators who failed either the requalification written examination or the annual operating test were removed from licensed duties and enrolled in an accelerated training program.

Any missed training was completed by the end of the next training cycle. If at the end of the next cycle the person was not current in training, the training group submitted the person's name to operation management for action. Persons who missed training were required to complete the same examination as the people who had attended the training. Licensed personnel were scheduled to complete 64 hours of simulator time, which exceeded the 60-hour TS requirement. If an individual completed only 56 hours of simulator time, that person's record was submitted to operations management for review. Individuals were removed from licensed responsibilities for failure to make satisfactory training progress. The replacement and requalification program contained sufficient controls to ensure that licensed operators were well trained and maintained the knowledge necessary to safely operate the plant.

3.2.6.4 Program Material and Facilities

Training materials appeared up to date in regard to plant design. Lesson plans were formatted to allow instruction by dif- rent instructors with no loss of information presented. Use of mockups and simulation devices was strength Mockups include a full-size reproduction of the steam generator Th and Tc bo and interferences, three simulated work areas for advanced radiation work permit training, and a reactor protective system simulator. The computer-based training (CBT) group was a strength of the training organization. The CBT group, which has received numerous local and State CBT awards, has developed cost-effective, instructionally sound training.

Student training records were maintained in three forms: hard copy, microfiche, and real-time training data base. The training folder and microfiche contained copies of examinations, completed JPMs, and certifications. The data base maintained a summary of the training completed and the grades received. Student information was easily retrieved using any of the three forms. Student training information was usually updated within one week of completion of training.

The training facilities needed improvement. Conducting training throughout the site, primarily in trailers, represents an inefficient use of instructor and trainee time and contributed to the poor communications within the Nuclear Tra ing group. The current plan calls for modifying the two administration annexes during 1992. A new facility will consolidate all classroom training, simulation facilities, and instructional staff offices.

The Training Department did not keep current with plant procedure changes. Minor changes to the procedures tended to be ignored by the staff. If there was a major change to one of the procedures, the staff was aware of the change and would verify/confirm the impact of the change on any training materials they were responsible for. While the procedures used by the training organization had improved, there was room for more improvement.

Plant personnel recognized the plant's lack of highly specialized training capabilities, and utilized contractors as necessary to conduct training. For example, team and communications skills training was being conducted by a consultant. Various instructors had completed INPO's advanced simulator instructor course and many instructors had received Mager instructional training and Kempner-Trago team training. Because of the large use of contractors and their upcoming release from the facility, the team was concerned about the licensee's ability to continue applying the resources necessary to develop, maintain, and improve the current training programs.

A computer-based question-and-answer bank was used for developing examinations and was considered a good initiative. The questions generated were easily related to a specific task; knowledge, skill, and ability statement; enabling objective; and reference. Full printouts of questions also incl ed time allowed for answering the question, mastery level required to answer the question, question type, point value, and last date of question revision.

Simulator performance was observed on four occasions: once during JPM training (one licensed student and one simulator instructor) and three times during scheduled team and communications skills training (one simulator instructor, one contractor team skill trainer, and one entire operating crew, including auxiliary operators). During one team-skills session, procedures designed to reduce the negative training impact of simulator fidelity problems were observed. During this session, the simulator response differed from the expected plant response. When the discrepancy was noted, the scenario was frozen, the erroneous response was discussed, and the exercise was terminated. No discrepancies were noted during this team-skills training. The licensee should be sensitive to the impact of this procedure during emergency operating procedures (EOP) and JPM training. In spite of known simulator fidelity problems, simulator training appeared adequate and negative training appeared minimal.

All simulator sessions were video-taped and followed by a discussion session facilitated by the simulator instructor/contract trainer. This method of reviewing the videotape and discussion of the exercise appeared to be an effective method of information exchange.

The simulator upgrade project was on schedule. Arrangements have been made to ensure that licensed operators and license candidates receive 60 hours of simulator time before the scheduled date when Singer-Link-Miles (Singer) will require use of the simulator for 20 hours per day. Present procedures require any lost simulator time to come from training time rather than from upgrade time and this could cut into the required 60 hours per year of simulator training. The licensee appeared committed to completing simulator upgrade as scheduled in early 1991. The licensee plans to purchase a Power Safety "see-through" reactor as allowed simulator training time continues to decrease. The licensee recognized the amount of simulator training required to support three units and was considering proposals to remedy simulator issues.

3.2.6.5 Implementation of Lessons Learned

Lessons learned, both plant specific and nuclear industry in general, were part of all areas of training, including individual discipline-specific training and updates to existing lessons. Training lessons reviewed indicated good communications and feedback on lessons learned. The manner in which the subjects were presented was considered a strength.

To ensure retention of information from lessons learned, prior to using a lesson plan, instructors were required to ensure the lesson was up to date and accurate. It is incumbent upon the instructor to do thorough research before presenting the training. Instructors voiced concerns that without some kind of tracking system, important events could possibly be missed. A weakness was identified that without a trending system for industry events, some information will be lost.

3.2.6.6 Monitoring of Training

The operations classroom training observed during this evaluation was conducted in accordance with an approved unit of instruction by an individual who demonstrated solid instructional skills. The instructor followed the unit of instruction, was poised and professional in his presentation, and maintained class interest. A followup interview with the instructor verified the instructor had a complete and thorough knowledge of the subject matter and was confident in his ability to relate the subject matter in an understandable manner. On this basis and on the basis of discussions with licensed operators, the DET concluded that instructors have an excellent rapport with operators. Well-qualified instructors were a program strength.

Instructors were evaluated during their certification process and annually thereafter. Training program evaluations based on numerous inputs (surveys of students, job incumbents out of training for 3 months, job supervisors, question analysis, and instructor performance evaluations) were analyzed for relevancy, and program improvements were implemented. Personnel interviewed, job incumbents, and supervisors felt that their training concerns were adequately addressed in a timely fashion by the training organization.

The training analysis group conducts independent evaluations of all accredited training programs. The evaluation ensures that the job/task list is current, ensures the objectives developed from the task list match the tasks, and ensures that the training (lesson plan) matches the objectives. The training analysts feel confident that, given time, the training programs will continue to improve.

3.3 Maintenance

The Diagnostic Evaluation Team (DET, the team) evaluated licensee maintenance activities by interviewing licensee personnel, observing work activities, and reviewing documents pertinent to maintenance. The motor-operated valve (MOV) program and its implementation were evaluated separately.

3.3.1 Organization and Personnel

The maintenance organization consisted of individual unit maintenance departments divided into mechanical, electrical, and instrumentation and controls (I&C) disciplines supplemented by a central Maintenance organization. (See Section 1.5.) Corresponding work control centers responsible for the planning and scheduling of maintenance activities were associated with each maintenance department. The unit maintenance departments were responsible for all maintenance in their respective units, except for a number of relatively large tasks, such as rebuilding reactor coolant pump motors, which was assigned to the central Maintenance Department. The central Maintenance Department was also responsible for a number of centralized maintenance tasks, such as heating, ventilation, and air conditioning (HVAC) maintenance, vibration monitoring, MOVATS testing, and station services. In addition, the central Maintenance Department was used at times to supplement the unit maintenance departments. In the past, unit maintenance had been performed primarily during the day shift, with only minimal coverage provided during the backshifts. Backshift coverage had been limited to two I&C technicians per unit, with the central Maintenance Department providing additional coverage. At the time of the evaluation, the licensee was in the process of increasing the staffing levels of the unit maintenance departments in preparation for the transfer of responsibility for backshift coverage from the central Maintenance Department to the unit organizations. This should improve maintenance support for the units.

Approved 1989 staffing levels for each unit included 43 mechanical, 15 electrical, and 31 I&C maintenance personnel. The 1990 budget included increases of mechanical and additional electrical maintenance employees. Unit work control groups included 1 tagging coordinator, 4 evaluators, 17 work planners, and 10 schedulers. More planners and schedulers were budgeted for 1990.

In the central Maintenance Department, 64 mechanical, 37 electrical, 31 I&C, 36 HVAC, and 24 station services employees were budgeted. The 1990 budget included more I&C, HVAC, and station services employees. The creation of a central maintenance support group was also planned for 1990. The central maintenance work control group contained 24 employees, with more employees budgeted for 1990.

In general, maintenance personnel appeared to be competent and capable of performing their assigned tasks. The licensee had also recently formalized the tracking of personnel qualifications required for specific tasks in order to ensure that only qualified individuals were used. However, several examples of inattention to detail during the performance of maintenance activities occurred during the evaluation (Section 3.3.10). Additionally, the licensee's reports indicated a high occurrence of component failures attributed to human or procedural errors. The work control groups were staffed by personnel who were familiar with the units and the tasks that needed to be performed, but who were not familiar with the administrative and technical requirements necessary for the preparation of good work packages. This contributed to the problems encountered with work packages (Section 3.3.2).

3.3.2 Corrective Maintenance

Although some maintenance procedures existed, the majority of work was performed using work orders. Corrective maintenance procedures appeared to be adequate in scope and level of detail. However, procedures did not exist for many tasks and most work was performed using instructions contained explicitly in work orders. Some of these work orders were inadequate in their level of detail and others contained errors. Maintenance personnel indicated that they routinely needed to correct work orders in order to perform the tasks correctly. The large percentage of errors contained in corrective maintenance work orders was determined to be a significant weakness in the program. Several examples of incorrect or inadequate work orders are listed below:

- Work orders (WOs) for pin replacement on two containment purge valves (WOs 391030 and 391038) included incorrect torque values for bolt tightening during valve reassembly. The torque values were corrected during performance of the work order.

- Instructions in a work order for the installation of valve packing in an atmospheric dump valve (WO 388338) required installation of the packing and adjustment of the packing gland nuts using "good mechanical judgment." These instructions were inadequate and during work performance, steps were added to install the packing and torque the nuts in accordance with detailed instructions included in procedure 31MT-9SG-04, "Atmospheric Dump Valve Disassembly and Assembly."

In addition to these two examples, the site Quality Control (QC) organization performed up-front reviews of work orders. Licensee documents indicated that over the previous 14 months, approximately 17 percent of all work orders were rejected during these reviews because of technical or administrative errors. Efforts to reduce the rejection rate had apparently been unsuccessful.

The licensee had instituted a model work order program to create generic work orders. Effective implementation of the program should eventually increase the quality, consistency, and efficiency of the work order process. The licensee planned to prepare approximately 475 different model work orders. However, no use of model work orders was observed during the evaluation period. In addition, the licensee was preparing a formal training and qualification program for work planners.

3.3.3 Preventive Maintenance

The licensee acknowledged that the preventive maintenance (PM) program in place at the time of the evaluation was piecemeal, especially for balance-of-plant equipment. Additionally, the use of criteria to develop PM requirements was inconsistent.

The PM backlogs in the Station Information Management System (SIMS) Repetitive Maintenance Report Monthly Summary for November were 32 percent for Unit 1, 12 percent for Unit 2, and 14 percent for Unit 3. The overall trend was toward a reduction in the backlog. The bigger backlog in Unit 1 was primarily due to the higher priority given to Units 2 and 3.

A PM improvement program had been developed, but approval required prior to implementation of the program had not yet been given. This program consisted of an initial verification of information in vendor equipment manuals and the development of a PM-basis document for each component. Procedures would then be prepared or modified as required and tasks would be entered into the SIMS and scheduled for performance. The program included both safety-related and balance-of-plant equipment. This program was still under review during the evaluation period. Effective implementation of the program should lead to an improvement to the overall maintenance at the facility.

Additionally, in response to previous concerns related to the control of postponed PM activities, the licensee had revised the PM program to require approval at the maintenance manager level for PM activities to be delayed beyond their grace period. A routine report to the plant manager on delayed PM tasks had also been implemented.

3.3.4 Control of Maintenance Activities

Licensee control of work activities, including maintenance planning and scheduling, showed a lack of coordination of efforts between site organizations. Inadequate outage planning and management contributed to the extension of refueling outages.

3.3.4.1 Maintenance Planning

Planning groups within each work control center planned maintenance and prepared work orders. As previously discussed, the level of detail in work orders was inconsistent and the instructions included were sometimes inadequate or incorrect. (See Section 3.3.2.)

A lack of coordination of activities during maintenance sometimes caused delays in the performance of work and interfered with proper root-cause analysis. Examples of this are:

- o Before the initial conditions were investigated to determine the cause of a damaged stem on an auxiliary feedwater (AFW) flow-regulating valve, the valve was disassembled in accordance with an unrelated work order.

- o After stem replacement on a Unit 3 AFW flow regulating valve, the valve was stroked and again damaged because of problems with the torque switch setting. After the second bent stem, the licensee discovered that the torque switch was at the wrong setting and the torque switch adjustment screws were loose. The engineer involved with this work stated that he had requested that the valve be tested before being stroked electrically. This testing may have identified the condition before damage occurred.

The licensee stated that a program to improve the work control process was being implemented. The program aimed at improving the training of work planners, work control procedures, and preparation of model work orders.

3.3.4.2 Maintenance Scheduling

Some lower priority maintenance tasks were not being performed in a timely manner because maintenance schedulers were not planning for or taking advantage of equipment outages in order to accommodate the performance of several tasks simultaneously. A number of old work request tags were found for the cleaning of vital electrical switchgear cabinets. The licensee stated that this maintenance could not be performed until the equipment had been taken out of service. This equipment had been taken out of service at least once after the work requests had been initiated, but these tasks had been overlooked during the equipment outage. Interviews with maintenance schedulers indicated that this was not an isolated occurrence.

At the time of the evaluation, the licensee was in the process of implementing a 12-week work schedule in Unit 2. The schedule in the other units was to be implemented 90 days after completion of the current refueling outages. This scheduling system should provide an effective means of scheduling and coordinating maintenance activities. Once fully implemented, the 12-week schedule will integrate the performance of surveillance testing (ST) with preventive and corrective maintenance. Effective implementation of the program should lead to improvement to the overall maintenance of the facility.

3.3.4.3 Outage Management

Inadequate planning for and management of outages by the licensee was a factor in the extension of planned 73-day refueling outages for Units 1 and 3 into outages in excess of 230 days. The outage plans, or schedules, were developed by the outage management group. These plans were simply compilations of the amounts of time required to perform certain "big ticket" activities in series, as opposed to being comprehensive work plans for outages. Immediately before the start of an outage, the schedule would be given to the work control groups for implementation. At this point, the outage management group would have completed its task and would have no further responsibilities.

No central person or organization was responsible for managing the outage; therefore, no one was accountable for meeting the outage schedule. In addition, there was very little pre-staging of parts for the outages, no tangible plans to deal with emergent work, and no cutoff date for the addition of maintenance or modification activities to the outage schedule.

3.3.5 Analysis of Maintenance Activities

Maintenance management was not sufficiently aware of the personnel deficiency reporting and equipment failure trending programs and was, therefore, unable to use them effectively. In addition, maintenance and work control center personnel did not understand or implement the quality deficiency report (QDR) system. These constituted significant weaknesses in the maintenance program.

3.3.5.1 Personnel Errors and Rework

The licensee had recently established the QDR system to identify non-hardware deficiencies and initiate corrective actions as appropriate. Because maintenance and work control personnel did not understand this system, they were not providing input to the system as required. The licensee intends to correct this by revising work control procedures to provide criteria for initiating QDRs and by providing training for appropriate personnel.

3.3.5.2 Equipment Failure Trending

The licensee had established an equipment failure trending program and periodically published the accumulated information in the "Component Failure Data Trending Quarterly Report" and the "Component Failures Associated With Human or Procedural Errors Report." These reports were prepared by a group within the Engineering Department. (See Section 3.6.16) The reports were distributed to a limited number of managers, primarily in the Engineering Department. No mechanism was in place to provide this information to the maintenance departments.

Maintenance personnel were not aware of these reports and were, therefore, unable to review the information in order to trend maintenance performance and implement improvement actions as appropriate. Several examples of items from the most recent (3rd quarter 1989) "Component Failures Associated With Human or Procedural Errors Report" that should have prompted corrective action are listed below:

- Forty-five examples of problems due to missing or incorrectly installed fasteners or fittings were identified.
- A high instance of rework because of incorrect or inadequate valve packing installation and adjustments was noted.
- Multiple problems with diesel generator systems because of poor maintenance performance were identified.
- Fifty examples of improper wire terminations or damaged insulation were given.

Several examples of problems with diesel generator test petcocks and incorrect packing installation were documented in the most recent "Component Failures Associated With Human or Procedural Errors Report." Similar problems recurred while the team was on site. (See Section 3.3.10.) In addition to these items, the report identified other types of problems for increased attention.

Maintenance management personnel were made aware of these programs as a result of the evaluation. The licensee stated that reports would be distributed to maintenance managers.

3.3.6 Maintenance Support Activities

A weakness existed in the control of documents in a readily usable format. An increase in the participation of maintenance personnel in training programs was determined to be an improvement.

3.3.6.1 Training

In response to concerns on the low priority given to training, the licensee had raised its priority and subsequently increased participation in training programs by maintenance personnel.

Maintenance training coordinators had been established to coordinate efforts between the Maintenance and Training Departments. In addition, formal tracking of personnel qualifications required to perform specific maintenance tasks had also recently been established.

The work control center planning groups had developed a formal qualification and training program. During the evaluation, the program was being reviewed by the Training Department; implementation was scheduled to begin during first quarter of 1990.

3.3.6.2 Control of Documents

Some drawings and vendor technical manuals were not being maintained in a user-friendly configuration. In particular, a number of document change notices (DCNs) were included which had not yet been implemented. Also, changes were not placed where they were needed in the text of the document, but were simply inserted at the front. The user would be forced to constantly refer to the front of the document in order to determine whether information in the text had been superseded. These practices increase the potential for errors during the planning and performance of maintenance activities. During the evaluation, the DET identified the following examples of weak document control:

- The set point document for MOV actuators (13J-ZZI-004) had 34 DCNs attached to it. Several of these DCNs were not yet implemented. Maintenance personnel were given this document with the associated DCNs to use in the field to select the correct valve operator set points. This document was difficult to use. During maintenance observations, qualified technicians selected incorrect limit switch settings while performing maintenance on a safety-related MOV. This was identified and corrected by a licensee quality assurance (QA) monitor just prior to work performance. Several additional examples of incorrect use of this document were identified in Corrective Action Request (CAR) 89-0082, which was initiated during the evaluation.

- The technical manual for the AFW flow-regulating valves contains a section concerning the Limitorque valve actuators installed on the valves. This section of the manual has not been maintained because the licensee maintains a separate manual with generic information on MOV actuators. This created the potential that maintenance personnel could use noncurrent information.

- The technical manual for the atmospheric dump valves had six changes with instructions on where the new pages should be inserted into the manual. All six changes were simply inserted at the front of the manual. In addition, a sheet containing eight comments was inserted at the front of the manual. There was no evidence that efforts had been made to resolve these comments.

The licensee was in the process of creating a generic MOV manual and placing references into other technical manuals to provide a single source of information. CAR 89-0087 was initiated to investigate problems with the use of reference documents and to initiate corrective actions.

3.3.6.3 Measurement and Test Equipment

During the evaluation period, the licensee was in the process of revising the program governing the use and control of measurement and test equipment (M&TE) in order to resolve NRC and site QA concerns. Interim revisions to the procedures to strengthen controls on M&TE use were issued during the last day of the DET's visit on site. The revised procedures required that equipment be checked out by individuals from a central depot. This M&TE could remain checked out until recalled for periodic calibration. M&TE usage was recorded in the associated work package and entered into the SIMS M&TE usage screen within 7 days of completion of the work. This permitted the review of all work orders performed using a particular piece of M&TE. Recall notices for test equipment requiring calibration were generated by the central depot and sent to the supervisor of the user who had checked out the equipment. "Out of tolerance" notices were issued within 7 days of the last possible usage for M&TE found broken or out of calibration and for equipment not returned when due for calibration. At the time of the evaluation, M&TE issue was being tracked manually. Further improvements will include development of a computer system to track the issue and calibration of M&TE.

3.3.7 Material Condition and Housekeeping

In general, the DET found housekeeping at the facility to be good. Several examples of a lack of attention to equipment condition were identified by the DET.

Most obvious deficient conditions were identified and entered into the licensee's work request system for corrective action. The DET observed several deficient conditions which had not been identified by the licensee. Examples of these deficiencies are:

- Packing leaks were observed on valves ECB-V45 and ECB-V46 in Unit 3.

- o The local position indicator for Unit 2 valve AFW-V36 was missing its cover plate and pointer.

- o A nut was missing from the limit switch compartment cover on Unit 3 valve AFW-V37.

- o Several mounting bolts on a Unit 1 vital area security door were sheared and the door did not close properly.

The licensee initiated corrective actions for these deficiencies upon identification by the DET.

The DET observed several areas of surface rust on components, indicating a lack of proper surface maintenance. Also, a high number of leakage containment devices were observed in the auxiliary buildings. These devices were typically installed to contain valve packing leaks. Some catch basin drains were directed toward the floor, allowing for the spread of contamination. This condition was corrected after the DET told the licensee about it.

3.3.8 Motor-Operated Valves

Because trained technicians could not properly use the motor-operated valve (MOV) data base drawing, MOV setpoints were not adequately controlled. In addition weaknesses in the MOV program included the lack of MOVATS baseline data for many MOVs, the lack of detailed procedures for disassembly and reassembly, and the lack of proper documentation for MOV setpoints. Internal responses to industry experience reports were incomplete and untimely. These weaknesses were not directly correlated with the MOV problems noted in the failure data trending program.

3.3.8.1 Program

There were 831 MOVs in use among the three units. Of these, 605 had Limitorque operators, 178 had Rotork operators, and 48 used operators manufactured by EIM. Of the 831 MOVs in use, 324 were classified as "Q" (quality-related); the remaining 507 were classified as "non-Q."

The MOV program at Palo Verde (73PR-9ZZ04, "Valve Motor Operator Monitoring and Test Program") provided for both corrective and preventive maintenance to MOVs, control of limit and torque switch settings, and the collection and trending of valve performance data. (As the majority of valves used at Palo Verde used Limitorque operators, evaluation of the MOV program dealt primarily with the Limitorque operators.) Data trending consisted of obtaining baseline MOVATS data for each MOV and comparing these baseline values to those obtained following such corrective maintenance as valve packing adjustments and torque and limit switch adjustment. Data would also be collected at periodic intervals in order to trend valve and operator performance degradation over time. Additionally, the licensee planned to use MOVATS information to diagnose problems with valve operators during maintenance.

At the end of the evaluation period, only 99 of the 324 quality-related (Q) valves (31 percent) had been MOVATS baseline tested; none of the non-Q valves had been tested. The valves which had been tested (33 per unit) had been tested in response to IE Bulletin 85-03. The licensee provided a tentative schedule for the baseline testing of all remaining valves, but this schedule had not yet been approved. The licensee planned to complete testing of all Q-class and other important non-safety quality-related valves by June 1991; testing of Q-class valves in Unit 2 was scheduled to begin in January 1990. The licensee formed an MOV Task Force to ensure that these and other commitments are met.

A number of weaknesses existed in the MOV program. These weaknesses included:

- o Because the MOV data base drawing (13-J-22E-004, "Motor Operator Data Base") included 34 DCN's, trained technicians had trouble (Section 3.3.6.2) selecting the proper MOV setpoints. Therefore, the licensee's controls of MOV setpoints were inadequate.

- o The thrust and limit calculations provided by the Engineering Department for the MOVATS testing of valves were informal and lacked proper documentation. (See Section 3.6.15.2.)

- o Procedures did not exist for the disassembly and reassembly of MOV operators. Creation of these procedures was recommended in SOER 83-9. (See Section 3.3.8.5.)

- o The licensee had removed the torque switch limiter plates from all valve operators which had been MOVATS baseline tested, stating that these limiters were installed by Limitorque to establish "arbitrary" limits for torque switch settings and were no longer necessary. This philosophy appeared to contradict to that used by Limitorque when installing the limiter plates. During testing of a Unit 3 AFW flow-regulating valve (AFW-V30), loose torque switch adjusting screws permitted the operator torque setting to increase, causing the valve stem to become bent. A limiter plate may have prevented this event. The licensee initiated Problem Resolution Sheet (PRS) 1067 in response to NRC questions. The purpose of this PRS was to determine whether the removal of torque switch limiter plates is acceptable.

- o No as-built list of torque and limit switch settings existed for MOVs. The torque and limit switch control document (13-J-ZZI-004, "Motor Operator Data Base") listed only the target ranges for torque and limit switches. The MOV program document (73PR-9ZZ04) stated that a procedure would be established to "maintain valve operator set points and equipment data for the operating life of each unit." The licensee initiated CAR-89-0082 to address changes to the torque and limit switch document. The licensee planned to make this document an as-built document, with settings provided specifically for each unit.

3.3.8.2 Organization and Personnel

The MOV program utilized central maintenance electrical group personnel to perform MOVATS testing of Limitorque valve operators. These personnel appeared to be well trained and knowledgeable in the MOVATS test procedures and equipment and in the theory of operation of Limitorque motor operators. Unit electrical and mechanical group personnel were used to perform corrective and preventive maintenance tasks on MOVs. Unit maintenance personnel appeared to lack sufficient training and experience to perform proper MOV maintenance, as evidenced by a number of entries in the licensee's failure data trending database related to personnel errors during maintenance activities on MOVs.

The licensee indicated that plans had been made before the DET's arrival to train more unit maintenance personnel in the use of MOVATS equipment in order to make MOV maintenance and testing more unit oriented. These plans were being reviewed as a result of DET questions concerning the number of personnel errors that occurred during MOV maintenance. This matter had not been resolved at the end of the team visit on site, but during subsequent communications, the licensee indicated that a central MOV maintenance group was being established to handle all MOV work during the upcoming Unit 2 refueling outage.

3.3.8.3 Procedures

Procedures utilized to perform PM on MOVs included 32MT-9ZZ48, "Maintenance of Limitorque Motor Operated Valves;" 32MT-9ZZ55, "Valve Motor Operator Performance Signature Acquisition Using MOVATS Equipment;" 40TP-9ZZ01, "MOVATS Testing for Auxiliary Feedwater System;" and 40TP-9ZZ02, "MOVATS Testing for Safety Injection System." Corrective maintenance tasks for MOVs usually contained references to one or more of these procedures along with specific steps for the completion of the individual maintenance task.

Procedures did not exist for the complete disassembly and reassembly of valve operators. Maintenance work orders referenced the Limitorque technical manual, but this document contained insufficient detail to be used as a comprehensive maintenance procedure. The licensee hired a contractor to write procedures for MOVs, but these procedures were not scheduled to be in place until September 1990.

3.3.8.4 Training

The licensee trained personnel on Limitorque, Rotork, and EIM valve operators. Contractors trained MOVATS technicians, but the licensee was developing an in-house course in the operation of MOVATS test equipment and in valve signature analysis. The training provided was adequate for performance of MOV testing.

3.3.8.5 Utilization of Industry Experience

Licensee utilization of industry experience reports was incomplete and untimely. Responses to information provided by Limitorque under Part 21 addressed only Q-list MOVs. Other communications, such as information notices and SOERs were not responded to in a timely manner. Examples included:

o Licensee response to a November 1988 Part 21 notification from Limitorque concerning degraded insulation on RH-insulated direct current (dc) motors installed in SMB-type actuators was closed on June 4, 1989, in Engineering Action Request (EAR) 89-0449. This EAR stated that only two MOVs could experience the conditions described in Part 21, but these MOVs were of a different model (type SB) and would therefore be unaffected. This response was reopened on October 28, 1989, after an engineer noticed that type SB operators were similar to and used the same style dc motors as type SMB operators.

- o Response to a Part 21 notification from Limitorque concerning failure of melamine torque switches in types SMB-00 and SMB-000 actuators addressed only safety-related MOVs. EAR 89-0448 indicated that melamine torque switches may have been stored in the warehouse for use in non-safety-related MOVs, but the warehouse staff was not formally notified to remove these torque switches from stock. The EAR noted that a copy of the closed EAR should be sent to the attention of the warehouse.

- o Licensee response to Information Notice 85-22, "Failure of Limitorque Motor-Operated Valves Resulting From Incorrect Installation of Pinion Gear," noted that technical manual J-605-162 did not contain information on proper motor pinion positioning for type SMB-0 operators. The response was closed out on July 5, 1985, by stating that an effort was being made to update the Limitorque technical manuals. These updated manuals had not been approved at the time of the evaluation, although the licensee indicated that these new manuals would be in place by December 29, 1989. The licensee response to this information notice was reopened pending the release of revised technical manuals.

- o Significant Operating Experience Report 83-09, "Valve Inoperability Caused by Motor-Operator Failures," had not been closed out by the licensee. This SOER was issued by INPO on October 21, 1983. A December 7, 1989 internal memorandum supplied by the licensee indicated that at least several of the recommendations included in the SOER had not been implemented. These recommendations were related to the creation of MOV disassembly, reassembly, and troubleshooting procedures. The memorandum stated that institution of these procedures should be completed by September 30, 1990. (See Section 3.3.8.3.)

3.3.9 Materials and Materials Management

Almost all maintenance personnel contacted by the DET indicated that inadequate parts availability was causing delays in the performance of maintenance. The licensee's "Corrective Maintenance Work Backlog Delayed for Materials" report, dated November 10, 1989, stated that 894 work orders were backlogged for materials in October. This was a reduction from the previous level of 1022 work orders. Some of the parts availability problems stemmed from previously inadequate communications and planning between the materials management group and the units and an inadequate basis for the available inventory.

During the evaluation, the DET noted that the licensee had failed to sample a steam generator as required for a period of 7 weeks. This problem occurred because a stainless steel yoke bushing nut was required for maintenance on a steam generator blowdown drain valve, but a replacement was unavailable. No replacement part was available for more than 7 weeks. This was observed to be an example of failure of the materials management organization to maintain an adequate parts inventory and to obtain parts on short notice.

The licensee was in the process of implementing a program to improve materials management (Material Control Department Pride in Excellence Program). The licensee had recently established parts coordinators for each unit in order to improve communications between the materials management group and the units. The intent of the program included improvements to the efficiency of operation of the materials management group, development of a plantwide accessible information system, and development of a basis for parts inventory. Effective implementation of the program should lead to improvement in the maintenance at the facility.

3.3.10 Maintenance Activities

During observations of maintenance activities, the team found that some work packages were cumbersome and difficult to use. One such example is the work package used in the adjustment of torque and limit switches using the MOV set point drawing. This document is discussed in Section 3.3.6.2.

Several examples of errors during maintenance that occurred or were identified during the inspection period are:

- During troubleshooting of an atmospheric dump valve (ADV), the licensee discovered that the wrong size packing had been installed, causing the valve to bind. The incorrect packing had been installed to correct a previous problem with binding caused by incorrect installation of the packing. (This event is not the same as the earlier ADV problems which were investigated by an NRC augmented inspection team.)

- Parts from a containment purge exhaust valve were inadvertently installed in a containment purge supply valve.

- A cylinder head vent petcock on an emergency diesel generator was inadvertently left open following maintenance activities.

The licensee instituted human performance evaluation system (HPES) investigations of these events. Results of the investigations were not available at the end of the evaluation period.

The DET observed that personnel at times lacked a sense of urgency to correct deficiencies or coordinate efforts in order to perform a maintenance activity. While an auxiliary operator was manually stroking an atmospheric dump valve in order to allow for valve packing removal, the handwheel came off the valve. This allowed for the potential loss of a woodruff key from the handwheel assembly which would have prevented manual operation of the valve. The operator stated that supervisory personnel were aware that this handwheel was loose; however, no work request had been initiated to correct this condition when identified. In addition, the lack of a sense of urgency and coordination of efforts resulted in delays in the replacement of an AFW flow-regulating valve stem which was at the time considered to be an item in the critical path to unit restart. Although the new stem was of a slightly different design and additional engineering approval was required, a similar task had just been performed in another unit.

An additional example involved a failure to recirculate and sample a steam generator for several weeks. (See Section 3.6.4.2.) This occurred because a replacement yoke bushing nut was required during maintenance on a blowdown drain valve but was not available. The licensee's actions to find a suitable replacement part were not timely.

3.4 Surveillance and Testing

The Diagnostic Evaluation Team (DET, the team) assessed the area of surveillance and testing (S&T) by reviewing selected Technical Specifications (TS), surveillance testing, and ASME Section XI inservice testing of pumps and valves; in addition, the DET reviewed surveillance testing that was not based on TS requirements. The review included the policies, programs, and procedures; the organization and staffing; the implementation of safety testing activities; and the generation and maintenance of testing records. The emergency diesel generators (EDGs) and support systems were reviewed, in part, during the inspection. Additionally, the DET reviewed licensee actions associated with safety-related check valves; the DET also reviewed other matters.

3.4.1 Surveillance and Testing Organization

Authorities and responsibilities were established for the organizations supporting the S&T program.

The organizational structure and staffing levels were adequate to implement the requirements. However, the organization, responsibilities, and authorities were not clearly described.

3.4.1.1 Organizational Requirements

The project organization supporting S&T was specified in the Nuclear Administrative and Technical Manual (NATM) procedures. The testing requirements were generally specified in the NATM procedure 010G-0ZZ01 ("Executive Vice President, Arizona Nuclear Power Project (ANPP), Organization and Responsibility Policy"), Revision 1, and procedure 020G-0ZZ01 ("Nuclear Productions Organization and Responsibility Policy"), Revision 0. The organization and responsibilities for testing, as described, were shared between the Director of Standard and Technical Support, and the unit managers. The team noted one discrepancy: the Operational Quality Assurance Program (OQAP), UFSAR 17.2.11 ("Test Control"), indicated that "responsibility for testing is assigned to the PVNGS [Palo Verde] plant manager." The OQAP was not current with the present organization and responsibilities. This discrepancy was brought to the attention of the licensee and Quality Deficiency Report (QDR) No. 89-102 (December 7, 1989) was issued to correct the description and initiate a review of the generic implication of the error.

The general management and supervision policies for S&T were specified in NATM procedure 73AC-9ZZ04 ("Surveillance Testing"), Revision 7, and procedure 73AC-0XC02 ("Inservice Testing of Safety Related Pumps and Valves"), Revision 2.

3.4.1.2 Organizational Assignments

The specific S&T requirements, associated with both the TS and ASME Section XI testing programs, were assigned to the Engineering Evaluations Department in accordance with NATM procedure 73AC-9ZZ04 ("Surveillance Testing"), Revision 7. However, document reviews and interviews revealed that the organization assigned the specific responsibilities for S&T was not involved in all aspects of the activity. The surveillance program control group generated and tracked activities using a monthly master schedule and also maintained the surveillance requirements matrices; however, the surveillance group did not directly schedule and track the activities associated with testing performed at intervals of 72 hours or less. These specific activities were implemented by a number of other organizations (e.g., the Operations group). These organizations and organizational relationships were not adequately described. The licensee had previously identified this matter and was considering possible corrective actions.

3.4.1.3 Qualification and Staffing

The personnel qualification requirements and staffing levels associated with the S&T groups were adequate and in accordance with the TS (6.0), Regulatory Guide 1.8, ANSI/ANS 3.1-1978 ("Personnel Selection and Training"), and the Updated Final Safety Analysis Report (UFSAR) Section 17.2, "Operational Quality Assurance Program." Document reviews and interviews revealed that the surveillance group was working between 10 percent and 30 percent overtime and additional contract personnel were used as required. The implementation of the augmented testing program for check valves, including development of the program and procedures, observations of activities, and performance of acceptance reviews, will likely strain existing resources. Interviews revealed that the licensee understood this potential shortfall and they were addressing the problem.

3.4.2 Surveillance and Testing Program

The S&T program for the EDGs addressed all the applicable requirements specified in UFSAR Section 9.5 regarding the EDG and support systems; UFSAR Section 17.2.11 ("Test Control"); Regulatory Guide 1.33, Appendix A, Item "q" ("Emergency Power Tests"); TS 3/4.8.1 ("AC Sources"); and ASME Section XI ("Pumps and Valves Testing") and, therefore was acceptable.

However, the responsibilities for the surveillance program were distributed among groups within the plant and support organizations, and there was no single, controlling program document which described the S&T activities fully.

3.4.2.1 Requirements

The requirements associated with the testing and test control program were specified in USFAR Section 17.2.11 ("Test Control"); general policies were issued by the Executive Vice President and the Vice President, Nuclear Production; and the testing program was described in detail in NATM procedures 73AC-9ZZ04 ("Surveillance Testing"), Revision 7, and 73AC-0XC02 ("Inservice Testing of Safety Related Pumps and Valves"), Revision 2. Special testing requirements were specified by the associated TS.

Additionally, the licensee had committed to the specific requirements of ASME Section XI, 1980, Winter 1981 agenda for each of the three units. The first 10-year program for each of the plants was: Unit 1--February 1986 through 1996; Unit 2--September 1986 through 1996; and Unit 3--January 1988 through 1998. The 'RC approved the 10-year programs in letters dated November 11, 1988 (Units 1 and 2) and June 21, 1989 (Unit 3).

3.4.2.2 Description

The provision of the program and implementing procedures for S&T activities were specified and controlled in accordance with established administrative procedures.

Document reviews and interviews revealed that the scheduling of testing activities was delineated. The surveillance group provided the scheduling of testing activities in accordance with established matrices (73DP-1ZZ01, 73DP-2ZZ01, and 73DP-3ZZ01 addressing TS testing; and 73PR-1XI01, 73PR-2XI01, 73PR-3XI01 addressing ASME Section XI pumps and valves). The surveillance group also provided a monthly master schedule for the portion of the S&T program performed at a frequency of once a week or more often. The surveillance group provided an informal tracking report regarding the items scheduled on the monthly master schedule; however, this tracking report was not addressed by the program procedures and the report did not address all of the surveillance tests scheduled and performed by other departments. The report noted any tests that were past the due dates (90 percent, 100 percent, and 125 percent), and was provided to various licensee personnel. The informal report appeared to be effective in that very few required surveillance tests had been missed.

The surveillance testing procedure (73AC-9ZZ04, Section 3.7.1, steps 1.12 and 1.14 of Appendix E), and the inservice testing procedure (Sections 3.3.3 and 3.3.4), required the ASME Section XI technical review. The review included the analysis by the assistant shift supervisor of the test data for safetyrelated pumps within 96 hours; however, limited guidance was provided regarding the scope and content of the 96-hour review. These reviews were documented on the surveillance test package review/cover sheet by signature, date, and time. Document reviews and interviews revealed that the assistant shift supervisor analyzed the data promptly for accuracy and anomalies that could affect operability, although the specific details of the analyses were not documented. The technical review of the data was also completed within the 96-hour period. The DET checked the calculations in a number of completed surveillance tests packages and found no errors.

3.4.3 Testing Implementation

The DET reviewed the S&T program implementation to ascertain the qualities of the activity. The overall implementation activities appeared to be acceptable; however, the activities observed and reviewed identified a lack of attention to detail on the part of certain individuals responsible for conducting tests.

3.4.3.1 Personnel and Procedures

On the basis of interviews conducted, the personnel selected to perform the surveillance testing were qualified and knowledgeable.

The testing packages reviewed included:

- 42ST-2DG01, Diesel Generator "A" test 4.8.1.1.2.1, Revision 5, Procedure Change Notice (PCN) #2

- o 41ST-1EC02, Essential Chilled Water Pump Operability Test 4.0.5, Revision 3, PCN #1

- o 42ST-2SP02, Essential Spray Pond Pump Operability Test 4.0.5, Revision 2, PCN #2

The testing packages were written clearly, were easy to follow step by step, and included the latest revision of the test procedure.

During the review of operating procedures utilized for routine testing purposes (41OP-1DG02, 42OP-2DG02, and 43OP-3DG02, "EDG B Operations"), one discrepancy was noted as follows. Procedure step 7.3.5 incorrectly required the securing of essential spray pond A system per procedures 41OP-1SP02, 42OP-2SP02, and 43OP-3SP02, rather than the required B spray pond system. The review of this item by the DET revealed that instruction change requests (ICRs) had been initiated on February 8, 1989, on the Unit 3 procedure and on May 22, 1989, on the Unit 2 procedure. The ICRs were classified as "E-3" (enhancement, low priority) rather than as representing a potential performance error. No PCN had been issued regarding this item since it was considered an enhancement item to be corrected by the licensee during the biannual procedure reviews. When questioned on the significance of the error, the licensee initiated a PCN to expedite correction of the procedure step.

Additionally, in response to this DET finding, the licensee initiated a review of the controlling procedures for classification of ICRs.

3.4.3.2 Calibration Task Acceptance Criteria

Regarding calibration tasks performed in support of the testing activities, document reviews and interviews revealed that during the performance of the tasks, instances had been identified when instrumentation loop accuracies were not provided. The Instrument Standards group calculated the instrument loop accuracies on an as-need basis. Engineering evaluation requests (EERs) had been initiated identifying the problems to the Engineering group and requesting a disposition on these specific items. The DET reviewed two specific completed calibration tasks and the associated EERs: (1) pressurizer level instrument 3JRCNLLOOP0103, task 045676, EER No. 89-RC-032, and (2) reactor coolant temperature instrument 3JRCATLOOP0115, task 37179, EER No. 89-RC-037.

This appeared to be a programmatic issue associated with the failure to provide the required instrument accuracies. This item is addressed further in Section 3.6.15.1.

3.4.3.3 Surveillance and Testing Observations

The DET observed the following tests and related activities and toured the facility (Units 1, 2, and 3).

(1) <u>42ST-2DG02, Diesel Generator B Test, Unit 2</u>

The DET observed the Unit 2 B EDG test on November 8, 1989. The EDG was started utilizing a simulated engineered safety features (ESF) signal. The auxiliary operator (AO) performing the test had a thorough knowledge of the prerequisites and precautions, the steps of the surveillance test

(ST) to be performed, the data to be taken, the location from which to take the data, and the corrective actions which should be taken in an emergency (EDG explosion or fire). After the licensee had completed the ST and the acceptance review, the DET reviewed the ST package. Before and after values of air pressures had been entered inappropriately into Appendix D for the starting air receiver B, which had been isolated by the ST procedure. These specific steps should have been marked as N/A (not applicable) for the B air receiver, as specified in the note in Appendix D. Additionally, the Nuclear Records Manager had not signed the ST package review sheet for the current revision as specified by procedure 73AC-9ZZ04, step 3.3.6. The licensee did not identify these errors during the acceptance reviews performed immediately following the completion of the ST. The failure to (1) mark the inappropriate procedure steps N/A, (2) check for the current revision, and (3) identify these errors during the performance of the acceptance review resulted from a lack of attention to detail.

(2) <u>42ST-EC02, Essential Chilled Water Pump B Operability Test 4.0.5, Unit 2</u>

The DET observed the performance of Unit 2 essential chilled water pump B operability test on December 6, 1989. This test was representative of the chilled water operability test performed on the other two units.

The technician's general knowledge of the ST and the data to be taken were fully acceptable. The DET observed, however, that AOs performing the test encountered a number of difficulties and did not question potential problems encountered during the ST which could affect the ST acceptability. At the start of the ST, two AOs tried to establish the flow rate of 400 gpm as specified by the procedure by throttling the essential chilled water pump B gate valve and snubbing down the Barton gauge (flow indications) root valves to dampen out the flow oscillations indicated on the Barton gauge. The operators could not establish the specified steady indicated flow of 400 gpm. After establishing and accepting an oscillating flow rate of 390 gpm to 405 gpm, which took 20 minutes, one of the AO's left the area. The DET questioned the remaining AO concerning specified flow rate of 400 gpm versus the actual flow rate of 390 gpm to 405 gpm. The AO tried for an additional 20 minutes to fine-tune the flow rate to 400 gpm by throttling the gate valve and snubbing the Barton gauge root valves. The DET noted that at one point the AO isolated the Barton gauge when trying to dampen down the indicated flow oscillations. After attempting to obtain the specified flow rate of 400 gpm by himself for 20 minutes, the AO enlisted the aid of a vibration technician to give flow-indication readings to the AO from the Barton gauge as the AO tried to throttle the flow rate to 400 gpm. After trying to establish the specified flow rate of 400 gpm for an additional 10 minutes, the AO finally established a flow rate of 395 gpm. The operator did not try any further to obtain the specified flow rate of 400 gpm. The DET noted that the Barton gauge gave a steady flow rate of 395 gpm; however, the root valves associated with the Barton gauge were almost fully closed. The DET asked the AO if, perhaps, a PCN or an ICR should be written on the difficulties encountered while attempting to establish an indicated flow rate of 400 gpm and performing the ST at 395 gpm. In response to questions regarding the test adequacy, the DET was informed that an ICR would be written to address only the difficulty in trying to obtain the specified flow rate of 400 gpm. After the ST was completed, the licensee reviewed it, and signed off on it as acceptable. Resolution of the ICR as written was not going to address the following items: (a) obtaining a stable flow rate of 395 gpm by throttling a gate valve not designed for this type of use might not be meaningful; (b) the flow indication provided by the Barton gauge may not be accurate since the system was subject to indicated flow oscillations and the Barton gauge root valves were almost fully closed; and (c) the established test conditions were less than the design conditions specified in UFSAR Table 9.2-28 (400 gpm). The DET observed the system during normal operating conditions following the completion of the testing and noted that the system flow indicated about 490 gpm, well above the design requirements.

During the performance of the test, the AO performing the independent verification (IV) of the essential chilled water outlet isolation valve position as specified in step 8.12 of the ST procedure did not perform the IV of step 8.12 until after step 8.14 (stopping the essential chilled water pump) had been completed. Also the AO performing the IV did not have the ST procedure or equivalent checklist in his possession when he performed the IV of step 8.12 (verifying the valve in the open position).

The DET reviewed the licensee requirement and noted that the person performing an IV per Administrative Control Procedure 02AC-0ZZ01, "Independent Verification of Valve Breakers, and Components," step 2.2.3.1, should conduct the IV "...with the proper level of integrity and attentiveness necessary to ensure plant system and equipment controlled in a manner that supports safe and reliable operation." Administrative Control Procedure 02AC-9ZZ04 ("Surveillance Testing"), step 3.4.4.1, states that all steps in an ST procedure must be performed in order and signed off on as they are performed, unless otherwise specified by the ST procedure. The DET noted that the performance of the IV step during the performance of 42ST-2EC02 did not appear to be fully supported by step 2.2.3.1 of 02AC-0ZZ01 and step 3.4.4.1 of 02AC-9ZZ04. For further details regarding IV refer to Section 3.2.3.8 of this report.

(3) <u>43ST-3AF02, Auxiliary Feedwater Pump AFA-P01 Operability Test White Copy, Unit 3</u>

The DET observed the special turbine auxiliary feedwater (AFW) pump ST in Unit 3 on December 4, 1989, investigating high discharge pressure and steam leaks associated with the turbine AFW pump. With exception of the auxiliary operator conducting the test, all personnel left the turbine AFW pump room within 15 minutes of starting the pump because so much steam accumulated in the room from the steam leak. This test could have been secured immediately (within approximately 10 minutes) after the engineers and technicians had completed their investigation since the pump was being operated for troubleshooting purposes. The test could have been better planned and controlled to prevent unnecessary exposure of personnel and equipment to the hot, wet, steamy environment.

The DET reviewed 17 selected ST procedures for completeness, including any followup corrective actions. The acceptance data and numerical calculations were performed correctly; however, 8 of the completed STs reviewed contained a number of minor errors.

(1) <u>42ST-2DG02, Diesel Generator B Test, Unit 2</u>

Diesel generator B test (42ST-2DG02) was performed on November 1, 1989. Section 7.13 of the ST procedure specified that Section 8.4 was to be performed. Apparently the operator performed or documented the performance of steps 8.2.1.1, 8.2.1.4, and 8.2.1.5 of Section 8.2 instead. The error was corrected before step 8.4.7 of the ST was properly executed.

This mistake was attributed to the operator's inattention to detail and failure to mark unnecessary steps "N/A."

(2) <u>43ST-3AF02, Auxiliary Feedwater Pump AA-P01 Operability Test, Unit 3</u>

Steps 8.1.1 and 8.1.2 of Section 8.1 of the ST procedure were performed or documented as performed instead of Sections 8.3 and 8.4 as specified in Step 7.1.5 before the error was identified and corrected. The error was attributed to the operator's inattention to detail and failure of both the operator and his supervisor to mark unnecessary steps "N/A."

The acceptance review sheets associated with the following STs were not properly completed: (1) Unit 3, DG Fuel Oil Surveillance Test (74ST-9DF01) performed on September 6, 1989. The train tested was not identified (tank A); (2) Unit 2, Auxiliary Feedwater Pumps AA-P01 Operability Test (42ST-2AF02) performed on November 25, 1989. The train used in the test was not specified; (3) Unit 3, Essential Chilled Water Pump Operability Test (43ST-3EC02) performed on October 20, 1989. The train tested was not identified; and (4) Unit 3, Diesel Fuel Oil Surveillance Test (74ST-9DF01), performed on November 7, 1989. The acceptance review sheet was changed incorrectly.

The DET reviewed selected preventive maintenance calibration activities associated with the EDGs, including air receiver pressure indicators (PIs 29 and 30 and PIs 214 and 216), fuel oil day tank levels (P-0005 and P-0006), fuel oil storage tank levels (P-0033 and P-0034), and temperature indicators (TIs-0025 and 0026). No apparent discrepancies were noted.

3.4.3.4 Emergency Diesel Generator Air Start Check Valve Test

The DET reviewed the testing of the EDG starting air system check valves to verify compliance with the TS and the NRC-approved ASME Section XI valve testing requirements.

Procedures 73PR-1XI01 (73PR-2XI01 and 73PR-3XI01), "PVNGS [Palo Verde] ASME Section XI Pumps and Valves Inservice Testing Program," Revision 0, addressed requirements of TS 4.0.5 and ASME Section XI, 1980 Edition, Winter 1981 Addenda.

ASME Section XI (IWV-3412) required the exercising of check valves. Procedure 73AC-0XI02, step 3.2.2, and procedure 73PR-1XI01 (73PR-2XI01 and 73PR-3XI01), Appendix F, implemented the exercising of the EDG starting air system check valves.

Document reviews and interviews revealed that the A starting air receiver on the B EDG in Unit 3 had been depressurized on April 15, 1989, during an air compressor outage. Required monthly surveillance 43ST-3DG02, "Diesel Generator B Test 4.8.1.1.2.a," was performed on July 20, August 18, September 15, October 10, and October 27, 1989, with the A starting air receiver isolated and depressurzied. Improper planning while in this configuration resulted in the failure to flow test the A side EDG starting air header and exercise check valve V-497 in the forward direction. Interviews indicated that the impact of the A starting air receiver outage had not been recognized.

The associated air compressor and the A starting air receiver were returned to service on November 13, 1989, and the system was tested on the same day, more than 6 months after it had been depressurized. The test results were satisfactory.

This deficiency was pointed out to the license and a problem resolution sheet (PRS-605) was issued on December 6, 1989, to fully assess this finding.

3.4.4 Testing Records

The DET reviewed specific records related to completed surveillance and testing activities. The records were fully acceptable, and provided in a timely manner indicating the records system was functioning properly.

3.4.5 Review of Contractor Report

The DET reviewed a recently completed evaluation of test control by a contractor (Report No. 01-1650-778, Revision 1, dated September 14, 1989). The review was contracted by the licensee to provide an independent evaluation of the S&T program.

The review of the contractor report revealed a number of program, implementation, and support weaknesses. The DET review of the S&T program identified similar deficiences. Document reviews and interviews revealed that the licensee had taken actions or was planning actions in response to the concerns. These licensee actions included improvements in planning, scheduling, tracking, and trending; upgraded surveillance and test matrices; enhancements in the QA audit and monitoring activities; improved self-assessment; and the development of a management level testing program procedure.

Completion of these improvements should strengthen the testing program.

3.4.6 Check Valve Testing, SOER 86-03

The DET reviewed selected actions taken by the licensee regarding Significant Operating Experience Report (SOER) 86-03, "Check Valve Failure or Degradation," dated October 15, 1986, and supplemented by Electric Power Research Institute (EPRI) Report NP-5479, "Application Guidelines for Check Valves in Nuclear Power Plants," dated January 1988. The licensee's response to SOER 86-03 was neither adequate nor timely. This was identified in early 1989 and a number of activities were taken to address specific deficiencies.

The DET review of the more recent activities regarding the SOER 86-03/EPRI Report NP-5479, including the completed Bechtel study and the plans to complete the program, and implementing procedures in order to support the scheduled refueling outage on Unit 2 in February 1990, indicated that the licensee was now taking appropriate actions.

3.4.6.1 Review of Licensee Actions

Document reviews and interviews revealed that SOER 86-03, which had been previously closed by the licensee, was reopened in May 1989. Bechtel Power Corporation completed Study No. 13-MS-A24 ("Check Valve Evaluation Program for PVNGS"), dated October 19, 1989, to assess the check valve applications and maintenance records for Palo Verde, Units 1, 2, and 3, against industry guidelines. The study also provided preventive maintenance guidelines for check valves. A total of 355 check valves on each unit were reviewed, and additional inspections were recommended on 213 check valves on each unit. The valves were classified into 10 separate categories for inspection purposes based on criteria such as the valve type, size, importance, maintenance history, and EPRI criteria (e.g., valve location, and operating conditions).

3.4.6.2 Check Valve Testing Program Upgrade

Interviews revealed that the licensee was in the process of evaluating the Bechtel study and developing a program and implementing procedures. The plans were to provide a program and implementing procedures to augment the present ASME Section XI testing program. The first 43 check valves on Unit 2 will be disassembled in the February 1990 refueling outage. The licensee plans on developing a separate inspection program for the initial inspection of the check valves and will consider upgrading the approved ASME Section XI inspection program for check valves at some later date. The next scheduled refueling outage on Unit 1 is in 1991 and the initial check valve inspections were planned during the scheduled outage. The valve service times were not specifically addressed by the Bechtel evaluation.

Document review and discussions revealed that the Bechtel evaluation did not identify any additional check valves that should have been in the present program; however, about half of the check valves identified were already included in the program. The additional check valves identified were to be included in the program for reliability purposes. A number of the check valves were also being tested in accordance with Appendix J to 10 CFR Part 50 as containment isolation valves.

Interviews revealed that the licensee had not yet completed the design review of the check valves to determine if check valve testing being performed verified that a particular valve would meet its intended safety function during accident conditions. This design study was going to be performed by Bechtel and was scheduled to be completed at the end of December 1989.

3.5 Quality Assurance/Quality Control and Other Oversight Groups

The Diagnostic Evaluation Team (DET, the team) reviewed the organization, staffing, scope of responsibilities, personnel qualifications and experience, and program implementation of each oversight group to evaluate its overall effectiveness in fulfilling its mission. For the purpose of this diagnostic evaluation (DE), the oversight groups included quality assurance/quality control (QA/QC) and the safety review committees (Independent Safety Engineering Group [ISEG], Plant Review Board [PRB], and Nuclear Safety Department [NSD]). The DET also evaluated the operating experience review (OER) program because of its similar role in problem identification and resolution. For each area, the focus of the review was on the final products generated by each group, which included inspection reports, audit reports, special investigations, meeting minutes, and monthly reports. These documents were reviewed for scope, depth, and thoroughness to determine if an adequate and performance-oriented evaluation of the area had been accomplished. Additionally, any deficiencies which were identified were investigated to determine if adequate corrective actions had been taken or were being taken. The DET also interviewed personnel at all levels and attended various meetings to complete the overall assessment.

3.5.1 Oversight Group Improvement Initiatives

Over the past 2 years, outside groups have criticized the performance of the oversight groups. These criticisms included the lack of identification of problems, weak prioritization, and untimely correction of identified problems. The licensee was made aware of these problems in numerous inspection reports and in the NRC's systematic assessment of licensee performance (SALP). The new management team at Palo Verde recognized oversight as a key problem area and took action to improve performance. One significant criticism was the overall coordination of the groups. To improve this area, the licensee developed and issued the nuclear safety management and self-assessment program, which better defined the responsibilities of each of the groups; quarterly meetings of the project self-assessment group (PSAG), which consisted of the managers of each of the groups, were implemented; a PSAG subgroup was established and was meeting more frequently to establish an agendum for the PSAG quarterly meetings, based on the day-to-day results of inspections at the plant; and the PSAG developed an integrated audit/investigation schedule which each group was using to plan its activities. Additionally, an integrated trending program for deficiencies was scheduled for implementation in the first quarter of 1990. These new initiatives were designed to improve performance, but had not been in place long enough to obtain the desired results.

3.5.2 QA/QC Functional Organization

The QA/QC organization at Palo Verde was led by the Director of Quality Assurance/Quality Control, who reported to the Executive Vice President, Nuclear. The QA/QC organization was staffed with approximately 130 people and engaged contractors as needed. Reporting to the QA director were the employee concerns program manager, the assistant QA director, the quality control manager, the quality systems manager, the quality engineering manager, the quality audits and monitoring manager, and the APS QA/QC supervisor (nonnuclear). Overall, the staffing, resources, organization, and expertise of the QA/QC organization appeared to be adequate.

The Audits and Monitoring Branch was responsible for conducting the audits to implement the QA program. This branch has also responsible for the QA surveillance (monitoring) program and for the coordination of quality deficiencies. The branch was in a state of transition because the manager had been promoted to that position in June 1989, and the monitoring supervisor had been changed. The branch was staffed with 28 people, most of whom had been at Palo Verde since the construction phase.

The Quality Systems Branch was new and had formerly been part of the Quality Engineering Branch. The manager and several of his staff were hired from outside Palo Verde. The branch members had a significant amount of engineering, operations, and QA talent. The branch was staffed with 11 people and was responsible for quality trending, quality program development, QA training, and special projects. This branch was the QA director's "troubleshooting" group and, as such, was the cutting edge for many of the new programs being implemented.

The Quality Engineering (QE) Branch was responsible for engineering document reviews, procurement QA functions, vendor audits and surveillances, and QA/QC engineering. The branch was staffed with 34 people and was led by a new manager who had been hired from outside Palo Verde in June 1989.

The QC Branch was staffed with 43 employees and was led by a manager who had been temporarily promoted. Plans were for the current QA assistant director to take the manager position once a new assistant director is selected. The QC Branch was responsible for plant inspections, modification inspections, and the receipt inspection activity.

3.5.3 QA/QC Improvement Initiatives

The Director of QA was part of the new management team at Palo Verde. The new director was hired in March 1989, and had aggressively implemented several personnel and programmatic changes to foster performance improvement both inside and outside the QA/QC organization. Overall, the personnel and programmatic changes were having a positive impact on the QA/QC organization and general licensee performance.

Personnel changes included the addition of 14 new people who had engineering degrees and/or operational experience. This should improve performance, but there was still a shortage of engineering and operations expertise. These personnel changes included the hiring of new managers of quality systems and quality engineering from outside Palo Verde. These new managers had degrees and significant QA operations experience. Additionally, the new director replaced the manager of audits and monitoring by promotion from within and was recruiting for the assistant director position. Several QA/QC supervisors also were replaced. Such major management changes in a relatively short period of time (8 months), naturally had the potential to destabilize the organization and diminish support from the working level. However, personnel at all levels within the QA/QC organization indicated that the changes were necessary to bring about needed improvements. A new commitment to improved performance and support of the new QA/QC management team was evident in nearly all the interviews.

Programmatic changes implemented by the new director included (1) a new material nonconformance reporting (MNCR) system for resolving significant material deficiencies, (2) a new station-wide, human performance quality deficiency report (QDR) system, (3) a site escalation procedure for identified deficiencies, (4) a revision to the employee concerns program to require investigation of concerns by line management rather than by QA personnel, (5) the QA stop work and QA recommended shutdown programs, and (6) a revision to the QA monitoring and trending programs.

All of these programmatic changes were designed to mal problems more visible, track problems to a more timely resolution, foster line-organization accountability for problems, and strengthen site performance in the area of corrective action. The new MNCR program included provisions for operability/reportability reviews and for automatic escalation of deficiencies not receiving adequate attention. The new QDR program provided a vehicle for identification of minor "software" problems by all Palo Verde departments. The other programmatic changes were designed to strengthen corrective action and to provide a means for the QA/QC organization to take appropriate actions upon discovery of a safety-significant deficiency. Although, these programmatic changes constitute improvements, they had not been in place long enough to fully achieve the desired results.

3.5.4 QA Audits

The DET evaluated audits by reviewing recent audit reports and plans, paying particular attention to the scope and depth of audits, the quality and quantity of audit findings, and the adequacy and timeliness of corrective actions. Overall, the QA audit program was weak, in that audits were based primarily on Technical Specifications and were compliance oriented. Further, the audit program did not provide the flexibility to allow auditors to use their individual experience and expertise in investigating potential problems. As a result, for the resources expended, relatively few safety-significant items were identified during 1989. Additionally, many items were not properly managed (by both the QA and the line organizations), and corrective actions, in some cases, were not timely or appropriate.

Two examples of items not receiving timely corrective action were:

- Corrective action request (CAR) 87-095, issued on September 22, 1987, reported a deficiency with regard to Final Safety Analysis Report (FSAR) commitments concerning the inspection and testing of fire barriers. The scope of this problem was not fully recognized by the QA or the line organizations until several months after the CAR had been issued. The corrective action due dates were extended many times, and the problem was finally escalated to the executive vice president level on July 14, 1989. Although many actions were taken to resolve this problem, the deficiency remained unresolved at the completion of the DE, more than 2 years after the CAR was issued.

- CAR 88-099, issued on November 10, 1988, reported a deficiency concerning the periodic review of site procedures. The QA organization issued several unsatisfactory responses to the line organization, and several followup inspections for closeout were performed with unsatisfactory results. The line organization was not aggressive in closing this deficiency and it remained unresolved at the completion of the DE.

The following items are examples of deficiencies that were not properly managed or for which the corrective action was inappropriate:

- The QA audit organization reported a safety-significant deficiency concerning steam generator sampling and nitrogen blanket problems at Unit 1 (see Section 3.6.4.2), in QDR 89-032. The slow corrective actions, including interim action, for this deficiency were indicative of a lack of urgency in resolving a safety-significant audit finding.

- Audit 89-008 identified several deficient health physics (HP) practices that collectively indicated a disregard of some HP fundamentals by HP personnel; for example, radiation protection (RP) monitors did not require personnel leaving the Unit 3 containment to frisk at the exit control point, two RP monitors removed a stepoff pad without wearing gloves (the stepoff pad had not been frisked) and disposed of the pad as radioactive waste without frisking the pad for contamination, and an RP monitor was working in a full-dressout area without wearing rubber gloves. No corrective action was required for these deficiencies. The audit indicated that the deficiencies were corrected on the spot, but failed to state what corrective action was taken, including action to prevent recurrence.

- Audit 89-005 identified an operability concern reported in engineering evaluation request (EER) 88-HJ-024. The concern was not resolved before the audit report was issued. No corrective action was requested for this deficiency and the concern was not resolved until the next audit of the area several months later.

- Audit 89-007 reported that there was a large backlog of work requests pertaining to out-of-service security equipment and that the Security organization's list of this backlog was inaccurate. This deficiency indicated that the Security group was not aware of the status of out-of-service equipment and was not aggressively pursuing equipment repairs. The audit report did not require corrective action for this deficiency.

- Audit 89-009 identified chemical spray addition vent and drain valves that needed to be in the locked-valve or surveillance program. The corrective action taken cleared the audit finding without investigation of other systems for similar deficiencies. (See Section 3.2.3.6.)

Although some efforts were made to improve the audit program, noteworthy results had not yet been obtained.

3.5.5 QA Surveillance (Monitoring)

The QA surveillance (monitoring) program at Palo Verde was revised recently to improve its performance-based aspects. Additionally, staffing was increased with three newly hired individuals with engineering and/or operations backgrounds. This new program was implemented during the last 2 weeks of October 1989. Even though the program was very new, the DET's review of recent monitoring reports showed that the new program was starting to identify technical and/or performance-based problems. Overall, the monitoring program had improved although one problem area was observed involving the use of corrected-on-the-spot (COTS) methodology to resolve deficiencies. The QA organization intended the COTS program to correct minor deficiencies of very limited safety significance. The deficiencies identified and corrected under this program were to be handled very informally. Under COTS, the monitor was to be responsible for obtaining corrective action for identified deficiencies. The monitor would then document the deficiency and the corrective action in the monitoring report, but would not issue a deficiency report. COTS-type programs, in general, fail to hold the line organization accountable for the deficiency, tend to make problems less visible, and should only be used for very minor deficiencies. In addition, the COTS program was not effectively implemented. The DET noted several specific cases in which the threshold for initiating a QDR had been reached; however, the monitors handled the deficiency by COTS. For example, monitoring reports 89-665 and 89-674 identified that the system status shown on control room drawings was not in agreement with the actual plant configuration. Monitoring report 89-693 noted that the maintenance staff was not signing off a work request/procedure as work proceeded. The licensee agreed that QDRs should have been issued for these examples.

3.5.6 Vendor Quality Assurance Program

The vendor quality assurance program, as a whole, was an area of strength. Palo Verde Quality Engineering (QE) personnel were very actively involved with the plant's suppliers through audits, source inspections, and QA program reviews. The QE review to firmly establish the receipt inspection requirements for specific purchases was a positive element.

Notwithstanding, one area of weakness in the program concerned the availability and use of vendor rejection data from the site receipt inspection process. Vendor rejection rates and detailed reasons for rejection were not formally tracked on a computer and were not readily available to all QA personnel involved in the procurement, vendor audit, and receipt inspection process. This weakness resulted in the inability of the licensee to:

- Adjust site receipt inspection requirements considering the specific vendor's history
- Change purchase order requirements to require specific vendor verification and signoff of attributes found to be previously deficient on the basis of the vendor's historical performance
- Take action to ensure that the vendor performed preventive and corrective actions for rejected material

These weaknesses are inconsistent with a strong vendor procurement QA program. Use of vendor rejection data will become even more important to the licensee after the implementation of corrective actions in response to Generic Letter 89-02, which will increase the technical content of receipt inspections.

3.5.7 QA Trending

QA trending was an area that showed improvement. Trending reports were being issued in a more timely fashion, and the format of the reports had been changed to highlight important problem areas. Extraneous data were removed from the reports and, as a result, the reports were reduced to a more manageable product. Increased visibility also was provided for older deficiencies. Consequently, increased senior management involvement in the corrective action process resulted in a decreasing number of open deficiencies (down from 207 in April 1989, to a low of 71 in September 1989, to 171 in November 1989) and in a reduction in the average age of outstanding deficiencies.

The new trending reports, however, did not identify significant new trends for management action and some quality deficiencies were omitted from the trending program. There were a large number of personnel errors in failure data trending (FDT) which were not captured in the QA trending reports (see Sections 3.6.16 and 3.3.5.2), and in several cases personnel errors were documented in work requests but not in QDRs. The result was that the QA trend graphs were not providing an accurate picture to management of the extent of site personnel errors. This weakness was considered to be the result of a lack of emphasis on the QDR program in the recent training given to maintenance personnel by the QA staff on the new MNCR/QDR programs.

3.5.8 Quality Control

The areas of QC that were evaluated by the DET were adequate. Responsibilities of the QC organization included inspection of hold and witness points in work requests, inspection and walkdown of modifications, and receipt inspection of new materials for installation in the plant. Most of the personnel in the QC organization had been at Palo Verde since the construction phase or were former construction contractors. To improve the organization, QC management intended to institute the "graded approach" to QC inspection. This new program will deemphasize the inspection of hold points (although hold points will still remain a part of the program) and will increase the use of witness points (random inspections) and surveillance-type inspections. QC findings will then be trended to determine where to best use inspection resources. Plans were to start this new program in the first quarter of 1990. This new initiative, if effectively implemented, should strengthen QC performance.

Two problems were noted in the QC area:

- There was no "after completion of work" review of work requests by the QC organization or any of the QA organizations. This review would be effective in resolving concerns and questions pertaining to work packages before the packages were closed out and permanently filed.

- The QC organization conducted a 100-percent, in-line, "before-work" review of work requests in an effort to correct the packages before they are implemented, and to insert inspection points in the package. The QC organization had conducted this review for the last 14 months and continued to find a significant number of deficiencies. Even though the licensee took a number of corrective actions and the QC organization had provided copies of its review checklists to the Planning Department and had trained some of the planners in its review techniques, the rejection rate for these reviews remained constant at about 17 percent. The fact that this problem had not been corrected over such a long period was indicative of the degree of weakness in the corrective action process. Use of inspection resources in this review, rather than holding the line organization accountable for the quality of its product, diverted inspection resources and slowed the process of correcting deficiencies in plant equipment. See Section 3.3.2. for additional discussion.

3.5.9 Problem Identification and Corrective Action

The new management team implemented a number of initiatives to strengthen problem identification and corrective action. New corrective action programs and a site escalation procedure were established. A policy of increased accountability for problem resolution was issued to all site personnel. The efforts resulted in improvement, although the following problems still persisted:

- o Weaknesses still existed in the problem identification area. Some of the problems included the following: (1) some issues were not addressed at all three units, (2) some conditions adverse to quality were not recognized, (3) some problems were not identified using trend information, (4) procedural guidance on actions to be taken for nonconforming conditions was not provided, (5) problems were not identified during review of tests, (6) problems were not identified during audits, and (7) the appropriate deficiency reporting document was not generated when required. (For specific examples, see Sections 3.2.3.3, 3.2.3.6, 3.3.5.1, 3.3.5.2, 3.3.10, 3.4.2.2, 3.4.3.3.1, 3.4.3.4, 3.5.4, 3.5.5, 3.6.6, 3.6.7.2, 3.6.7.4, and 3.6.7.8.)

- o Significant backlogs of deficiencies still existed, even though these backlogs had been reduced over the past several months. The backlog of QA/QC deficiencies was well defined, and the average age of deficiencies had been reduced. The total number of QA/QC deficiencies had been reduced from 207 in April 1989 to 171 in November 1989. At the close of the evaluation, 2288 EERs were open, which was down from a high of about 3500 earlier in 1989.

- o Problem resolution and implementation of corrective actions were slow. Technical evaluations by the line organizations were slow, and once completed, implementation of corrective actions by the line organizations was also slow. (See Sections 3.5.4, 3.5.8, 3.5.10, 3.6.2, and 3.6.4.)

- o The need to resolve problems quickly at the lower working level had not become a routine part of performance. (See Sections 3.5.4, 3.6.2, and 3.6.4.2.)

- o Root-cause analysis was weak. Often the investigation was stopped before the true root cause was determined. For some events, it was the repetition of those events that ultimately led to root-cause identification and correction. For other events, poor review and analysis prevented root-cause determination. (See Sections 3.2.5, 3.3.4.1, 3.6.4.1, 3.6.4.3, 3.6.4.4, 3.6.4.6, 3.6.7.2, 3.6.4.9, 3.5.4, and 3.5.11.)

These types of deficiencies were observed by all members of the DET and are documented in various sections of this report (see the sections referenced above).

3.5.10 Safety Review Committees

All of the oversight groups recognized the need for improved performance. Each oversight group, except the Plant Review Board (PRB), had developed a plan for improved performance that was well on its way to being fully implemented. The PRB, on the other hand, suffered from a lack of direction and was still struggling to develop its improvement plan. Although the overall performance of the groups was adequate and improving, several weaknesses existed.

As previously stated, coordination among the various oversight groups had improved during the past several months. This improvement was very important to both the Nuclear Safety Department (NSD) and the Independent Safety Evaluation Group (ISEG) because of the limited size of these groups.

Plant Review Board

As stated in the Palo Verde Updated Final Safety Analysis Report (UFSAR), Technical Specifications (TS), and PRB charter, the PRB was responsible for (1) review of all administrative procedures and changes, (2) review of all proposed changes to Appendix A TS, (3) investigation of all TS violations, (4) review of reportable events, (5) review of unit operations for potential nuclear safety hazards, (6) special review and inspection, and (7) review of prolonged operation with protection channels placed in bypass. Overall, the performance of the PRB was ineffective. This conclusion was based on the following:

- o Regarding the PRB meetings on November 8 and 15, 1989 which the team attended: The conduct of the meeting on November 8, 1989 was very weak, although the November 15, 1989 was much improved. Specific concerns identified in the first meeting were:

  - The PRB Chairman arrived at the meeting 10 minutes late.

  - Some board members did not participate in discussions of issues raised during the meeting; apparently they were inadequately prepared.

  - Sponsors or authors of items on the PRB agenda either were not present to address questions or issues raised or were not aggressive enough in responding to questions raised. This resulted in the rejection of a number of items that may have been shepherded through the meeting had proper support for the items been provided.

  - The meeting was continually interrupted by beepers sounding and people entering and leaving the room.

  - The meeting was unnecessarily interrupted for approximately 15 minutes because a fire alarm sounded. The alarm represented planned maintenance on the building's fire protection system and the interruption it caused could have been prevented by a public address announcement to disregard the alarm while the system was being tested.

  - The atmosphere of the meeting was casual and informal. A comment made during the meeting reflected a lack of professionalism.

- o The team also followed up on the deficiencies identified in a January 1989 contractor evaluation of the oversight groups. The items identified for PRB action, such as lack of documentation of board discussions in meeting minutes, slow distribution of meeting minutes, lack of programmatic controls to ensure that the PRB receives all of the material that it is required by TS to review, performing licensee event report (LER) trend review rather than reviewing each LER, lack of documentation and tracking of PRB unresolved items, lack of review of temporary modification and proposed changes in the composition of PRB, had received relatively little attention, and corrective action plans for many of the recommendations had not been firmly established or implemented.

o The DET also reviewed the Nuclear Safety Department's (NSD's) third-quarter assessment of PRB. Many of the items identified during this assessment were identical to items identified in the contractor evaluation, indicating that these weaknesses still persisted. This was confirmed by the observation of meetings and review of minutes. The response to this assessment was due to the NSD on November 10, 1989. On that date, the NSD extended the due date to November 28, 1989. On November 28, 1989, the NSD received a draft reply to the assessment, which it considered to be unacceptable, although the response was positive in regard to correction of the identified problems. A final satisfactory response, including a corrective action plan, was given to the NSD on December 8, 1989.

Independent Safety Engineering Group

As specified in the Palo Verde UFSAR, TS, and ISEG charter, the functions of the ISEG group were to (1) examine plant design and operating experience that may indicate areas for improving plant safety, (2) perform independent review and audits of plant activities, (3) aid in the establishment of programmatic requirements for plant activities, (4) maintain surveillance of plant operations and maintenance activities, (5) detect potential nuclear safety hazards, and (6) develop and present detailed recommendations to corporate management. The ISEG manager reported to the Vice President, Nuclear Safety and Licensing.

Overall, the ISEG was becoming more effective. A review of selected ISEG reports indicated that recent ISEG reports were more operationally oriented, referenced applicable industry and site operating experience, were thorough and generally technically correct, provided reasonable and thoughtful recommendations, and were being reviewed and commented on by the licensee's upper-level management. More emphasis was being placed on being pro-active, but some ISEG studies were still late (i.e., those in response to plant events or to the findings of outside agencies).

The ISEG identified some safety-significant problems and items were being resolved in a more timely manner. This conclusion was based on a review of recent ISEG reports, comments in recent NRC inspection reports (IRs) (e.g., IR 50-528/89-28, 50-529/89-28, and 50-530/89-28), and discussions with licensee personnel from the NSD who had recently assessed ISEG effectiveness.

Under previous management, the ISEG was understaffed and inappropriately qualified, with little upper-management support. Recent efforts to improve ISEG effectiveness appeared to be working. Given the many time-consuming initiatives to improve the ISEG, such as a major revision of the ISEG program and associated training in the new methodology, coupled with the many personnel changes within the ISEG (only the manager and one engineer had been in the group for more than 9 months at the time of the DET visit), if the initiatives were effectively implemented the group's productivity would noticeably and continually improve. Indicative of the new management's support, the ISEG had received approval for adding three engineers to its staff in 1990.

Lack of timeliness in evaluating and implementing ISEG recommendations by the line organization continued to limit its impact on improving plant performance. For example, in regard to ISEG Special Review Report (SRR) 87-01, the line organization's response was slow and the ISEG tracked commitments poorly. A response to recommended corrective actions for SRR 87-01 was requested by letter on October 19, 1987 (specifically, ISEG recommended that certain changes be made to the procedures controlling the design change package [DCP] process). On April 20, 1989, the Nuclear Engineering Department (NED) responded that existing controls were adequate and that no action was needed. On June 22, 1989, the ISEG responded to NED that the controls in place were "either not being followed, not being enforced, or both." During the second DET visit, the team was informed that NED had agreed to the revisions and that a completion date of March 31, 1990 had been agreed on. If this date is met, it will have taken approximately 2½ years to make relatively minor changes to procedures. In the interim, the problems continued to affect ongoing and planned work.

Inadequate engineering and technical evaluation in support of the implementation of corrective actions in response to ISEG reports also limited the effectiveness of ISEG. For example, in response to independent safety evaluation special investigation 89-01 which recommended installation of check valves to prevent spent fuel pool draindown events, the Engineering Evaluations Department (EED) responded that it would be "just as effective to add one or more of the three isolation valves to the locked-valve program." The isolation valves were already in the locked-valve program and this fact was stated in the ISEG report.

The ISEG did not ensure the adequacy and implementation of interim corrective actions needed to solve problems for the short term. Coupled with the excessive time required at Palo Verde to implement permanent fixes such as hardware or procedural changes, this allowed some problems to fester.

Nuclear Safety Department

As specified in the Palo Verde FSAR and TS, the functions of the NSD were to provide independent review and audit of designated activities in the areas of nuclear power plant operations, nuclear engineering, chemistry and radiochemistry, metallurgy, instrumentation and control, radiological safety, mechanical and electrical engineering, and quality assurance practices. The NSD, in practice, served as the group overseeing the other oversight groups, including the QA/QC organization. NSD consisted of a manager, four engineers with college degrees, and an administrative assistant. The NSD manager reported to the Vice President, Nuclear Safety and Licensing.

Overall, the NSD staff was highly qualified and was providing adequate oversight, including constructive criticisms and reasonable recommendations for improving the areas for which it was responsible. The NSD assessments of the PRB, the ISEG, and the OER program, for example, were similar to the conclusions reached by the DET. Partly in response to the NSD, the other oversight groups had improved. This represented a stronger NSD because historically, NSD did not have the management support to get its recommendations implemented.

Some of the recent improvement initiatives undertaken by the NSD included the use of a contractor to assess and recommend improvements for each of the oversight groups, and increased emphasis on the "vertical slice" methodology. Although not specifically an improvement initiative, the NSD had received approval for increased staffing in 1990.

3.5.11 Operating Experience Review

The OER program, had improved greatly although much remained to be done. Numerous plant events or cases of degraded equipment occurred in the past year that might have been prevented or reduced in severity by benefitting from "lessons learned" or by performing adequate and timely evaluation and corrective action. Continued management attention to improve the limited effectiveness of the OER program was warranted. The lack of representation from the various OER program elements to the project self-assessment group (PSAG) coupled with the fragmented nature of the OER program contributed to the limited effectiveness and "lack of a big picture perspective" of both the OER program and the QA/QC organization. As a result, relatively few problems or potential problems were identified or resolved at Palo Verde.

The OER program consisted of four basic parts: (1) the review of industry operating experience (e.g., INPO SOERs, INPO SERs, INPO O&MRs, and GE and CE SILs) which was coordinated by the Technical Data Department; (2) the review of NRC documents (e.g., INs, Bulletins, GLs, and selected NUREGs) which was coordinated by the Licensing Department; (3) the usage of the nuclear plant reliability data system (NPRDS) which was system coordinated by the Nuclear Engineering Department (NED); and (4) the incident investigation program (IIP) implemented by the shift technical advisors. The NPRDS is discussed in Section 3.6.16. The team did not review the IIP.

The NRC, in various inspection reports and the 1989 SALP report, criticized the licensee for its response to many operating experience issues (from internal and external sources) including the following:

- In regard to Generic Letter 88-07 concerning mid-loop operations, the licensee failed to recognize that operating procedures, organizational interfaces, and operating policy needed to be changed.
- The licensee had not received or evaluated relevant service information letters (SILs) pertaining to emergency diesel generator (EDGs) for applicability; hence, the recommendations in the SILs could not have been implemented.
- The NPRDS and operating experience were not extensively used by maintenance, system engineering or nuclear engineering personnel.
- The response to NRC Bulletin 88-04, "Potential Safety-Related Pump Loss" regarding Ingersoll-Rand pumps was repeatedly delayed; the response to Generic Letter 88-14, "Instrument Air Supply System Problems Affecting Safety-Related Equipment," was limited in scope and did not address all pertinent issues.
- The response to Information Notice 88-65, which described spent fuel pool (SFP) drainage events, was technically inadequate in that it failed to identify any vulnerabilities at Palo Verde. Two SFP drainage events subsequently occurred at Palo Verde.

Because these and other issues were not effectively addressed, several significant operating events occurred at Palo Verde that could possibly have been avoided or could have had less significance. An example was the March 3, 1989, event involving the atmospheric dump valves (ADVs) (similar problems have existed at Palo Verde for several years) and the air system (similar issues were raised in Generic Letter 88-14).

In the past, the ISEG was responsible for reviewing industry operating experience. Because the ISEG was understaffed and lacked an effective mechanism for escalating slow responses, the ISEG process was slow. In addition, items were closed out without 100-percent verification of the technical adequacy or implementation of corrective actions. As a result, this program was extremely weak.

In early 1989, the industry OER function was removed from the ISEG and given to the Technical Data Department. The Technical Data Department initiated many improvements to the industry OER program including the following: preparing OER books by system and discipline, performing surveys to determine effectiveness of operating experience feedback in reaching its target audience, and implementing as much of the OER process as possible, including corrective actions like simple procedural changes, before distributing the item to the assigned line organization for review. Items were tracked, elevated to upper management if responses were slow, and items were 100-percent verified for implementation before they were closed out. Areas that still needed improvement existed. A tracking mechanism was not in place to prevent OER commitments or lessons learned from being discarded in the future (removed during procedural or program revisions). The reopening of previously closed items caused some backlog. Industry OERs were handled primarily by contractors. The transition to a permanent staff was scheduled for 1990. During interviews, the licensee's staff expressed some concern that the permanent staffing level might not be sufficient to handle the demands of the program. As with some of the criticisms of other oversight groups, some criticisms of the industry OER program with regard to technical adequacy and timeliness were more appropriately given to the line organizations. The supervisor of technical data was not on the distribution list for NRC inspection reports or SALP reports and was not aware of many of the criticisms of the OER program in these reports. Finally, as identified by the NSD, no one was performing a "big picture" assessment of events that recur because of the lack of a strong interface between the various OER program elements. The present program was notably improved, but still relatively weak because of the items described above.

The Licensing Department was responsible for coordinating the review of NRC operating experience documents. This program received high priority in the past because of its regulatory nature. The Licensing Department primarily assigned the document to the appropriate department for review and implementation of corrective action and tracked the status of the item. Closeout generally consisted of a "reasonableness" check and a documentation review (e.g., review of the letter signed by a responsible party that the item had been implemented), rather than a verification that all items had been implemented and were in place. Some of the criticisms of this program in the past were attributable to the fact that a backlog was allowed to develop in 1988 as a result of competing priorities. The program appeared to be functioning as designed. Recent criticisms of the timeliness and technical adequacy of closeout, as in the industry OER program, fell more appropriately to the line organizations. In 1990, the industry and NRC programs are scheduled to be combined under the Technical Data Department, although the Licensing Department will still provide much of the coordination for NRC documents. This is a positive step.

3.6 Engineering Design and Technical Support

The Diagnostic Evaluation Team (DET, the team) reviewed adequacy and timeliness of engineering support by reviewing documents, conducting interviews, and performing system walkdowns. Emphasis was placed on review of the diesel generator and related support systems. The DET chose these systems because the licensee had recently completed (November 1989) design-basis reconstitution on the diesel generator system. The design evaluation of these systems provided in part, an evaluation of the thoroughness of the licensee's design-basis reconstitution program. In addition, the team reviewed the adequacy of engineering support to the site to identify, resolve, and correct deficiencies or problems in a timely manner.

3.6.1 Engineering Organizations - On Site

Onsite engineering was provided by the Standards and Technical Support Division, primarily within the Engineering Evaluations Department (EED). The Director of the Standards and Technical Support Division reported to the Vice President of Nuclear Production who in turn reported to the Executive Vice President (see Figure 1.5-5). The EED was made up of six subsections, including Technical Support Engineering, Reactor Engineering, Balance of Plant Mechanical Systems, Electrical Systems, NSSS/Mechanical Systems, and Instrumentation and Control Systems.

3.6.1.1 Engineering Evaluations Department

The EED was comprised of approximately 87 people and was approved to increase in size to 140 during 1990. Engineering personnel within EED appeared to be qualified for their positions in terms of education and years of experience and compared favorably in this regard to the technical support staffs of well-performing nuclear utilities. The licensee indicated that the engineers to be hired will hold college degrees, which will help raise the educational level. Within EED were approximately 53 systems engineers (SEs). Given the current workload, EED was understaffed and overworked; however, the staffing level of SEs was expected to increase to 70 during 1990, which should relieve some of the heavy workload on key individuals. Because EED has been expanding over the last two years, one-half of the current supervisory personnel had less than one year in their current positions. Continual management changes seem to have impaired both morale and productivity. One person stated that he had had six directors and four managers in the six years he had worked at Palo Verde, with corresponding changes in direction that lowered morale and efficiency of the section. Still more organizational and supervisory changes were being planned for EED at the close of the evaluation.

A common view within EED held by various auditing groups was that EED was understaffed and overworked given the required or assumed responsibilities; this was particularly true among personnel who had system responsibilities. The SE program was developed in 1988 to provide better engineering support to the site; however, its potential had yet to be realized. In October 1989, an independent consultant was hired to assist in sorting through and identifying the issues that were hindering the successful implementation of the SE concept. The SE support of the program has been weak, and expectations of the customer organizations conflict with the goals and objectives of the SE program.

Several weaknesses tended to diminish the quality, quantity, and timeliness of engineering support provided by EED. These included:

(1) A large backlog of engineering evaluation requests (EERs) consisting of largely insignificant issues

(2) Inadequate control/screening of EERs forwarded to EED for resolution

(3) Realistic responsibilities and authorities had not been defined for the system engineers due in part to inadequate management control of work assignments. For example, procedure 730G-0ZZ01, "Engineering Evaluations Organization and Responsibility Policy", Revision 0, did not agree with actual work being performed in EED. The procedure required that EED provide technical support services to plant operations, maintenance, and modifications work, to include initial plant change request evaluations, coordination of minor modifications, and conduct of testing services. System engineers had, with time, assumed too many inappropriate responsibilities related to routine maintenance activities, each having conflicting priorities.

    Also, procedure ES10.00, "System Engineer Program," Revision 0, gave a very extensive listing of the responsibilities of the SE within the EED and was in conflict with procedure 730G-0ZZ01 (above). Procedure ES10.00 required (among other things) that the SE maintain a cognizance of all engineering and maintenance work associated with assigned systems, serve as the focal point for technical and engineering information as well as current system status, to proactively identify and resolve problems related to assigned systems, function as the test director on selected surveillance tests or performance tests, to advocate the timely completion of engineering and maintenance activities conducted on assigned systems by monitoring task priorities and progress, and to be responsible for EERs, temporary modifications, site modifications, plant change requests, plant change packages, and special plant event evaluation reports.

(4) Inadequate staff to handle the assumed workload (current plus backlog) as mentioned in item 3 above

(5) Conflicting work priority systems between engineering (onsite and corporate) and site organizations

(6) Lack of a stable management workforce, including stable policies, practices and direction

3.6.1.2 Resident Nuclear Engineering Section

Resident Nuclear Engineering (RNE) was an onsite engineering section within the Nuclear Engineering Department (NED) that reported to the Manager of NED (offsite) who in turn reported to the Director of Engineering and Construction and the Executive Vice President (see Figure 1.5-6). The RNE group was in the process of staffing up and had not yet defined its function in detail. Consequently, the DET was unable to assess the support or long-term effects of the newly created organization. Procedure 81OG-0ZZ01, Revision 1, "Nuclear Engineering Department Organization and Responsibility Policy," had not been revised to explain the goals and responsibilities of RNE. A draft document listing some of the responsibilities of RNE was provided to the Engineering Assurance group (part of NED) for review and incorporation into procedure 81OG-0ZZ01. The expected responsibilities of RNE included providing immediate onsite design engineering support (including, in part, EER disposition, material nonconformance report (MNCR) evaluation, design change preparation, design change implementation support, and engineering task coordination and resolution), providing a single point of contact for onsite organizations, representing NED on site, and coordinating both planned and unplanned outage support to include backshift support.

The anticipated workscope of RNE, overlapped with the responsibilities and authorities of EED and corporate NED. As a result, the DET expects continued confusion as to roles and responsibilities of groups providing engineering support to Palo Verde.

On the basis of interviews with both site and corporate personnel, RNE was not being fully utilized. Onsite personnel tended to use proven sources whether the source existed in EED or corporate NED. The same was also true for communications between the corporate group and the site group. As mentioned above, there was an overlap of functions between EED, RNE, and corporate NED which needs to be resolved.

3.6.2 Engineering Organizations - Corporate

Engineering support for Palo Verde was controlled within the Division of Engineering and Construction, in the Nuclear Engineering Department (see Figure 1.5-6). The DET reviewed only the activities being performed by the Nuclear Engineering Department, as discussed below.

Nuclear Engineering Department

The Nuclear Engineering Department reported to the Director of Engineering and Construction who in turn reported to the Executive Vice President (see Figure 1.5-6). NED personnel appeared to be qualified for their positions in terms of education and years of experience, although many lacked actual nuclear design experience. Because of the heavy backlog of work assigned to NED, the licensee was forced to hire contractors to perform a large portion of work and was in the process of hiring additional company employees and contractor personnel. The number of staff (direct employees) was recently approved to increase from the current 152 to 192 for 1990.

To meet increasing demands to be more productive, NED continued to make supervisory personnel changes as the staff was built up. At the time of the evaluation, approximately half of the supervisors had been in their positions four months or less. In addition, at the close of the evaluation, additional supervisory changes were being planned.

While it has been a goal of NED to reduce its reliance on contractor support and accomplish more work in-house to build up a greater technical base, the licensee has had to greatly increase the number of contract personnel in an attempt to reduce the backlog of work, which was recently discovered (July 1989) to require 400,000 man-hours of effort to resolve. Over half of the NED work force was supplied by contract support from at least 19 separate vendors. With the addition of over 100 contractors to work off the backlog (primarily EERs), it appeared that NED would have adequate staff to handle the workload.

The type of plant support provided by NED has changed radically within the last two years when the transition from a construction project to an operating plant mode was accentuated by a major reorganization in November 1987. The role of NED changed from project management and review of work performed by the architect-engineer and nuclear steam supply system (NSSS) vendor, to direct technical responsibility. As this transition progressed, resources became strained and the backlog of work rapidly grew. An evaluation was performed by a contractor in mid-1988 which resulted in the establishment of the Engineering Excellence Program designed to improve plant support and communications.

A number of weaknesses have existed and will continue to exist until improvement programs have a substantial effect on work practices and products. These include:

(1) Inadequate attention to detail in engineering evaluations

(2) An excessive backlog of engineering work in the areas of EERs and modification-related activities that were not well managed or tracked in the past

(3) Lack of urgency and team work in addressing engineering problems and providing plant support

(4) A slow, cumbersome, and complex process for problem resolution

(5) An insensitivity to operability and reportability considerations within NED

(6) Unclear guidance as to what function and authority an NED system engineer (responsible engineer and backup engineers) should have

3.6.3 Engineering Evaluation Requests

The primary method to document problem identification, resolution, and corrective action was the EER which was controlled by procedure 73AC-0EE01, Revision 1. EERs provided a means to request technical clarification and/or an evaluation from EED. EERs may be initiated by any licensee direct or contracted employee and were required to be controlled, tracked, and trended by EED. The EER system was ineffective and was "overwhelming" the SEs with paperwork. Plant personnel attempted to resolve many minor issues using the EER process, which resulted in SEs being overloaded with low-priority tasks, in conjunction with crises situations. It took an inordinate amount of time to resolve problems which, in addition to the lack of resources, supervisory direction, and motivation, resulted in low morale on the part of many of the engineers.

The DET identified a number of weaknesses with the program and its implementation, which are discussed in the following paragraphs.

3.6.3.1 Engineering Work Prioritization

One of the most significant overall organizational weakness was the absence of an integrated, department-wide work prioritization system. Although prioritization systems have existed in the Nuclear Department since the early days of commercial operation, as late as one month before the start of the diagnostic evaluation none were department-wide. Each system was unique to its individual group. The inevitable result was that each group was working on its own highest priority items with, at best, inconsistent coordination with other groups.

Approximately one month before the start of the diagnostic evaluation, a department-wide priority system was finally initiated, but it was for modification work only. This system addressed none of the other work in the department that must be integrated across group boundaries, work such as EERs. Since modifications represented less than half the work transpiring between interfacing groups, more than half of this type work was still not covered by an integrated, department-wide system.

Most of EEDs efforts involved reacting to whichever plant submitted an assistance request first or whoever applied the most pressure to obtain engineering support. Consequently, because of the extended outage of all three units, it became necessary for the Vice President, Nuclear, to mandate the priority for the critical path EERs among the three units to ensure startup of the plant having highest priority. NED also had a system for prioritizing EERs but, as explained by the electrical backlog coordinator, this method involved contacting each of the electrical engineers within NED, determining which EERs were over 60 days old, and forwarding them to one of three major contractors for resolution.

Another weakness in the EER process was that anyone in the organization, regardless of their position or technical knowledge, could write an EER for any situation that was considered questionable. The licensee was not effective in screening out frivolous or irrelevant EERs or rerouting them to other organizations if they were not engineering related. Under the present system, for those inclined to take advantage of it, the EER provided a convenient mechanism to delay or unload work responsibilities on the engineering group, which rightfully should be handled by its own or other organizations. This practice, accepted by the engineering group, had been a significant contributor to the accumulation of the large EER backlog faced by engineering.

3.6.3.2 Review of Outstanding Engineering Evaluation Requests

At the close of the evaluation, a total of 2288 EERs were open: 1447 were assigned to EED, 643 to NED, and 198 were in other organizations. The DET determined that much of the time spent by engineering personnel to resolve various open EERs was a misuse of resources. The following is a list of EERs (still open during the evaluation period), some of which should not have been issued in the first place, or once issued, should have been resolved and corrected within a short period of time.

EER NUMBER	ISSUE DATE AND CONCERN
85-XM-005	August 13, 1985, the installation of a trailer for the rad protection group
86-ZZ-023	May 19, 1986, a 1 x 3 metal tag for rigging was difficult to work with
86-AS-025	August 10, 1986, a cork gasket material had rotted
86-FH-022	November 5, 1986, manuals do not provide coupling fastener torquing information
86-EC-018	November 15, 1986, were tube fittings compatible and interchangeable
86-FP-120	December 8, 1986, system cleanliness was indeterminate
87-OW-001	January 9, 1987, the tech manual and vendor do not agree on impeller size
87-FW-004	February 27, 1987, drawings need to be updated to reflect feed water line removal
87-ZZ-067	June 22, 1987, a fluorescent bulb could not be replaced because a grating was in the way
87-HA-026	October 12, 1987, the air handling unit has vibration levels above acceptable limits
87-HN-009	December 7, 1987, the cooling towers need a complete refurbishment
88-SI-023	February 3, 1988, a valve operator failed during MOVATS testing
88-SB-064	August 1, 1988, the trip set point for high pressurizer pressure is 8.44 V dc but should be 8.180 V dc. Attempts to adjust within tolerance were unsuccessful
89-MT-003	March 5, 1989, a torque switch was improperly set during maintenance due to the disposition of EER 85-MT-043

The licensee did review approximately 2500 open EERs in October 1989, primarily to determine which had an impact on Unit 3 startup from a Technical Specifications/safety function standpoint. The review also identified open EERs that were transferred to the material nonconformance report (MNCR) system. On the basis of information available from the licensee at the time of the review, a total of approximately 90 EERs were identified as having a potential affect on the unit (1, 2, or 3) restart, of which 37 were related to Unit 3. For Unit 3, 15 EERs potentially affected the Technical Specifications, FSAR, turbine trip, or reactor trip. Nine of the fifteen were still open (corrective action incomplete or indeterminate) as of January 5, 1989. The review also identified 17 EERs that could not be located and 127 potential MNCRs.

As part of the Engineering Excellence Program, the licensee has committed to reducing the EER backlog principally through the use of contracted support and improved screening of future EERs. The backlog reduction effort was scheduled for completion by October 1990. Review of the current reduction rate indicated that this objective would be difficult to achieve.

3.6.4 Corrective Action Support

Engineering support (both corporate and site) to resolve component or system deficiencies or failures was examined through interviews, EER reviews, licensee event reports (LERs), and recent events. As much as possible, the team examined events that occurred during the evaluation period to best assess engineering. Commitments to various regulations require that the licensee perform two basic functions with regard to conditions adverse to quality: (1) Determine the causes of the conditions and (2) take corrective action to preclude recurrence. Although the engineering organizations had the capability to identify the causes of conditions adverse to quality as evidenced by adequate responses to LERs, there was an overall inability to take timely, effective corrective action to resolve component or system deficiencies or failures. This was considered a major programmatic weakness. The DET found several instances that demonstrated this inability. The following is a brief discussion of both positive and negative findings in this area.

3.6.4.1 Diesel Generator Rocker Arm Failure

On January 4, 1989, during routine testing of the Unit 3 diesel generator A while the reactor was in Mode 1, the exhaust rocker arm for the 8L cylinder failed, resulting in a trip of the diesel generator. Inspection revealed that the failure was due to a crack which was determined to be a manufacturing defect. No inspections were performed on the remaining rocker arms at that time. The defective rocker arm was replaced, and two attempts were made to restart the engine. Both attempts failed when the unit tripped on high vibration. The trips were found to be due to a previously undetected turbocharger failure which had occurred as a result of the rocker arm failure.

On January 7, 1989, Unit 3 was shut down (cold) per the Technical Specifications. On January 11, 1989, one week after the initial failure, the remaining rocker arms on the 3A diesel generator were finally inspected, and another cracked exhaust rocker arm was found on the 9R cylinder. It and the turbocharger were replaced, and the engine was returned to service on January 12, 1989. On January 14, 1989, the 3B diesel generator rocker arms were inspected, and on January 16, 1989, the rocker arms in Units 1 and 2 diesel generators were inspected. No additional defective rocker arms were found. During this time both Units 1 and 2 were in Mode 1.

Although the cause of this failure was quickly identified, timely, appropriate action was not taken. Timely, appropriate action would have been to immediately inspect the other rocker arms on the failed engine and then promptly inspect each of the other engines in turn. This was not done. Had the initial attempts at restarting not been foiled by the failed turbocharger, it is questionable if any further rocker arm inspections would have been performed.

3.6.4.2 Steam Generator Chemistry Control

The layup and chemistry testing of the steam generators in Units 1 and 3 were not maintained, in accordance with procedures, during recent extended periods of plant shutdown. The lack of adequate chemistry control was the result of inaction or inappropriate action by chemistry, maintenance, plant management, and engineering.

On November 1, 1989, quality deficiency reports (QDRs) 89-0031 and 89-0032 were written by the Quality Audits group identifying that the condition described above existed in Units 1 and 3, respectively. In Unit 3, the nitrogen overpressure blanket required by procedure 74AC-9CY04 (Revision 0) "Systems Chemistry Specifications" had not been maintained since around May 1989. In Unit 1, in addition to the nitrogen overpressure blanket not being maintained, sampling three times per week required by procedure 74 CH-9XC16, "Sampling and Analytical Schedule," had not been performed for 7 weeks since September 25, 1989. Additionally, the team learned that steam generator No. 2 in Unit 3 was not sampled for 9 days during this period. At the time of the team's initial assessment of this condition on November 15, 1989, the nitrogen overpressure blanket had been restored to the Unit 3 steam generators since November 4, 1989. However, at that time, nitrogen still had not been restored to the Unit 1 steam generators, and sampling of the Unit 1 steam generators was not resumed. Recirculation and sampling were restored on steam generator No. 1 on November 17, 1989 and on No. 2 on November 19, 1989. Subsequent chemistry samples were found to be within specifications.

The nitrogen overpressure blanket had been secured in both units to accommodate outage maintenance work being performed. According to the licensee, this work not expected to last more than a few days. However, delays and additional maintenance work prevented reestablishment of the nitrogen due primarily to a concern for personnel safety and were conscious management decisions. The securing of recirculation and sampling was attributed to maintenance which had to be performed on a drain valve in the blowdown line on steam generator No. 2. After the valve had been disassembled, it was discovered that a stainless steel yoke bushing nut required replacement, and the exact replacement part was not available in the parts warehouse. Since no immediate efforts were made to either obtain the exact replacement part from another source or to substitute a different part, the work was not completed, and recirculation and sampling could not be performed.

An environment that could allow such neglect to persist for so long indicates a number of programmatic and management weaknesses, including (1) failure to follow plant procedures, (2) failure to plan for foreseeable contingencies, (3) The chemistry supervisor, the operations supervisors, the system engineers, the outage manager, the work planning group supervisor, did not take responsibility for the system and for seeing to it that corrective actions were taken in a timely manner. No one appears to have "owned" the steam generators, (4) failure of the parts organization to support plant operations, (5) lack of timely response to two QDRs on the steam generators were written on November 1, 1989. The licensee acknowledged that actions taken to maintain chemistry control were inadequate and untimely.

3.6.4.3 Emergency Diesel Generator Starting Air Compressor

The DET discovered by questioning the licensee that repetitive failures had occurred over several years with the starting air compressors. This is a generic problem area with Cooper-Bessemer diesel generators. It appeared that the root cause of these failures had not been identified, and even though the compressors had always been repaired or replaced when they failed, no corrective action had been taken to preclude repetition of the failures. The DET also found that the failures had occurred so often that, in 1988, the Operations group produced a Technical Specification interpretation to cover the condition where half of the starting capacity was out of service since outage of this equipment occurred so often. Consequently, this equipment condition did not conform with the description of the system in the FSAR. Compounding the problem was the lack of a cross-connect feature in the design which would allow one compressor to supply both accumulators and thus not degrade the starting capability. Design weaknesses which appeared to be the root cause of these compressor failures are described in Section 3.6.7.2.

3.6.4.4 Chronic Linear Calibration Switch Concerns

On October 31, 1989, Unit 2 was operating at 67 percent power when a reactor trip occurred. The licensee prepared Incident Investigation Report (IIR) 2-2-89-002 to evaluate the event. It became evident to the team that if adequate corrective action had been taken prior to the trip, the trip could have been prevented.

Several EERs had been written documenting longstanding problems with the linear calibration switches (LCSs). Related documents supplied by the licensee indicated that repeated problems had occurred at least since July 11, 1987. Related EERs (87-SE-019, 88-SE-018, 88-SE-019, and 87-SE-022) requested that a root cause of failure (RCF) analysis be performed to determine the cause of the LCS problems. However, an RCF was not performed. Not until EER 89-SE-003 (Unit 3) was initiated on March 1, 1989, was an RCF analysis documented as having been performed. This EER caused several actions to take place. The RCF analysis completed by EER 89-SE-003 was dispositioned on August 22, 1989. A contractor performed engineering analysis indicated that the LCS was not designed for low-current applications (as required in the Palo Verde application). An additional EER (89-SE-006) was subsequently dispositioned on August 29, 1989 by NED identifying the replacement switches and requested EED to initiate a plant change request (PCR) to implement switch replacement. A PCR was initiated by EED but it was subsequently cancelled by the Plant Modification Committee (PMC) on September 19, 1989. Subsequently EED was directed to issue an equipment change evaluation (ECE) to install new switches instead of doing a design change. Corrective action was not taken until after the reactor tripped on October 31, 1989 when the channel B middle excore detector input to core protection calculator (CPC) B failed low, causing a trip of the departure from nucleate boiling ratio (DNBR) parameter on the channel B plant protection system (PPS). The Channel B middle excore detector input failure was attributed to an intermittent failure of the LCS.

Subsequent to the reactor trip, the licensee implemented a temporary modification on all four of Unit 2's excore safety channels which bypassed the detector isolation contacts of the LCS. Final installation of the new LCSs was expected to take place in February 1990 under the aforementioned ECE.

3.6.4.5 Bent Valve Stems on Auxiliary Feedwater MOVs

Four auxiliary feedwater flow control valves were discovered to have bent valve stems within a period of a week. During performance of surveillance test 36ST-9SA98, difficulties were experienced with the motor-operated valve (MOV) breaker tripping. Troubleshooting on valve 3AFBHV030 eventually determined that the motor was burned out and that torque switch settings were not maintained. During the troubleshooting period (October 31 through November 5, 1989), no one recorded basic parameters such as torque switch settings and general as-found conditions. On November 4, 1989, a meeting was held which included the IED SE, to develop an action plan. Later that same day, it was discovered that the valve stem was bent and had a runout of 0.250 inch.

Attempts were made to replace the valve stem with a stem that was removed from valve 1AFAHV033 (Unit 1 valve), since Unit 1 was in a refueling outage; however this stem was also found to be bent. A new stem was procured for valve 3AFBHV030 and was installed. Engineering had not resolved the stem bending phenomenon prior to cycling the valve (3AFAHV033) which resulted in bending the replacement valve stem. Additional inspections indicated that the stems installed in valves 2AFBHV031 and 3AFBHV031 were also bent. Initial design calculations indicated that the stems should not have bent even under worst-case conditions; however, a contractor later (December 5, 1989) indicated that the valve stem would bend, and that the valve stems should be replaced with a higher strength material. The licensee was planning on issuing an ECE to replace the valve stems during the next outages.

An EER documenting the motor problems was not issued until November 7, 1989, and the EER documenting the bent stem problem was not issued until November 12, 1989. At the close of the evaluation, both EERs were still open and a root cause analysis for either EER had not been performed. The licensee predicted that the analyses would be completed by the end of January 1990.

3.6.4.6 Fuel Oil Day Tank Level Controller

Local annunciators "DG Fuel Oil Day Tank Room A Flow Low" (identical for room B) were illuminated continuously. Three work requests identified a problem where the fuel oil day tank level controller for the 3A diesel generator controlled the level too high during operation. In subsequent troubleshooting with the engine not running, the controller performed correctly. There was no indication that the problem was resolved or that the Engineering group became involved in finding a resolution. The licensee originally identified this problem in June 1986.

The licensee acknowledged that a weakness has existed regarding timely corrective action. As a result, several new programs have been developed which address this concern, including the new MNCR program which required an evaluation of a material non-conforming condition to be evaluated within 24 hours of discovery and a final disposition to be completed within 14 days.

3.6.4.7 Inadequate Chemistry Control of Essential Spray Pond

The chemical addition systems for Units 1, 2, and 3 essential spray ponds have been inadequate to maintain system chemistry and reduce corrosion rates. They have been inoperable for approximately 4 years due to initial poor design of the system. Manual bulk chemical additions were being used to maintain proper chemistry control which, in turn, caused accelerated corrosion rates on system heat exchanger tubes and localized structural degradation of the spray pond concrete liner. To recirculate the chemicals, the spray pond pumps had to be run daily. After repeated audit findings within the last 2 years (including INPO), a PCR was initiated on February 1, 1989, followed by design change packages 1, 2, 3-FM-SP-058 on September 19, 1989. As an interim fix, the licensee installed a temporary modification in May 1989 to provide sulfuric acid and chemical addition for each spray pond. The permanent modification was expected to be installed in all three units by April 1990.

3.6.4.8 Circuit Breaker Design/Maintenance

The licensee had identified failed and cracked welds in type AM 4.16 (4160-V) circuit breakers in each unit, and was investigating the cause of weld failure to determine whether the failures were caused by improper weld design or improper weld procedures or processes. Eight circuit breakers were identified with cracked or failed welds in Unit 1; information provided by the licensee indicated an equal number in Units 2 and 3. The licensee's procedures for review of conditions adverse to quality for reportability pursuant to 10 CFR 21 (procedures 6I417.18.01 and 94AC-OLC02) required that the Independent Safety Evaluation Group (ISEG) review conditions adverse to quality and request NED to determine reportability under 10 CFR 21. The DET received no documentation indicating that ISEG had reviewed the AM 4.16 circuit breaker weld failures, or that NED had performed the required 10 CFR 21 reportability determinations.

3.6.4.9 Spray Pond Pump B Circuit Breaker

Corrective action/root cause analysis was inadequate regarding the spray pond pump B circuit breaker (PPB-504C). The breaker had closed several times during safeguards testing without operator action. At least two work orders had been issued to troubleshoot and repair the breaker without success. The SE from EED was not notified of the problems with the breaker until several months had passed since the symptoms were first noticed. EER 89-PB-021 was issued after the DET questioned the licensee concerning adequate corrective action. Root cause of the inadvertent breaker operation was not determined while the team was on site.

3.6.4.10 LER 530/89-007," Malfunctioning Relays"

This LER was initiated on May 5, 1989 as a result of Potter-Brumfield MDR 7000 relays failing to operate. The licensee's Engineering group, with the assistance of the manufacturer, determined that the relay rotor and stator were contaminated with epoxy during manufacture. Once Engineering personnel became involved in the issue, adequate attention was given to finding the root cause of the failures, and corrective action was taken. The installed relays were redesigned MDR 7000 series relays having epoxy-coated coils. The relays were redesigned as a result of corrective action required to resolve LER 88-018 documenting the malfunction of Potter-Brumfield MDR relays having varnished coils.

The licensee has located all MDR relays on site, initiated a test program to identify contaminated relays, and has replaced those that failed to test satisfactorily.

3.6.4.11 LER 528/89-012, "Emergency Lighting Deficiencies"

On May 10, 1989, the licensee identified 24 areas in each unit where the emergency lighting system did not meet the design bases or 10 CFR Part 50 (Appendix R) requirements. This was determined to be a deficiency in the original design of the emergency lighting system. Corrective action included performing an engineering review and walkdown of the plant areas that contained equipment or components that were necessary for the safe shutdown of the plant and to identify those areas with deficient emergency lighting. The design of the emergency lighting system was upgraded or modified to meet design-basis and Appendix R requirements. Deficiencies in Units 2 and 3 were corrected. Unit 1 deficiencies were scheduled to be corrected during the current outage. Engineering support for this LER was deemed adequate.

3.6.4.12 LER 329/89-001, "Loss of Site Power to 4.16-kV Buses"

On January 3, 1989, Unit 2 experienced total loss of offsite power to Class 1E 4.16-kV buses 2E-PBAS04 and 2E-PBB-S04. The loss of offsite power caused both Unit 2 diesel generators to start and assume the loads on the two Class 1E buses. The diesels performed as designed. The licensee's troubleshooting and investigation identified two damaged bushings on each of the ESF transformers associated with buses 2E-PBA-S03 and 2E-PBB-S04. The damaged bushings created a line to ground fault that caused transformer supply breakers to open resulting in a loss of offsite power to the two 4.16-kV buses. The licensee's preliminary investigation results determined that the event was caused by a lightning strike that damaged the transformer bushings. Engineering support for this LER was deemed adequate.

3.6.4.13 LER 528/89-003, "Loss of Power to Alternate Fuel Building Effluent Radiation Monitor"

On February 17, 1989, licensee personnel discovered that the preplanned alternate sampling system for the fuel building was inoperable. An investigation revealed that the circuit breaker supplying power to the system was open. The alternate system was in operation because a detector in the normal sampling system was inoperable. The alternate system was a cart-mounted plug in type unit. The licensee's root cause analysis determined that circuits supplying power were at or near their capacity loading. When the alternate sampling system was added to the circuit, the breaker apparently opened on overload.

This event occurred as a result of inadequate preliminary engineering reviews for the sampling system in that an inadequate power supply existed for the portable unit. As corrective action, the licensee initiated a PCR to provide dedicated power to the sampling cart.

3.6.5 Engineering Excellence Program

In mid-1988, an evaluation of the Engineering Department by an independent contractor was commissioned by department management. This evaluation identified 12 major problems in the department as follows:

(1) Too much workload to manage with the existing resources
(2) Inadequate prioritization system
(3) Poor integration of NED into the overall organization

(4) Need for project awareness of configuration management
(5) Inadequate design-basis training for design engineers
(6) Incomplete, poorly documented calculations
(7) Out-of-date documents
(8) Out-of-date analytical skills and tools
(9) Poor vertical communications and teamwork within department
(10) Inadequate emphasis on training and long-range objectives
(11) Lack of career path planning and advancement potential
(12) Poor assistance of NED by other departments

To correct these problems, an Engineering Excellence Program was initiated. At the beginning of this program, five major goals were established: (1) Understand and buy into the engineering role, (2) be proactive in the support of Palo Verde's needs, (3) maintain a high degree of technical competence with personnel trained and experienced in the Palo Verde design, (4) ensure quality by practicing attention to detail in all engineering activities, and (5) develop a strong teamwork attitude toward accomplishment of Palo Verde objectives.

To achieve these goals, 14 objectives and action plans were developed. As a result of these efforts, a number of significant accomplishments had been completed or were under way during the evaluation, including the following:

(1) A configuration management policy and a training lesson plan had been completed

(2) A local area network (computer) had been installed at most engineering work stations. Technical software was being installed, developed, and purchased

(3) A procedures update/streamlining effort had begun

(4) Supervisors and managers had begun visits to other nuclear utility organizations

(5) Technical responsibility definition/training was completed

(6) Update of engineering calculations was begun

(7) A dual career path program for NED engineers was begun, and a third path was being considered

(8) Pilot design-basis reviews had been completed on four systems, design-basis documents had been written, and formal training had been performed from these documents

(9) An aggressive recruiting program was started, staffing levels were increased, and the salary structure was upgraded

(10) Long-range goals and objectives were established

(11) A performance management program was established

Interviews with NED senior level engineers and supervisors indicated strong enthusiasm and support for the Engineering Excellence Program. Most saw the program as having started NED on the way to achieving the level of competence required of a modern nuclear engineering organization. Although many of the elements of the program were far from complete, the current overall effect on NED personnel attitudes and support capabilities was very positive.

3.6.6 Design-Basis Reconstitution Program

The DET reviewed the licensee's design-basis reconstitution program which included the creation of design-basis documents. Two design-basis documents were reviewed: "Diesel Generator and Class 1E Standby Generation System" and the "Diesel Generator Control Room Ventilation System." The DET also reviewed the Updated Final Safety Analysis Report (UFSAR, Rev. March 1989), Chapter 8, "Onsite Power Systems." In addition, interviews were conducted with the authors of the design-basis documents and with the design-basis program supervisor.

Although specific weaknesses were discovered, the design-basis reconstitution program was considered to be good overall when compared to the industry norm and considering that the licensee was in the early stages of the program. The documents themselves appeared to be well organized, and for the most part, thorough and complete. Additionally, the functional interface requirements summary, the DCP/site modifications historical summary, and the open items summary, which were included as appendices, were considered as strengths. The approach used in generating these documents was also seen as noteworthy. Direct employees rather than contractors were assigned to produce the documents. This ensured that the knowledge gained by the experience would remain within the organization.

Notwithstanding the fact that the design-basis program and documents were good overall, weaknesses were observed including the following (See also Section 3.6.7):

(1) Discrepancies identified in the NED open items summary list were not promptly evaluated for operability/reportability. NED had generated lengthy lists of open items as each system was being reviewed. The diesel generator system, as an example, had 92 findings logged against it, with only a few that appeared to be closed out. The DET questioned NED personnel concerning evaluations of the open items and the process being used by NED to close out items. NED was determining how to handle open items during its design-basis reviews which resulted in a revision (addition of Appendix O, "Open Item Log Sheet") to procedure 81DP-4CC01, "Design Documentation Review." The procedure revision was issued on November 23, 1989. An open item log sheet was required by procedure to be used to document design discrepancies found while performing design-basis reviews. The licensee did indicate that it intended to transfer all current and future design findings/discrepancies to the log sheets to allow proper evaluation and closeout and to be in compliance with procedure 81DP-4CC01. However, NED had not utilized the form. Further, the requirement to perform operability/reportability determinations for discrepancies found during the licensee's design documentation review were not required by the procedure. The DET was told that such determinations would take place with greater emphasis in the future, and there was a commitment that procedure 81DP-4CC01 would be revised to include guidance

on how to disposition design findings and operability concerns discovered during design-basis reviews. The DET considered the extended period taken to resolve potential reportability/operability concerns to be a weakness of the program.

(2) Operating surveillance and maintenance procedures, the FSAR, and non-design-basis output documents were not reviewed for adequacy and completeness as a part of the design-basis reconstitution program. Review of such documents is vital to (a) detect facets of the design that may not have been revealed in the formal design documents and (b) to assure that the interpretations of the design in these other documents are consistent.

(3) Discrepancies existed between UFSAR Tables 8.3-1 ("Class 1E Loads") and 8.3-3 ("Load Bases for Class 1E Buses"). Specifically, the locked rotor current (LRC) values given in the two tables were not consistent. The licensee initiated engineering action request (EAR) 89-2169 to evaluate the accuracy and safety consequences of these discrepancies. A review of the design-basis documents showed that potential safety concerns did not exist. However, the review did conclude that the table values were inconsistent and that the tables would have to be revised to reflect the correct values for LRC, actual load, full load current, load size, efficiency, power factor, and so forth. EAR 89-2170 was initiated to update UFSAR Sections 7, 8.3, 9.5, and 15 to reflect the correct values identified in the "Diesel Generator Loading Calculation 13-EC-DG-200" which is the design-basis document. EAR 89-2170 was completed on December 6, 1989 with the issuance of a safety analysis report change notice (SARCN) #3147.

Overall, these weaknesses indicated a lack of recognition by the Nuclear Engineering Department that to fully and properly execute its responsibilities it needs to be more aware of the business of the other departments in the plant organization.

In response to the above and to other related findings, the licensee committed to changing the program to include the requirement to review design-output (process) documents and plant procedures to assure conformance with design requirements.

3.6.7 Design Evaluation of the Emergency Diesel Generating and Support Systems

A limited design review of the emergency diesel generator (EDG) and support systems was conducted to assess its operational readiness and the quality, completeness and followup provided by the design-basis reconstitution program. The team found several design issues associated with the EDG and support system which were similar to design findings discovered by the licensee during its design bases reconstitution that had not been corrected. Most involved incorrect design information or utilization in site process documents and involved the air-start system, engine lubrication system, combustion air and exhaust system, fuel oil system, HVAC, the EDG building and crankcase level instrumentation.

3.6.7.1 Cooling Water Subsystem

The review of the cooling water subsystem included reviewing the results of the analysis for heat transfer to the spray pond cooling system and reviewing the failure modes of the various valves and controls in the system. The analysis appeared to have the correct inputs and assumptions, make the appropriate considerations, and the results appeared to be correct and consistent with the inputs. Review of the failure modes of the valves and controls identified no inadequacies.

3.6.7.2 Emergency Diesel Generator Air Start Subsystem

The review of the air start subsystem focused on three primary areas: the ability of the diesel generators to function upon loss of control air (the air compressors are non-safety-related and non-Class 1E powered), the appropriateness of the low-pressure alarm set point versus the pressure required to produce a 10-second start, and the adequacy of the design of the compressors and other components of the starting air subsystem.

(1) Control air: Although many of the engine functions are controlled by control air, the team could detect none which were essential to the operation of the units in the emergency mode. Loss of control air in the emergency mode would appear to have no detrimental effect on the ability of the units to perform their safety function.

(2) Low-pressure alarm set point: Prudent engineering practice for establishing alarm set points is to leave adequate margin between the design set point and the alarm set point to allow for instrument inaccuracy and drift, calibration uncertainties, and operator action. The starting air accumulator low-pressure alarm set point did not account for these factors. The set point was significantly less than the pressure required to start the diesel generators in 10 seconds. The minimum pressure at which the diesel generators will start in 10 seconds, according to the manufacturer, is 175 psig. The low-pressure alarm set point was found to be 150 psig ± 7 psig. With this set point, upon receipt of an alarm, the diesel generator would already be inoperable per Technical Specification 4.8.1.1.2.a.4.

    The licensee discovered this condition in 1988 and documented it in EER 88-DG-042, dated March 11, 1988. However, in the disposition of that EER, the 150-psig set point was evaluated as being acceptable. The team considered this to be an inappropriate disposition.

    The condition was identified again by the licensee during the generation of the design-basis document, and EER 89-DG-098, dated September 22, 1989, was generated to correct this condition. As of the close of this evaluation, the licensee had scheduled the issue of a modification to raise the set point by March 30, 1990. No projection was available for when the modification would be installed.

(3) Design of the air compressor and the air cooler: The starting air compressors had experienced numerous failures. Although in each case the compressors had been repaired or replaced, the root cause of the repeated failures did not appear to have been identified, and corrective actions were not performed to prevent recurrence.

The minimum accumulator pressure to start the diesels five times on each receiver as mentioned in the Standard Review Plan is 240 psig. However, to provide this minimum pressure, the accumulators must be pressurized to more than 250 psig to account for the tolerances and the deadbands of the control instruments. To achieve this pressure, the compressor discharge pressure must be higher still to overcome the system pressure drop through the cooler, the dryer, and other components between the compressors and the accumulators. This compressor discharge pressure is often 275 psig or more as evidenced by regular lifting of the compressor discharge safety valve which was set at 275 psig. The design pressure of the compressors and the coolers was 250 psig. The air compressors were not designed (continuous operation) for the higher pressure except for intermittent duty only. When the safety valve lifts, air is diverted from the accumulator, resulting in the compressor operating for long periods of time at the elevated pressure. Therefore, due to the as-built condition, the compressors were regularly being operated at greater than the design pressure and for more than intermittent duty. This appeared to be the major cause of the compressor failures that have been experienced at Palo Verde and at other plants having a similar design. Although this equipment was not safety related in itself, it was important to safety and the proper functioning of the diesel generators. Accordingly, the DET considered the licensee's compressor operational practices imprudent.

This problem was identified to the Engineering group by EER 88-DG-075, dated September 1988. The Engineering group disposition of this EER said that nothing could be done about the problem, and if it occurred again, to contact Engineering again. It also stated that operation of the compressor above the design pressure was allowable, and that the routine safety valve lifting was acceptable. This disposition was completely unsatisfactory because it advocated operation of equipment outside design conditions and it, in effect, chose to ignore a recurring problem which has a direct bearing on the reliable operation and availability of safety-related equipment.

Additionally, due to the close proximity of the compressors to the safety-related accumulators, gross failure of a compressor has the potential to cause damage to both accumulators.

During the evaluation, the licensee initiated a study of the air compressor failures which was scheduled for completion by March 27, 1990.

(4) Control room alarm: During the review of the EDG air-start system, the DET identified a design deficiency involving the alarm system. This deficiency could result in an EDG disabling condition not being alarmed in either the main control room (MCR) or the EDG local panel due to the use of common (multiple input) alarms in the EDG alarm system. For example, at the safety equipment status system (SESS) panel, located in the MCR, the "Air Start System" annunciator window (which does not have reflash capability) can be actuated by any one of the following active conditions: Receiver A low pressure, receiver B low pressure, receiver A isolation valve closed, receiver B isolation valve closed, or turning gear engaged. Any one of these conditions will also actuate the "Starting Air Pressure Low or System Malfunction" annunciator window (which does not have reflash capability) at the EDG local panel. The EDG has two starting

air trains. With one starting air train out of service, failure of the operable starting air train would be masked at the MCR and local panel. On Unit 3, the licensee has had this situation occur for a considerable period of time and has considered the diesel generator operable by performing local monitoring "status" checks every 6 hours. The DET questioned NED concerning the alarm design deficiency and discovered that during the licensee's design-basis review, EARs 89-1898 and 89-1899 were issued (October 6, 1989) to all EDG disabling conditions which would render the EDG incapable of responding to an automatic start command were alarmed in the MCR and at the local panel, and that EDG disabling and non-disabling alarms were separate and precise. At the prompting of the DET, this effort was completed by a contractor on November 30, 1989. Followup action recommended that an engineering study be performed to review and recommend possible regrouping of the disabling alarms to meet the following criteria: (1) The disabling alarms should be separate and precise at the local panel and/or the MCR, (2) an annunciator window shall be designated for disabling alarms in order to clearly alert the control room operator, (3) reassess the application of the high and low priority alarms, (4) review all alarms for duplicity, and (5) specifically address the need to provide indication of the loss of the starting air system given that the redundant starting air system has previously failed or been rendered inoperable.

The licensee issued EAR 89-2472 on November 30, 1989 to initiate an EDG alarm study, make recommendations, and initiate a plant change request. A contractor was conducting this effort and had scheduled it for completion by January 31, 1990.

3.6.7.3 Emergency Diesel Generator Engine Lubrication Subsystem

The review of the engine lubrication subsystem focused on four primary areas: (1) the capability to detect a reduction of lubrication capacity before loss of engine capability, (2) the capability to detect a loss of lube oil heating while in the standby mode, (3) the capability to monitor and replenish lube oil to the units while they are in service, and (4) the proper operational configuration for the lube oil filters, including the on-line ability to cope with plugged filters. Individual strengths and weaknesses in each area are discussed below:

(1) Detection of reduced lubrication: The design of the engine was found to be adequate in this area with alarms provided for low engine lube oil pressure, low turbocharger lube oil pressure, low crankcase level, and high lube oil filter differential pressure.

(2) Detection of lube oil heating loss: Recirculation and heating of the lube oil is provided when the diesel generators are in their normal standby mode to ensure that they have the ability to start in the required 10 seconds. If lube oil temperature drops below $110^{\circ}F$, the units are not considered to be operable. Although a low lube oil temperature alarm was provided, the set point of the alarm was found to be $100^{\circ}F$. This was considered too low to prevent the engine from becoming nonoperable for a loss of lube oil heating. This condition had also been identified by the licensee in 1985 (EER 85-DG-017) and again during the design-basis document-generation process for the system (EER 89-DG-098). The

Engineering group's response to this identified design discrepancy was inadequate. At the close of the evaluation, the licensee projected that a modification package would be issued by March 1990, with no projection for completion of the modification.

(3) Lube oil replenishment: The units were found to have the required features to allow monitoring of crankcase lube oil level and to replenish the lube oil while the engine was in operation.

(4) Lube oil filtration: The lube oil system was provided with duplex filters lined up with one of the filters in service and the other in standby. A high differential pressure alarm was provided to detect a loaded filter condition. The design allowed such a condition to be corrected with the unit in service by switching to the standby filter while the loaded filter was being cleaned.

3.6.7.4 Combustion Air and Exhaust Subsystem

The design of the combustion air and exhaust subsystem was reviewed with particular attention given to the calculated versus allowable pressure drop through the system for the worst-case design condition, the design-basis dust storm. The maximum combustion air pressure drop allowed by the diesel generator vendor through the entire combustion air inlet subsystem including the oil bath filter is 5 inches of water as documented in the Diesel Generator Design Manual, Section 5.1.4.1. "Operations Department Guideline No. 49," Revision 6, contained engine data sheets which were to be completed by the operator whenever the diesel generator was operated. For the intake air filter differential pressure (dp) data, a note was provided to clean the filter if the dp was above 5 inches of water. This limit was too high for normal operation in that it contained no margin for the dp generated by the balance of the intake air system (very low) and no margin for the post-LOCA design-basis filter loading (approximately 0.2 inch).

The licensee was also asked to provide the analysis which showed that for the design-basis dust-loading conditions shown in Section 9.4.7.2 of the FSAR of 131 milligrams per cubic meter for 5 hours, the total pressure drop through the air intake system would not exceed the limit of 5 inches of water. Although a design calculation had been performed, it had not considered the additional pressure drop due to the filter loading during the design-basis dust storm. However, before the onsite evaluation had been completed, documents were discovered which showed that the design-basis dust storm had been considered in the original design, and that the additional filter differential pressure due to the design-basis dust storm would be insignificant, only 0.18 inch of water. On the basis of this research, a change to the Operations Department guideline was initiated to clean the filter whenever the dp reached 4.3 inches of water.

This finding exemplifies the previously described weakness in the design-basis document program of not addressing the non-design documents associated with the systems, such as the FSAR, operating procedures, surveillance procedures, or other process documents. The licensee acknowledged this weakness and committed to change the program to include review of design output documents and plant procedures.

3.6.7.5 Emergency Diesel Generator Fuel Oil Subsystem

The design of the fuel oil subsystem was assessed, including the capacity of the pumps and piping to transfer fuel at the required volume under the most adverse conditions, the capacity and configuration of the fuel oil filters and strainers, the ability to cope with plugged filters and strainers on line, the ability to detect and remove contamination from the fuel oil tanks, the possible failure modes of the system, and the capacities of the tanks. All of these aspects of the design were found to be satisfactory. One aspect of the system design, the fuel oil day tank capacity, though adequate, did not correspond to the description in the FSAR. Section 9.5.4.2.3 of the FSAR stated that the capacity of each diesel generator fuel oil day tank was sufficient for 2.5 hours of continuous operation at maximum operating load without replenishment from the fuel oil storage tank. The consumption rate at full load was 390 gallons per hour. The required fuel to meet the FSAR statement was, therefore, 975 gallons. The fuel oil day tank level at which the transfer pump starts corresponds to approximately 725 gallons, or 1.86 hours of running time at full load. Therefore, in the normal standby condition, the tank level may be less than that required to meet the FSAR statement.

This inconsistency probably would have been caught by the design-basis document process had review of documents other than design documents been required as a part of the program as described in Section 3.6.6 of this report. The licensee initiated a change to the FSAR to show the capacity of the fuel oil day tank consistent with the actual design.

3.6.7.6 Emergency Diesel Generator Engine Components

Miscellaneous engine components and the physical configuration of the diesel generators were also reviewed by performing walkdowns of the units and by reviewing drawings, vendor instruction manuals, operating procedures, and the annunciator response procedures for the units. Considerations made during these reviews included divisional separation, particularly through the floor drain system; heating, ventilation, and air conditioning (HVAC) ductwork; piping penetrations; and seismic 2-over-1 and other system integrity threats. No significant design discrepancies were found with the engine components.

3.6.7.7 Electrical Distribution

Walkdown of the diesel generator systems, 4160-V switchgear and dc systems did not reveal areas of inadequate separation of cells or equipment. Components were installed according to applicable drawings and in accordance with vendor design requirements. In general, the material condition of the systems included in the walkdown was good.

The EDG load sequencer was reviewed through various document reviews, interviews, LERs, and actual inspection. The design was straightforward and appeared to be adequate.

3.6.7.8 Diesel Generator Building HVAC

The DET reviewed the diesel generator building HVAC, including the diesel generator room HVAC, and the diesel generator control room HVAC. The following weaknesses were discovered:

(1) Diesel generator control room HVAC: The FSAR and the design-basis manual for the diesel generator building HVAC stated that the filters for the air handling units for the control room shall be designed for performance without maintenance for 30 days with the maximum credible incidence of dust storms (5 hours at 131 milligrams per cubic meter). However, the specification under which the air handling units were purchased (specification No. 13-MM-721A) did not give any of these requirements, and no dust loading calculations for these air handling units could be found in the engineering files. The licensee discovered this condition in August 1989 while performing research for the design-basis document for the system.

When the licensee became aware of the team's concern with this matter, a calculation was performed which showed that the filters in the air handling units would not meet the FSAR 5-hour dust-storm requirement. However, it was found that the installed filters were adequate for any single credible dust storm which could be expected to occur at this time of the year, and special precautions were given to the Operations group that the filters may need to be changed after such a storm. Additionally, a design change was initiated to install filters before the next dust-storm season with sufficient capacity for the full 5 hours, and a review was initiated of the filters in other safety-related air handling units in the plant.

(2) Diesel generator room HVAC: Although the diesel generator room HVAC design was found to be adequate, another inconsistency was found between the actual design and the description in the FSAR. Section 9.4.7.2 of the March 1989 revision of the UFSAR described a water spray adiabatic cooling system for the diesel generator rooms that was used for personnel occupancy. However, during plant startup, this system had been found unsatisfactory because it sprayed water on the generator end of the diesel generator. Since that time, the system had not been used and had been abandoned in place. Therefore, the UFSAR description was obsolete.

Upon further review, it was found that this inconsistency had been discovered in 1986, and an attempt at correction had been made in UFSAR Amendment 16, dated November 1986. This change was also incorrect in that it described the use of the system as optional, which it was not. However, this revision was short lived, for in the March 1989 UFSAR revision, the description was changed back to the original wording. This was attributed by the licensee to a word processing error. To determine if this error might have affected other revisions, the licensee checked 10 other Amendment 16 changes. No other errors were found. At the end of the onsite evaluation, the licensee had initiated an UFSAR change to remove the description of the cooling system completely.

This is another example of the weakness in the current design-basis document generation program: the program did not require review of design output documents such as the UFSAR. The licensee indicated that it would change the program to require such reviews.

3.6.7.9 Diesel Generator Building Fire Protection and Detection

The team reviewed the design of the EDG building fire protection and detection systems as well as the coordination of the design of the floor drains system with the fire protection system. No discrepancies were found in the fire protection and detection systems. However, a major discrepancy was found by the licensee regarding Appendix R separation of the Class 1E electrical trains.

In 1985, a condition was discovered in all three units wherein the seismic gap area between the diesel generator buildings and the control buildings had not been analyzed during the fire hazard analysis. An oil fire in either diesel generator space could threaten the opposite train because there was an unsealed penetration from the diesel generator building to this space. This could allow an oil fire in one train to propagate into the seismic gap between the two buildings where there is no vertical fire barrier separating the cables for the two trains and no fire-suppression equipment. The opening was sealed and LER 85-096-00 was written stating that a review of the units verified that all other seismic gap areas met Appendix R requirements.

However, on October 23, 1989, in preparation for this evaluation, the licensee discovered four additional large openings in the same wall in all three units. These were visible only when the gratings over the pipe trenches were removed, indicating that the inspections associated with the 1985 LER and the production of the design-basis manual had not been thoroughly done.

When this problem was identified, the licensee acted immediately by establishing fire watches in all three units, and a PCR was written to close the holes. The licensee projected an issue date of March 1990 for the required site modification. However, in a second LER, No. 89-017, dated November 22, 1989, documenting the new discoveries, the projected date for closing the openings was revised to February 28, 1990.

This case appears to be another example where a significant safety concern was identified by the licensee, and yet implementation of corrective action was slow. The required correction in this case (e.g., doing the work to make the wall configuration conform to the original design drawings) was projected by the licensee to take months.

3.6.7.10 Temperature Instrumentation

A review of the EDG exhaust temperature sensor instrumentation and calibration procedures indicated that the instrumentation and procedures were adequate.

3.6.7.11 Crankcase Level Instrumentation

A review of the EDG crankcase level switch instrumentation and calibration procedures indicated that the instrumentation and procedures were adequate. A discrepancy was noted, however, concerning the vendor-specified set point of 5-3/4 inches (M018-458/M018-577-1) and the instrumentation calibration data list set point of 7-3/8 inches (13-J-ZZI-003). A check of EERs revealed that EER 89-DG-052, dated May 5, 1989, was issued to resolve this problem; however corrective action had not been taken.

3.6.8 Design Evaluation of Safety-Related Batteries

Palo Verde has four safety-related battery sets per unit. The battery size was based on a station blackout event as being the worst-case loading for the batteries. Two batteries were rated 1140 ampere-hours each and two at 1800 amperes-hours each. Procedure 81DP-4CC04, "Calculations," Revision 1, and calculation No. 13-EC-PK-20, dated September 14, 1989, were reviewed. The calculation indicated that the batteries were sized for a coping capability as defined in 10 CFR 50.63 of 2 hours without load shedding, which met the original design requirements. With selective load shedding of nonessential loads, the batteries have a capability of 4 hours. The licensee has initiated DCP 1, 2, 3- FE-PK-35 and plant change package 88-13-XE-002 to replace the 1140 ampere-hour batteries with 1800 ampere-hour batteries to increase the coping capability to 4 hours in compliance with the licensee's commitments to Regulatory Guide 1.155 and 10 CFR 50.63. The DCPs are scheduled for completion between September 1992 and September 1993, depending on outage schedules. The DET identified no design inadequacies.

3.6.9 Design Evaluation of Various Electrical Components

The DET evaluated selected electrical components, including Class 1E switchgear, motors, and relays. In general, the electrical components met the stated design criteria in capacity ratings, protection schemes, and maintainability. The Class 1E switchgear design used at Palo Verde was similar to designs used in most other nuclear plants. Walkdown of the switchgear and review of applicable drawings assured that the switchgear was installed according to design documents. Review of LERs and work requests/orders revealed two problems that could be attributed to component or system design problems. These were weld failures in 4160-V circuit breakers and the Unit 3 spray pond pump motor circuit breaker closing without operator action (see Sections 3.6.4.8 and 3.6.4.9 for additional information).

3.6.10 Procurement and Dedication of Electrical Components

The licensee had established a Procurement Engineering section responsible for reviewing procurement documents and determining critical characteristics for each part or component procured for use in critical applications. Procurement Engineering was not responsible for parts/components installed through the NED modification program. The specifications for these items were established by the NED responsible engineer. Generally, Class 1E electrical components were procured as Class 1E, and upgrading or dedication as Class 1E was not necessary. In those instances in which upgrading parts was required, the procurement engineer established the critical characteristics of the part for inspection, test, or analysis to upgrade the part for Class 1E applications.

The DET review of Procurement Engineering activities indicated that the procurement engineering program was adequately supporting safety-related activities at Palo Verde.

3.6.11 Design Review of Safety-Related Pumps/Motors

The DET evaluated the Unit 2 auxiliary feedwater pump motor and the Unit 3 spray pond pump B motor. No design deficiencies were identified with either motor. Review of pump curves indicated that the motors were properly sized, motor protection was provided by relays and coordinated circuit breakers, and motor speeds were as specified by the pump manufacturers. Review of LERs, EERs, and work requests did not reveal problems that resulted from poor design or installation.

3.6.12 Engineering Modifications

Modifications related to the EDG system and subsystems were reviewed to determine modification package content, including thoroughness, clarity, 10 CFR 50.59 evaluations, and postmodification testing. Although the mechanical modifications reviewed by the DET did contain safety evaluations, the narrative portions of these documents were poor. However, considering the time frame in which they were produced, they were typical in quality for the industry. Two recent-vintage safety evaluations were reviewed and were found to be adequate. One had been performed on Material Nonconformance Report 89-HD-0004 concerning the diesel generator control room essential air handling units not being capable of meeting their design requirements as discussed in Section 3.6.7.8 and modification 1, 2, 3 OE-DG-060 concerning replacement power supplies PS-1 and PS-2 in the diesel generator control system as discussed in item 1 be[illegible]

Modification packages reviewed by the team which related to the diesel generator system were adequately designed, planned, and executed with the exception of one which involved an inadequate materials review by Engineering. Examples of both weaknesses and strengths are given in the following paragraphs.

(1) Modification 1, 2, 3 OE-DG-060

This modification concerned the replacement of power supplies PS-1 and PS-2, Lambda catalogue No. LUS-10A-28-40381-1 and resistor 6 SPR in the diesel generator control circuitry. The engineering evaluation to determine the suitability of the Lambda power supplies for this application appeared adequate. Prior to implementation of the modification, another evaluation was performed to determine the acceptability of the power supply qualification tests that had been performed at an independent laboratory. Walkdown of the installed modification identified no deficiencies.

(2) Modification 2-OE-PE-018

This modification concerned the replacement of installed relay 50R3 with an Agastat E7000 series time-delay relay and to adjust and test the Agastat to a 2-second time delay. The modification was required to prevent trip-free operation of the diesel generator breaker during diesel start and load sequencing. The modification was properly evaluated by the Engineering group. Procurement documentation met the engineering specifications, installation was performed according to the design change package, and postmodification tests were properly evaluated by system engineering personnel.

(3) Modification 1, 2, 3-SM-DG-014/012

Site Modification 1, 2, 3-SM-DG-012 was initiated to remove switches 33E01 and 33E02 which were determined to be unqualified for Class 1E applications. The modification received the appropriate reviews and approvals, and was implemented. Subsequently, the licensee discovered that the originally installed switches were Class 1E qualified and another modification (1, 2, 3-SM-DG-014) was initiated to remove the recently installed switches and reinstall the original switches. These errors indicated weaknesses within the engineering review and approval process, although this particular engineering error appeared to be an isolated case.

3.6.13 Outstanding Unit Modifications

Interviews with engineering group personnel indicated that potential design differences existed between the units because of the manner in which modifications were installed or not installed due to the time frame of construction or operations activities. In response to this question, the DET asked the licensee to provide information regarding modification implementation among the three units. The licensee performed searches by discipline to determine which DCPs had been cancelled for each unit, whether modifications were accomplished by some vehicle other than a DCP, and the status of each.

The DET reviewed the documents and discovered both strengths and weaknesses:

(1) Document retrieval capabilities were considered a strength. In a short period of time, the licensee was able to provide documentation on why certain modifications were not performed on all three units, many of which were related to the staggered construction and the various systems used to make modifications to plant components or systems (e.g., field change requests, vendor procurement changes for later units, superseded modifications, poorly designed initial modification, modification performed by maintenance work order, drawing changes, transferred to a site modification, done by a temporary modification which became permanent, nonconformance report, or by a startup field request).

(2) Numerous DCPs had been cancelled for no apparent reason. The large number of cancelled DCPs was considered to be an indicator of poor initial modification screening by Engineering. The licensee recognized that the modification process needed to be improved and was studying ways to streamline the controlling procedures and had developed a Plant Modification Committee (PMC). The purpose of the PMC was to screen proposed modifications to look at the potential safety and cost benefit prior to approval of the modification. Modification initiation control by the PMC should minimize the number of cancellations.

(3) DCPs have not been uniformly installed in all units. This condition became apparent when reviewing outstanding modifications. Errors had been made in the past where modifications were actually installed even though they were officially cancelled. Other modifications had been postponed due to financial or schedular conflicts, or simply cancelled on subsequent units because the modifications failed to improve a system or component as expected. The licensee appeared to be gaining greater control over modifications through the PMC.

3.6.14 Availability of Design Records

Virtually all design records requested were provided very quickly. This was considered a strong indicator that Engineering was well organized and supported, an important consideration in the effectiveness of an organization. In the few areas in which design records were not 100-percent available, such as some of the design calculations referred to in the preceding sections, the licensee had already identified these areas and had begun a program to restore these records as described in Section 3.6.5 concerning the Engineering Excellence Program. Additionally, the ongoing design-basis document generation program should continue to identify and correct document weaknesses.

3.6.15 Design Calculations and Revisions

The team reviewed various mechanical and electrical design calculations to determine adequacy. Overall, the team observed that design calculations were generally clear and concise, although in some instances the licensee took a nonconservative approach (see also Section 3.6.7). The following paragraphs identify weaknesses that were observed.

3.6.15.1 Instrument Loop Accuracy Calculations

Instrument loop acceptance criteria values for non-plant protection system/engineered safety features actuation system trip computer set points, which are used to provide acceptable as found/as left and minimum/maximum conditions, identified for various locations (e.g., test jacks and test points) as specified in NSSS/balance-of-plant procedures were apparently calculated by the I&C Plant Standards group using the square root sum of the squares (SRSS) method. However, there was not retention of the results of these SRSS calculations nor was there an established procedure to ensure that consistent methods would be employed by all individuals performing these calculations. In accordance with prudent engineering practice, support calculations are expected to be available to confirm calculated values specified in plant procedures.

A design guide for instrument set point methodology was in the final stages of being developed and is to be completed by June 15, 1990. A parallel effort was also under way to obtain loop inaccuracy and set point information from Combustion Engineering. The design will address the level of detail that different types of loop calculations will be taken to, both safety related and not safety related.

3.6.15.2 Set Point Calculations for MOVs

MOV set point calculations were not reviewed and approved and instances of nonconservative control of torque switch settings were identified. For example:

(1) There were no reviewed and approved set point (stem thrust/torque switch) calculations for MOVs. Calculations did exist, however, in various locations, and were used to create procedure 13-J-ZZI-004, discussed in item 2 below. The calculations were suspect, since errors had been discovered by the licensee in existing calculations when responding to IE Bulletin 85-03 and included incorrect dp values across valves (i.e., the basis for thrust calculations).

(2) Procedure 13-J-ZZI-004, Revision 5, "Motor Operator Data Base" (MODB), was the controlling document for torque and limit switch range settings for both safety-related and non-safety-related MOVs; however, torque switch ranges were given for only those valves which fell under IE Bulletin 85-03. EERs written in 1987 suggested that the remainder of safety-related MOVs be tested and included in the program. Subsequently, NED initiated action to resolve outstanding MOV issues such as switch setting discrepancies, obtaining vendor information, defining maximum dp on safety-related valves, performing calculations, recommending torque switch settings, and incorporating all data into the design-basis, however, this NED action was not performed.

(3) Document 13-J-ZZI-004 did not list torque switch ranges for torque switch settings (e.g., 2-1/4 to 2-3/4) but instead gave the maximum and minimum open and closed thrust values. Consequently, thrust values obtained through MOVATS testing could not easily be compared with actual switch settings.

(4) A January 1988 response to IE Bulletin 85-03 which contained a "Valve Data Summary for AFW and HPSI" indicated that valve 3AFCHV-033 had a thrust value over the maximum design, but that it was acceptable per Note 5. Note 5 stated that "Due to conservative construction, Limitorque allows actuator output thrust values to exceed published rated values by 10 percent." Exceeding the output thrust by 10 percent was allowed by Limitorque as long as the operator was limited to 100 lifetime cycles. This particular overthrust stipulation was not mentioned by the licensee. It was not known whether the licensee kept track of the number of cycles each time "Note 5" was invoked.

(5) Note 14 of drawing 13-J-ZZI-004, which related to MOVs that were not MOVATS tested, stated that: "When as the result of testing the range of torque switch adjustment exceeds the limiter plate, the limiter plate should be modified and left in place where possible instead of removing the limiter plate completely. This will ensure that the new maximum setting will not exceed valve or valve operator maximum." Leaving the limiter plate installed was an act of engineering conservatism to ensure proper protection of both valve and valve operator. Note 15 of drawing 13-J-ZZI-004 took a much less conservative stand, however, in allowing the limiter plates to be removed once the MOV had been MOVATS tested. Removing the limiter plate may allow the valve/operator to exceed its design limits, particularly if the screws that secure the torque switch settings become loose. A similar concern was manifested during the evaluation when two valve stems were bent and a motor was burned out in an AFW flow control valve (see Section 3.6.4.5). Engineering personnel were questioned as to why the limiter plates were allowed to be removed, including the existence of any accompanying safety evaluations; however, the DET received no documentation to support the licensee's decision.

The licensee recognized the need for formalizing thrust calculations, performing design-basis evaluations, and preparing the thrust evaluation and calculation methodology, and intends to review the original IE Bulletin 85-03 valves as part of its response to Generic Letter 89-10. NED also had committed to reconstitute all the MOV design-basis set points, develop formal thrust calculations and documentation. It is the intent of the licensee to use contractors to perform an independent check of their calculations and problem evaluations.

3.6.15.3 Mechanical Calculations

The DET reviewed four mechanical calculations, of which three had been performed late in 1989. Three of the four calculations were clear and concise, with the assumptions, inputs, results, and conclusions being logical and well documented. The one exception involved piping located in the 2A diesel generator control room.

During walkdowns, a vertical section of copper domestic water pipe was identified in the Unit 2A diesel generator control room as potentially not being seismically qualified. The distance between the supports appeared to be too great. The concern was that seismic stresses could split this pipe, spraying water on critical electrical equipment in the control room, and potentially incapacitating the diesel generator.

During the evaluation period, the licensee made several attempts to analyze the piping in question. Several analyses were completed where elements of the analyses were incorrect, lacking in the necessary detail, or inconsistent with the hardware in the field. An analysis package was finally completed which corrected these deficiencies, showing that the stresses would indeed exceed the allowable stress, potentially causing the pipe to split. However, the licensee was able to show that the resultant spray would not harm any safety-related equipment in the room.

Although the licensee resolved the strict technical concern, the DET considered it undesirable to have a design which would allow water to spray on safety-related electrical equipment as a result of a seismic event. Additionally, the manner in which this concern was resolved calls into question the analysis techniques practiced in NED and the consideration that was given in the plant design to other similar potential spray threats to safety-related equipment.

3.6.16 Plant Equipment Operating Experience

Two main systems are used to track and trend component or system failures; (1) the nuclear plant reliability data system (NPRDS) and (2) the failure data trending (FDT) system. At the time of the evaluation, the procedure governing the NPRDS was not yet approved; however, it was written on October 13, 1988. Procedure 81AC-0RA01, Revision 0, "PVNGS Failure Data Trending Procedure," required that NED maintain the FDT data base and issue quarterly FDT reports (component failures and human performance evaluation system) to the EED and to the system engineers and their supervisors.

Neither maintenance nor NED was on the distribution list for the FDT reports. Programmatic and EED implementation weaknesses associated with the FDT program resulted in its having very limited effectiveness on improving equipment reliability. EED had the responsibility to (1) ensure a timely root cause resolution of all significant component failure trends and (2) evaluate the possible impact of human error on system reliability. Supervisors in EED were also responsible for initiating a root cause analysis either from the FDT quarterly reports or from interactive use of the FDT system.

The licensee's QA Department had written two corrective action requests (CARs), CA89-0032 and CS89-0066, which documented deficiencies within EED regarding inadequate responses to FDT reports. CAR CA89-0032 was written on May 31, 1989 and required an initial reply concerning corrective action by June 21, 1989. Implementation of corrective action related to the CAR was not timely, and the due date had to be extended. Corrective action was completed and subsequently verified by QA on October 3, 1989.

CAR CS89-0066 was written on September 6, 1989, to identify continued problems related to FDT and required an initial reply concerning corrective action by October 5, 1989. During a self-initiated maintenance team inspection, the FDT program was found to contain problems that should have been corrected earlier. The CAR identified as one of the root causes "Insufficient Attention by both System Engineers and EED Supervisors." Root causes were determined for the insufficient attention given the FDT report by EED; root causes included the following: (1) engineers were overworked, (2) EED was understaffed, (3) overall quality of the FDT report needed to be improved, and (4) training and understanding of the FDT program were lacking. Once again, the response to the CAR was not adequate in that EED's response did not adequately identify the extent of the problem (weakness in trending and use of FDT reports), the root cause, timely remedial action or actions or acceptable plans to prevent recurrence that are in keeping with the station goals regarding backlog of problems identified.

The Nuclear Safety Department (NSD) conducted an assessment of the operating experience program during October and November 1989 and concluded that the current programs used to evaluate industry operating experience and in-house events have significantly improved, although more improvement was required for implementation and closure of corrective actions, recurrence of events, and utilization of NPRDS. The NSD assessment also indicated that "No single department, individual or manager feels responsible for maintaining a 'big picture' perspective to: (a) evaluate the significance of recurrence, (b) direct events of recurrences to upper management, or (c) determine the impact on previously closed corrective actions."

The DET found several examples of these same weaknesses that occurred during the onsite evaluation period indicating that the conditions reported in the NSD assessment continued to exist in spite of programmatic improvements. For example, the DET reviewed the latest FDT quarterly report which was issued on November 1, 1989 (for third quarter 1989). The report contained 197 entries, many of which involved multiple line items for each entry. Of the 197 entries, only 81 had been addressed to some degree by the close of the evaluation.

EED's responses to the reports were both inadequate and untimely; this was in agreement with recent QA findings. For example:

(1) There did not appear to be a standard approach to addressing individual line items for each FDT entry (formatted as Q3.89-x). Entry Q3.89-52 had 17 line items with fail dates going back to 1986. The system engineer listed three EERs which would address 4 of the 17 items. One EER (89-SB-065) was written on August 28, 1989, concerning a failure which occurred on July 29, 1988, and was still open. No reasons were given for not generating additional EERs.

(2) Although it was correct in many instances to say that failures listed on each entry (i.e., Q3.89-52 had 17 items) were not related or were isolated cases, it was not true in the broader sense when looking across many systems. Examples include packing leakage, fuses, flange leakage, fitting leakage, body-bonnet leakage, loose hardware, test failures, torque switch problems, limit switch problems, incorrect grease installed in MOVs, poor maintenance, poor design, or damaged components.

(3) EED made numerous mentions of "normal component wear," "due to normal operation," or "human error" without any substantiation.

(4) EED made numerous responses such as "cause of failure already determined on work orders" without any substantiation.

(5) The reviews performed by EED appeared to be cursory in nature without any review by EED management for adequacy.

4.0 EXIT MEETING

On January 24, 1990, the Director of the Office for Analysis and Evaluation of Operational Data (AEOD), the Regional Administrator for Region V, the Associate Director for Reactor Projects (Office of Nuclear Reactor Regulation ((NRR)), the Director of the Office of Enforcement (OE), the Manager and Deputy of the Palo Verde Diagnostic Evaluation Team (DET), and other Nuclear Regulatory Commission (NRC) staff met at the NRC's Region V office with the President and Chief Executive Officer (CEO), of the Arizona Public Service Company (APS), and the Executive Vice President, Nuclear (APS), and several of the top managers responsible for the facility. At this meeting, the NRC presented preliminary results of the diagnostic evaluation. The list of attendees is provided at the end of this section. Briefing notes, summarizing the DET's preliminary findings and conclusions, are attached as Appendix A.

E. L. Jordan, Director, AEOD, began the meeting by introducing the principal NRC participants. W. F. Conway, Executive Vice President, Nuclear introduced O. M. DeMichele, President and CEO. He also introduced the representatives from Southern California Edison Company (SCE), Los Angeles Department of Water and Power (LADWP), Public Service Company of New Mexico (PNM) and Salt River Project Agricultural Improvement and Power District (SRP) -- four of the licensees in partnership with APS for Palo Verde. The remainder of those in attendance introduced themselves by name and organizational affiliation. Mr. Jordan then summarized the purpose of the NRC's Diagnostic Evaluation Program and explained the evaluation process. Next, following the briefing notes (see Appendix A), he proceeded to discuss the more significant APS initiatives, the deficiencies in performance that precipitated the diagnostic evaluation, and probable the root causes for the performance problems.

M. J. Virgilio, the DET Manager, presented the preliminary findings and conclusions of the DET in the following major functional areas: engineering, maintenance, quality programs, operations and training, and surveillance and testing. In each of the functional areas, the more significant weaknesses, positive attributes, and strengths were identified and examples provided. During this portion of the presentation, Mr. Jordan emphasized the significance of the DET's findings regarding the limited effectiveness of the Plant Review Board and weaknesses in the check valve and motor-operated valve reliability improvement programs.

In response to the discussion on check valves, Mr. Conway acknowledged overall progress had been slow; however, he pointed out that the review had been reopened by the new APS management in early 1989 when it recognized the programmatic inadequacies because of the importance of check valve reliability. In response to the DETs preliminary conclusion and its basis regarding the limited effectiveness of the Management Review Committee, Mr. Conway stated that his objective was to foster teamwork among the new managers in APS. Further, he expected the committee, now comprised of the new managers, would utilize the opportunity to learn about the facility.

Mr. Jordan summarized the DET's overall conclusions related to the design, construction, operation, and management of Palo Verde.

Mr. Conway discussed the resource - intensive nature of a diagnostic evaluation. He discussed his approach to the evaluation; specifically, his desire to make it a positive experience by utilizing the DET's insights to help foster additional performance improvements. He reviewed some of the actions he took early in the process to ensure that objective; specifically, those related to forthright communications regarding known deficiencies at Palo Verde. In summarizing, he stated that APS has already taken actions to address many of issues discussed in the NRC's presentation.

ATTENDEES LIST

NRC

E. Jordan
S. Rubin
M. Virgilio
J. Martin
R. Scarano
H. Wong
D. Coe
B. Faulkenberry
D. Kirsch
R. Huey
W. Ang
R. Zimmerman
S. Richards
G. Cook
J. Partlow
T. Chan
J. Lieberman

SRP
R. Henry

APS

M. DeMichele
W. Conway
J. Levine
J. Allen
J. Bailey
T. Bradish
P. Caudell
B. Page
B. Ballard
C. Rogers

SCE
D. Cox

LADWP
R. Balingit

PNM
J. Maddox

APPENDIX A

ARIZONA PUBLIC SERVICE/NRC MEETING

ON THE

RESULTS OF THE PALO VERDE DIAGNOSTIC EVALUATION

JANUARY 24,1990

APS INITIATIVES

- AT THE TIME OF THE DIAGNOSTIC APS HAD OVER 50 MAJOR INITIATIVES IN VARIOUS STAGES OF DEVELOPMENT AND IMPLEMENTATION. SOME OF THE MOST SIGNIFICANT ARE LISTED BELOW:

INITIATIVE

SITE FACILITIES PLAN
STAFFING ANALYSIS
ENGINEERING EXCELLENCE
MATERIAL CONTROL-PRIDE
MANAGEMENT EXPANSION
MANAGEMENT OBSERVATIONS
COMMITMENT TRACKING -CATS
NUCLEAR SAFETY & SELF ASSESSMENT
MATERIAL NONCONF. REPORTS
EMPLOYEE CONCERNS
MOV PROGRAM
PM PROGRAM ENHANCEMENTS
STRATEGIC INFORMATION PLAN
SIMS ENHANCEMENTS
UPGRADED MAINTENANCE
12 WEEK SCHEDULE
PARALLEL MAINTENANCE ACTIVITIES
CONCERNS RESPONSE TEAM
CHEMISTRY CONTROL PROGRAM
SITE RESTORATION
UNIT/EED MEETINGS
WORK CONTROL PROCESS
UNIT TEAM BUILDING
CENTRAL PROCESSING
QUALITY DEFICIENCY REPORT
QA STOP WORK/SHUTDOWN
QA TREND PROGRAM
QUALITY REPORTING
5 POINT PROGRAM
MANAGEMENT REVIEW COMMITTEE
OPERATOR CONCERNS
PROGRESSIVE DISCIPLINE
TRAINING DEPARTMENT REORG.
QA VERIFICATION
MONITORING PROGRAM REVISIONS
SYSTEM ENGINEER EXCELLENCE
PLANT MODIFICATION COMMITTEE
HUMAN PERFORMANCE EVALUATION SYSTEM

DEFICIENCIES

- SUBSEQUENT TO LICENSING, OPERATIONAL EVENTS AND INADEQUATE RESPONSE TO CERTAIN PROBLEMS LED TO THE MANIFESTATION OF DEFICIENCIES IN THE FOLLOWING AREAS:

LEADERSHIP	OWNERSHIP
MANAGEMENT INVOLVEMENT	MOTIVATION
TEAMWORK	WORK PLANNING
RESOURCE UTILIZATION	WORK CONTROL
COMMUNICATIONS	WORK PRIORITIZATION
ACCOUNTABILITY	PROBLEM IDENTIFICATION
CREATIVITY	PROBLEM RESOLUTION
TECHNICAL EXPERTISE	CORRECTIVE ACTION

ROOT CAUSES

- o INSUFFICIENT TECHNICAL AND MANAGEMENT DEPTH
  - HEAVY RELIANCE ON OTHERS DURING CONSTRUCTION
  - MORE, BUT NOT ENOUGH, MANAGERS AND STAFF BROUGHT ON TO SUPPORT STARTUP
- o MANAGEMENT AND TECHNICAL RESOURCES FOCUSED ON THE NEXT UNIT IN LINE FOR STARTUP AT THE EXPENSE OF THE OTHER UNITS
- o 1987 REORGANIZATION COMPOUNDED MANAGEMENT DEFICIENCIES

ENGINEERING

WEAKNESSES

- ENGINEERING SUPPORT WAS OFTEN UNTIMELY AND INADEQUATE
  - MANY NEW SUPERVISORS AND MANAGERS
  - UNCLEAR AND UNREALISTIC ENGINEER ROLES AND RESPONSIBILITIES
  - LARGE BACKLOG OF WORK
  - NO INTEGRATED DEPARTMENT-WIDE PRIORITY SYSTEM
  - UNTIMELY OR INADEQUATE CORRECTIVE ACTION
- FAILURE DATA TRENDING INFORMATION WAS NOT BEING EFFECTIVELY EVALUATED OR UTILIZED
- FLAWS WERE NOTED IN DESIGN BASES RECONSTITUTION EFFORTS
  - DEFICIENCIES NOT PROMPTLY EVALUATED FOR OPERABILITY
  - SLOW TO INITIATE CORRECTIVE ACTIONS
  - FSAR, OPERATING PROCEDURES, MAINTENANCE PROCEDURES NOT REVIEWED

ENGINEERING

POSITIVE ATTRIBUTES

- QUALITY STAFF IN EED

- STRONG SUPPORT FOR THE ENGINEERING EXCELLENCE AND OTHER IMPROVEMENT EFFORTS

STRENGTHS

- DOCUMENT RETRIEVAL CAPABILITIES

- ELECTRICAL COMPONENTS AND SYSTEMS DESIGN

MAINTENANCE

WEAKNESSES

- MAINTENANCE TASKS WERE NOT ALWAYS BEING PERFORMED IN A QUALITY, TIMELY OR COORDINATED MANNER
  - INEFFECTIVE SCHEDULING AND COORDINATION OF MAINTENANCE ACTIVITIES
  - INEFFECTIVE OUTAGE PLANNING
  - PIECEMEAL, INCOMPLETE, REACTIVE PM PROGRAM. MANY TASKS WERE OVER DUE
  - SPARE PARTS WERE NOT ALWAYS AVAILABLE WHEN NEEDED
  - WORK PACKAGES, DRAWINGS AND TECH MANUALS WERE INACCURATE, CUMBERSOME AND DIFFICULT TO USE
  - THERE WAS A SIGNIFICANT HUMAN ERROR RATE
  - URGENCY IN MAINTENANCE ACTIVITIES WAS LACKING
- MOV PROGRAM REVIEW IDENTIFIED NUMEROUS WEAKNESSES

POSITIVE ATTRIBUTES

- HOUSEKEEPING AT THE FACILITY WAS GOOD

QUALITY PROGRAMS

WEAKNESSES

- IN SOME CASES DEFICIENCIES WERE NOT BEING IDENTIFIED AND CORRECTIVE ACTIONS WERE INEFFECTIVE OR SLOWLY IMPLEMENTED
  - COMPLIANCE BASED AUDIT PROGRAM
  - LINE ORGANIZATIONS N[illegible]NTIFYING ALL SIGNIFICANT PROBLEMS
  - SLOW TO DETERMINE ROOT CAUSE
  - CORRECTIVE ACTIONS TAKEN WITHOUT FULLY ADDRESSING ROOT CAUSE
  - IN SOME CASES TRENDING PROGRAMS WERE NOT IDENTIFYING ADVERSE CONDITIONS
  - SLOW CORRECTIVE ACTION PROCESS
- THE PRB WAS NOT FUNCT ONING EFFECTIVELY
- OPERATING EXPERIENCE REVIEW EFFORTS WERE NOT ALWAYS EFFECTIVE

QUALITY PROGRAMS

POSITIVE ATTRIBUTES

- o PERSONNEL AND PROGRAMMATIC CHANGES HAVE HAD A POSITIVE IMPACT ON PERFORMANCE

  - o OVERSIGHT GROUP PERFORMANCE HAS IMPROVED SIGNIFICANTLY

  - o THE MONITORING PROGRAM IS IDENTIFYING TECHNICAL PERFORMANCE BASED ISSUES

  - o THE BACKLOG OF QUALITY ASSURANCE DEFICIENCIES IS DECREASING

- o GOOD VENDOR QUALITY ASSURANCE PROGRAM

OPERATIONS AND TRAINING

WEAKNESSES

- SYSTEM ALIGNMENT CONTROLS WERE NOT FULLY EFFECTIVE
  - THE INDEPENDENT VERIFICATION PROCESS WAS NOT WORKING AS INTENDED
  - SYSTEM STATUS PRINTS AND VALVE LOGS WERE NOT WELL MAINTAINED
  - INATTENTION TO DETAIL BY OPERATORS
- COLLECTIVE SYSTEM OF SUPERVISION, TRAINING AND OPERATING PROCEDURES WAS NOT SUFFICIENTLY EFFECTIVE TO ENSURE CERTAIN TECHNICAL SPECIFICATION LIMITS WOULD BE SATIS[illegible]
- COMMUNICATIONS BETWEEN OPERATIONS MANAGEMENT AND STAFF WAS NOT ALWAYS EFFECTIVE
- THE ABILITY TO CONTINUE TO MAKE IMPROVEMENTS TO TRAINING PROGRAM WAS A CONCERN
- MANAGEMENT REVIEW COMMITTEE MEETINGS WERE NOT FULLY EFFECTIVE
- STAFFING WAS ADEQUATE TO PROVIDE FOR SAFE OPERATION, HOWEVER, THE POTENTIAL SHORTAGE OF OPERATORS WAS A CONCERN

OPERATIONS AND TRAINING

POSITIVE ATTRIBUTES

- COMMUNICATIONS AT THE WORKING LEVEL WERE GOOD
  - BETWEEN ALL GROUPS DURING CREW TURNOVER BRIEFINGS
  - BETWEEN OPERATING CREWS
  - DURING PLANT EVOLUTIONS
- LICENSED AND AUXILIARY OPERATORS WERE KNOWLEDGEABLE AND PROFESSIONAL

STRENGTHS

- THE USE OF MOCKUPS AND COMPUTERS IN TRAINING

SURVEILLANCE AND TESTING

WEAKNESSES

- INATTENTION TO DETAIL DURING PLANNING, PERFORMANCE AND REVIEW ACTIVITIES

- RESPONSE TO INDUSTRY GUIDANCE ON CHECK VALVE TESTING WAS UNTIMELY

SUMMARY

- PVNGS IS A WELL DESIGNED AND CONSTRUCTED FACILITY
- APS HAS CAPABLE MANAGERS AND SUFFICIENT FINANCIAL RESOURCES
- MAINTENANCE AND ENGINEERING ARE FUNCTIONAL AREAS IN NEED OF ADDITIONAL APS MANAGEMENT ATTENTION AND EFFORT
- APS MANAGEMENT UNDERSTANDS THE MAJOR PERFORMANCE ISSUES
- IMPROVEMENT INITIATIVES HAVE BEGUN AND SOME PROGRESS IS EVIDENT IN RESOLVING THE ISSUES
- THE RATE AT WHICH THE ISSUES ARE BEING RESOLVED IS BEING LIMITED BY A NUMBER OF FACTORS

FACTORS LIMITING RATE OF IMPROVEMENT

- INSUFFICIENT TOP LEVEL IMPROVEMENT PROGRAM INTEGRATION
- A LACK OF SYSTEMATIC/COMPLETE PROGRAM PLANS AND IMPLEMENTING STRATEGIES
- INSUFFICIENT MANAGEMENT OVERSIGHT OF IMPROVEMENT EFFORTS
- ORGANIZATIONAL INSTABILITY, UNCERTAINTY AND INSECURITY