NUREG–0847
Supplement No. 17

Safety Evaluation Report

related to the operation of
Watts Bar Nuclear Plant,
Units 1 and 2

Docket Nos. 50–390 and 50–391

Tennessee Valley Authority

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

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ABSTRACT

This report supplements the Safety Evaluation Report (SER), NUREG-0847 (June 1982), Supplement No. 1 (September 1982), Supplement No. 2 (January 1984), Supplement No. 3 (January 1985), Supplement No. 4 (March 1985), Supplement No. 5 (November 1990), Supplement No. 6 (April 1991), Supplement No. 7 (September 1991), Supplement No. 8 (January 1992), Supplement No. 9 (June 1992), Supplement No. 10 (October 1992), Supplement No. 11 (April 1993), Supplement No. 12 (October 1993), Supplement No. 13 (April 1994), Supplement No. 14 (December 1994), Supplement No. 15 (June 1995), and Supplement No. 16 (September 1995) issued by the Office of Nuclear Reactor Regulation of the U.S. Nuclear Regulatory Commission with respect to the application filed by the Tennessee Valley Authority, as applicant and owner, for licenses to operate the Watts Bar Nuclear Plant, Units 1 and 2 (Docket Nos. 50-390 and 50-391). The facility is located in Rhea County, Tennessee, near the Watts Bar Dam on the Tennessee River. In this supplement, NRC examines the significant problems of construction quality and quality assurance effectiveness that led TVA to withdraw its certification in 1985 that Watts Bar Unit 1 was ready to load fuel. Also discussed are the extensive corrective actions performed by TVA according to its nuclear performance plans and other supplemental programs, and NRC's extensive oversight to determine whether the Watts Bar Unit 1 construction quality and TVA's operational readiness and quality assurance effectiveness are adequate for a low-power operating license to be issued. SSER 17 does not address Watts Bar Unit 2, except for the systems which are necessary to support Unit 1 operation.

CONTENTS

ABBREVIATIONS

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASRR	Additional Systematic Records Review
AWS	American Welding Society
CAP	Corrective Action Program/Corrective Action Plan
CAQ	condition adverse to quality
CATD	Corrective Action Tracking Document
CFR	Code of Federal Regulations
CRS	Concerns Resolution Staff
CNPP	Corporate Nuclear Performance Plan
DBD	design-basis document
DBVP	Design Baseline Verification Program
DCRDR	detailed control room design review
DOE	Department of Energy
DR	discrepancy report
ECP	Employee Concerns Program
ECSP	Employee Concerns Special Program
EQ	environmental qualification
ERT	Employee Response Team
ESQ	equipment seismic qualification
FES	final environmental statement
FSAR	final safety analysis report
HFT-1	first Hot Functional Test
HFT-2	second Hot Functional Test
HVAC	heating, ventilation, and air conditioning
ID	Idaho Operations Office
IDI	Integrated Design Inspection
IFI	inspection followup items
IG	Inspector General
I&H	intimidation and harassment
INPO	Institute of Nuclear Power Operations
IR	inspection report
MC	manual chapter
MELB	moderate energy line break
MFL	Master Fuse List
MIC	microbiologically induced corrosion
NPP	Nuclear Performance Plan
NRC	Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
NSRS	Nuclear Safety Review Staff
ORAT	Operational Readiness Assessment Team
PAC/AQ	Program for Assurance of Completion and Assurance of Quality

PTI	preoperational test instructions
QA	quality assurance
QC	quality control
QIP	Quality Improvement Plan
QTC	Quality Technology Company
RAAR	Reasonable Assurance Assessment Report
SALP	Systematic Assessment of Licensee Performance
SCAR	Significant Corrective Action Report
SER	safety evaluation report
S&L	Sargent and Lundy
SMP	Start-up Manual Procedure
SP	Special Program
SRP	standard review plan
SSER	supplement to safety evaluation report
SWEC	Stone and Webster Engineering Company
TI	temporary instruction
TMI	Three Mile Island
TS(s)	technical specification(s)
TSD	Test Scoping Document
TVA	Tennessee Valley Authority
VSR	Vertical Slice Review
WBPP	Watts Bar Program Plan
WBNPP	Watts Bar Nuclear Performance Plan
WEP	Weld Evaluation Program
WP	Welding Project

EXECUTIVE SUMMARY

Safety concerns in 1985 led Tennessee Valley Authority (applicant or TVA) to shut down Browns Ferry Unit 3 in March 1985 (Browns Ferry Unit 1 was already shut down to correct the problems of environmental qualification of electrical equipment, and Browns Ferry Unit 2 was shut down for extended modification work); both Sequoyah units in August 1995; and, later in April 1986, withdraw its certification that Watts Bar Unit 1 was ready for fuel-load. The specific reasons for the actions at the three sites were different, but they all had a common root cause: programmatic and management deficiencies in TVA's nuclear programs. In the spring of 1985, TVA employees informed NRC and some members of the United States Congress of many safety concerns related to the Watts Bar facility. TVA also learned of the employee concerns about nuclear safety through its own Employee Concerns Program. Some of the employees expressed to NRC a fear of reprisals from TVA's management for bringing safety issues to NRC's attention. On September 17, 1985, NRC issued the fifth Systematic Assessment of Licensee Performance (SALP) report to TVA. In the letter forwarding the SALP report, the staff informed the applicant that it had demonstrated ineffective management in many areas of its nuclear program. The staff identified three general areas of concern for which it asked TVA to address specific corrective actions in its response. The three areas were programmatic and management deficiencies; plant-specific deficiencies at Browns Ferry, Sequoyah, and Watts Bar sites; and a lack of confidence expressed to NRC by a number of TVA employees. The NRC staff asked that, in order for NRC to determine whether TVA's licenses should be modified or suspended or an application denied TVA submit, pursuant to 10 CFR 50.54(f) under oath or affirmation, information about its plans for correcting its problems.

TVA responded to the staff's September 17, 1985, letter with an integrated plan consisting of a Corporate Nuclear Performance Plan as Volume I, and site-specific nuclear performance plans for Sequoyah, Browns Ferry, and Watts Bar as Volumes II, III, and IV, respectively. The staff reviewed TVA's plans and subsequent revisions to those plans, and found them acceptable. The staff concluded that TVA's nuclear performance plans were comprehensive and, if implemented thoroughly, were capable of addressing the identified problems.

TVA implemented its nuclear performance plans and made modifications to Watts Bar Unit 1 to address many problems related to construction quality and quality assurance identified since 1985. Although TVA developed adequate plans to correct problems of construction quality and quality assurance, implementation of these plans was not initially effective. TVA stopped work at Watts Bar Unit 1 in December 1990 to eradicate the root causes of problems of ineffective work control.

The overall trend in the quality of TVA's corrective actions has improved since 1991, although there have been some problems identified at points along the way. The improved quality of the design output documents, the improved work control process, and better attitudes about quality control have resulted in a general trend of significant improvement in construction quality.

However, during the summer of 1994, the staff pointed out problems with TVA's implementation of corrective actions. TVA's quality assurance organization made similar findings. There were several specific cases identified in late summer and the early fall of 1994 in which work that TVA considered complete was found either not to have been completed or to be deficient. After discussions between the staff and TVA management on the implications of these problems, TVA took measures to correct the problems and to prevent their recurrence. TVA's management and quality assurance organizations are now effectively identifying problems of implementation of corrective actions and are proactive in correcting them. Implementation of corrective actions is not complete, but is proceeding satisfactorily. Further NRC inspections are planned to confirm the adequacy of corrective actions before fuel load and low-power operation are authorized.

The history of implementation of corrective actions specified in TVA's nuclear performance plans has been one of identification of problems and improvements in implementation of corrective actions over a long time period. The improvements have occurred following TVA's self-assessments of its performance and implementation of corrective actions for NRC inspection findings. The progress in improvement of performance occurred largely after the December 1990 construction stoppage and has continued to a point that 1995 performance is considered adequate.

In June 1995, TVA concluded in its "Reasonable Assurance Assessment Report," for Watts Bar Unit 1, that its employee concerns programs have effectively addressed the concerns raised in the past, and that the present Concerns Resolution Program is responsive to current employee concerns. NRC's inspections have addressed concerns regarding NRC-regulated activities and programmatic controls in place to prevent retaliatory action against those employees who report concerns. The inspections show that the employee concerns programs in place at Watts Bar Unit 1 are effective, that the number of employee concerns has decreased significantly, and that a large percentage of TVA employees have confidence in TVA's overall nuclear programs. NRC concludes that TVA is effectively addressing safety concerns raised by employees.

The NRC staff inspected TVA's readiness to operate Watts Bar Unit 1 and found that programs and procedures, including emergency operating procedures, are in place and adequate to support startup and operation of the plant. The plant staff has been adequately trained and is qualified to support plant operations. Operators have been recently tested and are licensed to operate the plant. At the NRC's request, TVA performed a second Hot Functional Test between July 24 and August 22, 1995, as a demonstration of readiness to operate Watts Bar Unit 1. All activities were conducted or simulated as if fuel were present in the reactor. Operator performance during the second Hot Functional Test was adequate and significantly improved over that of the first Hot Functional Test in the spring of 1994. The Watts Bar operating organization evaluation and resolution of emergent problems during the recent hot functional testing were appropriate. The Quality Assurance organization is adequately staffed with qualified personnel to support plant startup and operation. Self-assessments have been objective, producing results consistent with NRC findings.

The quality, construction, and material condition of the rooms and areas turned over to the operating organization have been good. The systems turned over are generally complete and functional, and meet the design requirements. Preoperational testing indicates that systems can be expected to perform as described in the Final Safety Analysis Report (FSAR).

The NRC staff concludes that the management and safety problems that led to TVA's withdrawal in 1986 of its certification for fuel load are being effectively corrected. Although substantial progress has been made, all the work necessary to certify readiness for fuel load and low-power testing is not yet complete. NRC will supplement its conclusions on the effectiveness of TVA's corrective actions in a future supplement after TVA completes the remaining construction and preoperational testing, and certifies to NRC its readiness to load fuel.

1 INTRODUCTION AND DISCUSSION

1.1 Introduction

In June 1982, the Nuclear Regulatory Commission staff (NRC staff or staff) issued a Safety Evaluation Report, NUREG-0847, regarding the application by the Tennessee Valley Authority (TVA or the applicant) for licenses to operate the Watts Bar Nuclear Plant, Units 1 and 2. The Safety Evaluation Report (SER) was followed by SER Supplement No. 1 (SSER 1, September 1982), Supplement No. 2 (SSER 2, January 1984), Supplement No. 3 (SSER 3, January 1985) Supplement No. 4 (SSER 4, March 1985), Supplement No. 5 (SSER 5, November 1990), Supplement No. 6 (SSER 6, April 1991), Supplement No. 7 (SSER 7, September 1991), Supplement No. 8 (SSER 8, January 1992), Supplement No. 9 (SSER 9, June 1992), Supplement No. 10 (SSER 10, October 1992), Supplement No. 11 (SSER 11, April 1993), Supplement No. 12 (October 1993), Supplement No. 13 (SSER 13, April 1994), Supplement No. 14 (SSER 14, December 1994), Supplement No. 15 (SSER 15, June 1995), and Supplement No. 16 (SSER 16, September 1995). To date, the staff has completed its review of the applicant's Final Safety Analysis Report (FSAR) up to Amendment 89.

This SSER documents the staff's overall assessment of the quality of construction, operational readiness, and the effectiveness of quality assurance at Watts Bar Unit 1.

The staff concludes that the applicant has made substantial progress in completing work to correct the problems of construction of Watts Bar Unit 1 and to assure that the plant has been built in accordance with the design documents, applicable codes and standards, and the FSAR. Further, the staff of the Operations organization at Watts Bar Unit 1 is capable of operating the plant safely. In addition, management and safety problems which led to TVA's withdrawal of its certification in 1986 that Watts Bar Unit 1 was ready to load fuel are being corrected. Although substantial progress has been made, all work necessary to certify readiness to load fuel is not yet complete. The NRC staff will supplement its conclusions after all work is completed.

The SER and its supplements were written to agree with the format and scope outlined in the Standard Review Plan (SRP, NUREG-0800). Issues raised by the SRP review that were not closed out when the SER was published were classified into outstanding issues, confirmatory issues, and proposed license conditions. See Sections 1.7, 1.8, and 1.9, respectively, of SSER 16 (dated September 1995).

In addition to the guidance in the SRP, the staff issues generic requirements or recommendations in the form of technical reports, bulletins and generic letters. Each of these documents carries its own applicability, work scope, and acceptance criteria; some are applicable to Watts Bar. The review and implementation status of applicable generic issues are addressed in Appendix EE of SSER 16.

The chronology of this safety review appears in earlier SSERs. Appendix E lists principal contributors to this supplement. The other appendices are not changed by this supplement.

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24 OVERALL ASSESSMENT OF THE QUALITY OF CONSTRUCTION, OPERATIONAL READINESS, AND QUALITY ASSURANCE EFFECTIVENESS OF WATTS BAR UNIT 1

24.1 Introduction

24.1.1 Purpose of the Assessment

In this chapter, the NRC staff examines the significant problems at the Watts Bar Nuclear Plant (Watts Bar) Unit 1 concerning construction quality and quality assurance (QA) that caused the Tennessee Valley Authority (applicant or TVA) in April 1986 to withdraw its certification that it was ready to load fuel at Watts Bar Unit 1 and outlines the actions taken by TVA to correct these problems. This chapter also examines the improvements made by NRC since the early 1980s to eliminate the causes that led to its ineffective regulatory oversight.

The staff assesses TVA's efforts to eradicate the root causes of the safety problems that led to TVA's withdrawal of its certification that it was ready to load fuel in Watts Bar Unit 1 in 1986. Additionally, the staff assesses the success achieved by TVA in detecting and correcting the management and safety problems of its corrective actions at Watts Bar since 1986, and the success achieved by NRC in correcting its own problems that led to its ineffective regulatory oversight of Watts Bar Unit 1.

Finally, the staff also assesses TVA's organizational structure, and the applicant's programs for operating Watts Bar Unit 1 and assuring quality, in order to determine whether Watts Bar Unit 1, if licensed, can be expected to operate safely.

The history of construction problems and the implementation of corrective actions specified in TVA's nuclear performance plans has been one of identifying problems and improving implementation of corrective actions over more than 22 years since the construction permit was issued for Watts Bar Unit 1. The improvements have followed TVA's self-assessments of its performance and implementation of corrective actions for NRC inspection findings. In this chapter, the staff assesses whether adequate corrective actions are in place and if the applicant complies with NRC requirements for readiness to load fuel and operate Watts Bar Unit 1 at low power.

24.1.2 Organization of the Chapter

The staff describes the historical perspective and problems addressed between 1985 and 1991 (Section 24.2). TVA's plans and NRC's actions to recover from the problems of declining construction quality and effectiveness of quality assurance programs in mid-1985 are discussed in Sections 24.3 and 24.4. Significant regulatory issues, such as employee concerns programs (Section 24.3) and welding, electrical cables, and quality assurance records (Section 24.5), are discussed beyond 1991 to keep the material cohesive. NRC activities to improve its regulatory oversight are discussed in Section 24.6. The problems of Watts Bar construction and corrective actions performed after the restart of construction in 1991 were of different character from those that occurred in 1985, and these are discussed separately in Section 24.7. In

Section 24.8, the staff discusses the integrated approach to assure that the present construction quality at Watts Bar is acceptable. NRC has used its oversight of TVA's activities to assess TVA's latest performance and the trend of that performance. NRC assessment of the recent performance and its trend is discussed in Section 24.9. Section 24.10 is the NRC review of TVA's "Reasonable Assurance Assessment Report" on Watts Bar. Section 24.11 describes TVA's qualifications and assesses its readiness to operate Watts Bar Unit 1. NRC's overall assessment of this study is in Section 24.12.

24.2 Historical Overview Of Construction Problems

On January 23, 1973, NRC issued a construction permit for Watts Bar Unit 1. On February 20, 1985, TVA certified that Watts Bar Unit 1 was ready to load fuel. In the February 20, 1985, letter, TVA certified that the design, construction, testing, and preparation for operating Watts Bar Unit 1 had essentially been completed in accordance with descriptions contained in the Final Safety Analysis Report (FSAR) and other licensing documents. In the spring of 1985, a number of TVA employees informed NRC and some members of Congress of safety concerns primarily related to Watts Bar. TVA also learned of a large number of employee concerns through its own organization. The concerns indicated that many TVA employees had lost confidence in TVA's overall nuclear management and its ability to conduct nuclear activities properly. Some of these employees also expressed fear of reprisal from TVA management for voicing concerns. On May 30, 1985, NRC asked TVA to submit a compilation of all reviews that supported TVA's conclusion that the Watts Bar facility complied with its licensing commitments.

In early 1985, recognizing that its existing programs to resolve employee concerns were not fully effective, TVA implemented the Employee Response Team (ERT) program at Watts Bar to collect and systematically investigate employee concerns relating to the design and construction of Watts Bar specifically, and the TVA nuclear power program in general. TVA's independent Nuclear Safety Review Staff (NSRS) was assigned the responsibility for the ERT program. In May 1985, TVA awarded a contract to Quality Technology Company (QTC) to confidentially interview all TVA employees associated with Watts Bar. In addition, QTC allowed employees from other TVA nuclear sites who had also worked at the Watts Bar site to add their concerns about the Watts Bar program (see Section 1.16 of SSER 13).

During that period in 1985 when these events were taking place, NRC conducted the Systematic Assessment of Licensee Performance (SALP) for all TVA plants. In the September 17, 1985, letter that transmitted the SALP for all TVA sites, NRC stated that TVA had demonstrated ineffective management of its nuclear program by its continued poor performance. Also, in the September 17, 1985, letter, NRC concluded that TVA's performance was only marginally acceptable and confirmed TVA's verbal commitment not to restart the previously shut down Browns Ferry Units 1, 2, and 3, and Sequoyah Units 1 and 2 without NRC concurrence. NRC requested, pursuant to 10 CFR 50.54(f), that TVA submit information about its plans for correcting programmatic and management deficiencies throughout the TVA nuclear program, for correcting the site-specific problems that contributed to each of the SALP areas rated as a Category 3, and for correcting the lack of confidence in TVA management expressed to NRC by TVA employees regarding the adequacy of construction at Watts Bar.

During late 1985 and early 1986, employees continued to express concerns about the construction of Watts Bar. Some of these had come directly to NRC; many were being expressed to QTC. The NSRS, which had been established in the early 1980s, reported directly to the TVA Board of Directors and, as a result, was independent of the line organization. The NSRS inspected the TVA nuclear plants to advise the TVA Board about nuclear safety. In the fall of 1985, an NRC Commissioner asked the NSRS to brief him on its perception of Watts Bar's readiness for an operating license. The NSRS stated that Watts Bar did not meet the requirements of 10 CFR Part 50, Appendix B, which is the NRC quality assurance program regulation that is intended to ensure that nuclear power plants are properly constructed. The concerns expressed were very significant and, as a result, in January 1986, NRC asked TVA to address these concerns formally. TVA responded in March 1986 to the NSRS concerns, and on April 11, 1986, TVA concluded that Watts Bar Unit 1 was not ready for fuel load and confirmed that it was not seeking an operating license for Watts Bar Unit 1 at that time.

In January 1986, the TVA Board of Directors hired Admiral Steven White (U.S. Navy, Retired) to oversee all aspects of TVA's nuclear power program. Admiral White engaged a new team of contract managers from a number of companies with experience in the design, construction, and operation of nuclear power plants. The initial task was to set up a new employee concerns program in order to attempt to regain employee confidence and to develop a revised Corporate Nuclear Performance Plan (CNPP) to address the programmatic and management deficiencies. The new employee concerns program was initiated on February 1, 1986. The revised CNPP was submitted to NRC on March 10, 1986. The employee concerns that QTC had received at Watts Bar before February 1, 1986, were placed into a separate employee concerns program called the "Employee Concerns Special Program" (ECSP). The ECSP contained approximately 6,000 employee concerns dealing with specific aspects of construction; engineering; operations; material control; welding; harassment and intimidation (H&I), and misconduct; management and personnel; quality assurance; and industrial safety. Most of these concerns were specific to Watts Bar.

On March 19, 1986, TVA established a special Watts Bar Task Force, which was comprised of senior personnel experienced in nuclear design and construction, to determine the corrective actions to be completed before fuel load. The resulting corrective actions, known as "Special Programs," grouped similar or related problems previously identified by NRC, INPO[1], outside contractors, and various corporate and site quality assurance processes. Establishing the Watts Bar Task Force was the first action taken to consolidate issues and develop corrective actions to address similar issues collectively through an integrated plan. Because earlier discovery programs found instances of inadequate root cause determinations and inadequate recurrence control for identified weaknesses, questions arose about the degree to which the design and construction of Watts Bar complied with regulatory requirements. Questions also arose about the adequacy of records documenting the acceptability of nonconforming design, construction, and installation.

To provide reasonable assurance that licensing requirements and TVA's commitments would be met, TVA established an independent Watts Bar Program Team in November 1987 to perform an integrated systematic evaluation of Watts

[1] The Institute of Nuclear Power Operations

Bar. The objective of that team was to look beyond the known problems and perform an overall evaluation of plant design and construction in order to identify all of the corrective actions necessary to license Watts Bar. A key part of the systematic evaluation was the performance of a Vertical Slice Review (VSR) by the Sargent and Lundy Company. The VSR was performed between April 1988 and March 1989 and comprised an engineering review, a construction review, and a records review. Its purpose was to confirm that the planned corrective actions were adequate to resolve the problems; however, in the process, the VSR detected an extensive number of deficiencies that previous discovery programs had not revealed.

The Program Team developed the Watts Bar Nuclear Performance Plan and proposed 18 Corrective Action Programs (CAPs) and 11 Special Programs (SPs) to TVA management. The CAPs and SPs did not contain all the work necessary to license Watts Bar. They identified only those areas in which TVA sought NRC's early review and approval of TVA's proposed approach, because NRC disagreement with TVA's approach was likely to delay licensing Watts Bar. The CAPs are general in nature, and contain plans to identify, scope, and resolve technical issues. The resolutions in the CAPs describe the revision of the relevant design output documents and procedures; the establishment of corrective actions for items not in conformance with the design output documents; and the installation, modification, and inspection of the corrective actions. Significant issues, which were not as broad in scope as CAPs or in which substantial progress had already been made towards resolution, were compiled as SPs.

In May 1988, TVA submitted for NRC review its Watts Bar Program Plan (WBPP), which outlined its overall strategy for evaluating Watts Bar. NRC endorsed TVA's WBPP in June 1988. TVA proceeded with the implementation of WBPP until December 1990, when it voluntarily stopped construction to address work control problems at Watts Bar. During the stoppage, TVA decided to hire a contractor to perform all future construction/modification work. Also during the work stoppage, TVA significantly upgraded the work control process and reduced its backlog of items necessary to support construction work. All systems were transferred back to the Engineering and Modifications organization, and in February 1992 a decision was made to repeat the entire preoperational testing program before TVA would certify that it was ready to load fuel at Watts Bar. This retesting was being done to demonstrate and confirm that the safety systems would perform as designed. Limited construction work was restarted in November 1991, and full construction resumed in June 1992. Since construction restarted, almost all work performed has been on Unit 1 and on those Unit 2 systems necessary to support Unit 1 operation.

24.3 Employee Concerns Programs

24.3.1 The Employee Concerns Special Program

TVA established the Employee Concerns Special Program (ECSP) to resolve the approximately 6,000 employee concerns received before February 1, 1986. Some of the concerns were applicable to TVA nuclear plants other than Watts Bar. The ECSP drew concerns from several sources: some were obtained from the confidential interviews conducted by QTC; some were concerns identified by NSRS that were still unresolved; others were concerns that arose from the Stone and Webster Engineering Company (SWEC) review of incoming NRC

correspondence; and still others had been generated by the ECSP evaluators. The concerns were grouped into nine categories (Construction; Engineering; Operations; Material Control; Welding; Intimidation, Harassment, Wrongdoing, or Misconduct; Management and Personnel; Quality Assurance/Quality Control; and Industrial Safety). The concerns in the nine categories were then sorted into 107 subcategories. The subcategories were broken down into elements, which grouped the concerns by issue. Concerns were then investigated by issue. The ECSP investigations revealed that some concerns could not be substantiated (Class A), some were substantiated but did not represent a problem (Class B), in some cases the corrective actions had been implemented but had not been completed (Class C), and, in some cases, corrective action needed to be initiated (Classes D and E). The collective results of the investigations for all the plants were published in category reports and subcategory reports, and these were submitted to NRC on February 6, 1989.

Within the framework of the ECSP, Corrective Action Tracking Documents (CATDs) were issued for validated issues that were believed to need additional corrective actions (Classes D and E). Approximately 700 CATDs were issued that were applicable to Watts Bar (approximately 600 of these were in safety-related categories). With ECSP concurrence, corrective actions were developed by the responsible line organization for the issues identified in the CATDs. These corrective actions were called CATD Corrective Action Plans (CATD CAPs). The program was set up so that when the CATD CAPs are completed, the employee concerns will be resolved. An independent verification process was established to ensure that the CAPs were properly completed. The independent verification process was usually assigned to the QA organization.

A deviation process was later established to allow for changing the CATD CAPs. The deviation process established a Senior Review Panel to assess changes and determine their acceptability. In addition, the process classified the deviations into three levels according to safety significance and established criteria to be considered when NRC concurrence was needed. Level I deviations were defined as deviations from technical specifications, deviations from the design basis, deviations from the FSAR, or deviations that could cause a reduction in safety margins. Level II deviations were those that affected multiple plants, had programmatic areas of weakness, deviated from the techniques or methods established in commitments, or involved organizational changes that directly affect CATD CAP closure. Level III deviations were described as "all other changes."

In late 1988, ECSP staff realized that the ties between the Class D and E employee concerns and the CATDs that resolved them had not been adequately documented. As a result, the overview process was set up to perform a final review to ensure the corrective actions resolved the associated employee concerns. This included linking the employee concerns with the associated CATDs.

24.3.1.1 NRC Review of Employee Concerns Special Program

NRC accepted the programmatic aspects of the TVA ECSP in a letter dated October 6, 1987. The NRC approach was to review the implementation for each plant as the corrective actions were identified and implemented. Initially, TVA published the results of the investigations for Sequoyah in element reports. To support the restart of Sequoyah, NRC documented its reviews of the specific Sequoyah element reports in letters to TVA dated March 11 and

November 11, 1988. This was an initial look at the ECSP implementation, since the collective results for all the plants were published in category reports and subcategory reports which were submitted to the NRC on February 6, 1989. NRC published the initial sample review results for the subcategory reports for Browns Ferry Unit 2 restart (15 of 107) on May 31, 1990. In a letter to TVA dated April 15, 1991, NRC accepted a deviation process to approve corrective action changes.

For Watts Bar, NRC initially planned to review a sample of the safety-related subcategory reports, as was done for the Browns Ferry review. However, because NRC had reviewed all of the 29 CAPs and SPs, which included the ECSP corrective actions for those areas, the staff concluded in NUREG-0847 Supplement 9 that it had fulfilled its commitment to review the ECSP subcategory reports for Watts Bar.

NRC is inspecting the ECSP corrective action implementation at Watts Bar under Temporary Instruction (TI) 2512/15. Many of the CATDs are reviewed in conjunction with the CAP/SP inspections. Initially, NRC focused its inspections on the CATD process. In mid-1993, these inspections indicated that approximately 10 percent of the CATD corrective actions had not adequately resolved the associated employee concern(s) and that between 15 and 20 percent of the CATD closure packages contained deficiencies. In addition, NRC inspections indicated that some of the corrective actions that were already in place before the ECSP investigation, but that were not complete (Class C employee concerns), may not have been completed (NRC Inspection Report (IR) 50-390, 391/93-24). As a result of these findings, TVA initiated the "Lookback Project" discussed next.

24.3.1.2 Lookback Project

In response to the NRC's inspection findings, TVA initiated the Lookback Project to ensure that all corrective actions (Class C and CATDs) taken in response to employee concerns were completed and that the employee concerns were adequately resolved. The Lookback Project review of Class C concerns revealed that corrective actions for some Class C employee concerns were being tracked to closure by CATDs. The ECSP had initiated CATDs for Class D and E concerns for which no corrective action was in place, but not for Class C employee concerns. NRC questions about the validity of ECSP classification of concerns, and confirmation by the Lookback Project during the Class C employee concern reviews that classification methodology was not always adhered to, led TVA to expand the Lookback Project to also include the review of the classification of Class A and B employee concerns. Results of the Class A and B review confirmed that the original ECSP classifications did not always serve the classifications described in the subcategory reports. The Lookback Project reclassified the Class A and B concerns as "legitimate" and "not legitimate," upgrading approximately a third of the unsubstantiated concerns reviewed. The basis for the upgrade was that (1) corrective action for the area that the employee concern addressed was taken as a result of previous corrective action that was completed before the ECSP review, (2) corrective action was being taken through a similar CATD or Class C concern, or (3) corrective action was initiated after the ECSP reviews were completed. The upgrade allowed Lookback to confirm that the concerns were properly resolved through the already established process being used for the Class C and CATD verification process.

Collectively, the Lookback effort significantly improved the confidence that employee concerns contained in the ECSP were adequately resolved. The overall review effort of the Lookback Project has revisited all employee concerns in the ECSP to ensure that corrective action was being taken for concerns that needed correction. Although the original intent of the Lookback Project was to address only CATDs and Class C concerns, TVA expanded the program to ensure that all employee concerns that needed correcting were getting such action and were being properly closed. This included a verification through sample review that the post-1986 employee concern program was also properly classifying and resolving concerns.

Initial NRC inspection of the Lookback Project effort on Class C employee concerns (IR 50-390, 391/93-83) noted a lack of attention to detail, particularly in relation to documentation. However, Lookback Project management had already recognized this weakness and was well along in correcting the problem. Similar reviews were conducted under the Lookback Project for CATD, and the same documentation method was used. A later NRC inspection (IR 50-390, 391/94-10) found that the level of detail in the CATD documentation was greater than the level of detail observed in the inspection of Class C reviews reported in IR 50-390, 391/93-83, and was adequate. NRC inspection of the Class A and B review (IR 50-390/94-30) revealed that some Lookback reviews were not only shallow, but also that they missed the proper classification. However, TVA's ECSP missed no issues since, when classifications were missed, other documents (CATDs or Class C concerns) were addressing the same issue. NRC review during the QA Records CAP inspection (IR 50-390, 391/94-40) of some Class A and B concerns indicated that Lookback was having some problems with classification and with the links to the associated corrective actions when investigations into wrongdoing were involved. This problem appeared to result from overlapping organizational responsibilities because of the sensitive nature of wrongdoing investigations. Later inspections have indicated that this problem was corrected by the Concerns Resolution Staff (CRS).

In late 1994, the Quality Assurance organization began trending the quality of CATD closure packages based on using the QA and Lookback review results as quality indicators. Initial trends indicated unsatisfactory results for the line organization. However, this discovery focused management's attention on improvement; quality indicators now indicate that closure packages are of acceptable quality.

Since Lookback was added to the process, NRC inspections show that the percentage of CATDs that would not have resolved the associated employee concerns dropped from approximately 10 percent to 3 percent, indicating that Lookback has significantly improved the CATD verification process.

24.3.2 Concerns Resolution Program

TVA established the Employee Concerns Program (ECP) for handling all employee concerns raised after February 1, 1986. Those concerns that had been received earlier remained in the Employee Concerns Special Program discussed in Section 24.3.1 above. This program was a first step in TVA's recovery program to bridge the gap between senior management and employees, and to regain the trust of its employees. The program reported directly to the new Manager of Nuclear Power, bypassing the management chain that the earlier employee concerns had described as being a bottleneck to the identification and

correction of problems at Watts Bar. The Employee Concerns Program was retitled Concerns Resolution Program on July 16, 1991. The program did not change its function.

The Concerns Resolution Staff (CRS) comprises a concerns resolution manager, located at the corporate office in Chattanooga, and a site representative at each of TVA's nuclear sites. Each site and the corporate location have a small staff to receive and investigate employee concerns. The TVA corporate standard that discusses the Concerns Resolution Program encourages employees to express concerns directly to their supervisors and establishes that one of a supervisor's primary responsibilities is listening to employee concerns and assisting in their resolution. The Concerns Resolution Program provides an alternate avenue for employees to express concerns, maintaining confidentiality when requested.

In 1986, all employee concerns were investigated independently by the ECP staff. In 1988, the ECP staff began referring some concerns to line management for investigation, protecting the concerned individual's identity. After 1990, essentially all employee concerns were referred to the line organization for investigation. The corporate standard gives guidance for the referral, such as independence from the specific line organization involved and consent from the concerned individual. The CRS function then becomes one of monitoring and reviewing the investigation performed by the line organization. All correspondence with the concerned individual is handled through CRS, unless the concerned individual does not object to talking directly with the line organization.

In 1991 and 1992, TVA began requiring major contractors to set up their own employee concerns programs; this requirement was part of the contract language. CRS audits these contractor programs and closely monitors their performance and the concerns being received. Contractors must immediately report harassment and intimidation concerns to CRS. In addition, the TVA's Inspector General (IG) audit of the Concerns Resolution Program also reviews the contractor program implementation.

The number of employee concerns received per year by the program has decreased from 551 in 1986 to fewer than 75 per year at present.

24.3.2.1 NRC Review of Concerns Resolution Program

NRC reviewed and documented its acceptance of the Employee Concerns Program in NUREG-1232, Volume I, dated July 1987 (now called Concerns Resolution Program). NRC inspections of the program in 1990, 1992, and 1993 indicated that the program was adequately resolving the technical issues raised by TVA employees. CRS refers issues dealing with intimidation and harassment to the TVA IG. The 1992 and 1993 inspections determined that the referrals to the TVA IG were being properly made. In a 1994 inspection, it was found that not all persons leaving Watts Bar were being interviewed (exit interview) by an employee concerns representative (either CRS or contractor ECP) as required by the corporate and site procedures. It seems that both managers and employees were misinterpreting the checkout form. To correct the situation, TVA clarified how to use the checkout form and mailed questionnaires to the individuals who had left the site without having had the exit interview.

In the 1993 inspection, NRC interviewed a significant number of employees. A very large percentage expressed confidence in the program and supported continuing it. The NRC interviewers also found strong support for the program among senior managers. NRC has concluded that the program is reasonably effective and is needed. However, no clear link is found between plant performance and number of employee concerns received, or between ECP and number of employee concerns received.

24.3.3 Conclusion

NRC inspections addressed concerns regarding NRC-regulated activities and programmatic controls in place to prevent retaliatory actions against those employees who report concerns. NRC's inspections showed that the number of employee concerns had decreased significantly and that a large percentage of TVA employees had confidence in TVA's nuclear programs. NRC concludes that TVA has an effective Employee Concerns Program that is responsive to its employees' safety concerns.

24.4 Recovery Plan

24.4.1 Nuclear Performance Plans

The Nuclear Performance Plans were TVA's response to NRC's September 17, 1985, request for information pursuant to 10 CFR 50.54(f). In that letter, NRC stated that TVA had demonstrated ineffective management of its nuclear program by its continued poor performance, which was only marginally acceptable. NRC requested, pursuant to 10 CFR 50.54(f), that TVA submit information about its plans for correcting (1) programmatic and management deficiencies throughout the TVA nuclear program, (2) the site-specific problems that contributed to each of the SALP areas rated as a Category 3, and (3) the lack of confidence in TVA management expressed to NRC by TVA employees regarding the adequacy of construction of Watts Bar. TVA responded by addressing the corporate information requests in Volume I of the Nuclear Performance Plan and the site-specific requests in a separate volume of the Nuclear Performance Plan for each site. Volume IV was TVA's Nuclear Performance Plan for correcting the construction problems and other problems at Watts Bar.

The Corporate Nuclear Performance Plan addressed the requests for information about actions planned by the TVA Board of Directors to remain informed about and involved in improving nuclear plant performance (including (1) experience and qualifications of personnel filling new assignments, (2) corporate controls established to ensure that the status of TVA commitments to NRC is tracked, and (3) the program for escalating action on QA audit findings) to ensure problems are quickly resolved. TVA reorganized to place all nuclear power functions under a single manager reporting directly to the TVA Board of Directors. Previously, nuclear functions were fragmented under several organizations with the Engineering, Construction, Security, and Nuclear Power organization under separate managers reporting to the TVA Board, and the Quality Control function split among many departments. TVA considered part of its problem to be inexperienced managers. To correct that problem, TVA hired retired Admiral Steven White to lead its nuclear program. Other contract managers were also hired to fill key positions. Under this plan, TVA set up a new Employee Concerns Program, increased upper management awareness of nuclear activities, improved management systems and controls, and improved the Corrective Action Program. An important function of the management systems

and controls was the corporate procedures system to govern and standardize activities for TVA's Office of Nuclear Power.

The Watts Bar Nuclear Performance Plan (Volume IV) addressed the requests for information relating to the Watts Bar site, specifically with respect to employee lack of confidence in TVA management regarding the adequacy of construction at Watts Bar. TVA formed an independent Watts Bar Program Team to perform an integrated systematic evaluation of Watts Bar. The Watts Bar Program Team was to look beyond known problems and perform an overall evaluation of plant design and construction in order to identify the necessary corrective actions. The Watts Bar Program Team developed a program plan for performing a systematic evaluation of Watts Bar design and construction, for developing corrective actions, and for preparing the Watts Bar Nuclear Performance Plan.

The systematic evaluation included the development of 80 elements and 3,300 attributes which were to be confirmed in compliance with licensing requirements and TVA commitments. The systematic evaluation also included an independent Vertical Slice Review, conducted by the Sargent and Lundy Company, to independently verify that the design and construction of Watts Bar Unit 1 meets its licensing commitments. The systematic evaluation identified a number of nonconforming conditions. However, the most significant result from this effort was the grouping of broad scope, generic, or programmatic issues into Corrective Action Program plans, and the development of Special Programs to address corrective action for other significant issues (discussed below).

The Watts Bar Nuclear Performance Plan documents the Watts Bar Program Team's approach and the results of the team's reviews. The WBNPP also describes other changes necessary to complete and license Watts Bar. These included implementation, verification, and closure of corrective actions; management and organization changes; management control and involvement changes; lessons learned from the restart efforts at the Sequoyah and Browns Ferry sites; and the Operational Readiness Program.

24.4.1.1 NRC Acceptance of Corporate Nuclear Performance Plan

NRC staff reviewed the Corporate Nuclear Performance Plan and issued a Safety Evaluation Report (SER) (NUREG-1232, Volume I) on TVA's revised Corporate Nuclear Performance Plan in July 1987. The NRC staff found that TVA's revised Corporate Nuclear Performance Plan (Revision 4) was acceptable. The staff concluded that the organization and staffing of TVA's Office of Nuclear Power and the programmatic improvements in place or under way were sufficient, if implemented properly, to resolve the problems at the corporate level that led to issuance of the 10 CFR 50.54(f) letter of September 17, 1985, and to support continuing TVA nuclear activities, including plant operations.

24.4.1.2 NRC Acceptance of Watts Bar Nuclear Performance Plan

NRC staff reviewed the Watts Bar Nuclear Performance Plan (WBNPP) and issued an SER on it (NUREG-1232, Volume IV) in January 1990. In NUREG-1232, NRC endorsed the general approaches of various corrective actions described in the WBNPP, and stated that the endorsement was limited to the approach and general methods. If adequately developed into Corrective Action Programs and implemented thoroughly, the approach and the methods were capable of addressing the revealed deficiencies. A revised WBNPP (Revision 1) was issued

in September 1991, but the NRC staff determined that it did not present any significant changes (see Section 1.13 of SSER 9).

24.4.1.3 Sargent and Lundy Vertical Slice Review

The Sargent and Lundy (S&L) Vertical Slice Review (VSR) was a principal element of the systematic evaluation contained in TVA's Nuclear Performance Plan. The VSR provided an independent, systematic, structured, and comprehensive evaluation of the adequacy of the design and construction of Watts Bar structures, systems, and components. The VSR was performed by S&L in 1988 and 1989 on the component cooling system and emergency auxiliary power system.

The VSR utilized a "top down" review approach which was conducted by comparing licensing requirements and design-basis documents with design output documents (e.g., drawings and construction specifications), and finally with installed hardware and associated QA/QC records for representative elements of the systems selected. The VSR was conducted in accordance with a formal plan that the NRC had reviewed in August 1988. A total of 507 discrepancy reports (DRs) resulted from the VSR.

The open DRs were tracked and controlled in an administrative control program documented by onsite procedures. The objective of the onsite program was to ensure that all corrective actions were accurately identified, tracked, and reviewed for closure to ensure that commitments were met.

24.4.1.4 NRC Inspection of Vertical Slice Review

An NRC team inspected the VSR effort on two occasions at the S&L corporate office in Chicago, Illinois. The first inspection, conducted between November 28 and December 2, 1988, reviewed the contractor's methodology for assessing the engineering verification portion of the VSR. As a result of that inspection, NRC concluded that the methodology for assessing the design adequacy of selected systems was adequate. NRC reported the inspection results in IR 50-390/88-09, issued on February 27, 1989.

The second NRC inspection was conducted between February 13 and 17, 1989. The team examined QA audits, personnel qualifications, 10 CFR Part 21 compliance, and internal review committee functions, and reviewed 36 VSR-documented discrepancies in the areas of records, construction, and engineering. The inspectors concluded that the methodology for assessing the design adequacy of selected systems was adequate. NRC reported the inspection results in IR 50-390/89-02, issued on May 2, 1989.

The NRC staff continued its evaluation of the VSR by conducting several follow-up onsite inspections of TVA's implementation and adequacy of the resolution of VSR DR findings. NRC reported the results of the followup inspections in IRs 50-390, 391/93-40, 93-42, 93-45, 93-51, 93-58, and 94-66.

NRC inspections uncovered some deficiencies in the TVA resolution and closure process of the outstanding VSR DRs. However, generally, the various team inspections and ongoing onsite inspections have determined that the VSR review performed by S&L was thorough and adequate. The TVA onsite resolution of the issues identified by the VSR have also been generally adequately resolved. NRC's remaining concern is completion and closure of the open DRs.

24.4.2 Corrective Action Program Plans and Special Programs

The systematic evaluation conducted by the Watts Bar Program Team revealed a number of nonconformances. The broad-scope, generic, or programmatic issues formed the basis of the Corrective Action Program (CAP) plans. Other significant issues formed the basis of the Special Programs (SPs). Portions of these issues were identified earlier as deficiencies in the Corrective Action Program, the ECSP, the Vertical Slice Review, and by NRC open items. The applicant identified these specific items (e.g., CATDs, VSR DRs, CAQs, and NRC open items) for each CAP in a July 13, 1989, letter to NRC. The CAPs were intended to address the root cause by collectively evaluating the individual items to ensure the corrective actions for the CAP bounded and resolved the broad-scope, programmatic, and generic issues. The CAPs are listed below:

Cable Issues
Cable Tray and Tray Supports
Design Baseline and Verification Program
Electrical Conduit and Conduit Support
Electrical Issues
Equipment Seismic Qualification (ESQ)
Fire Protection
Hanger and Analysis Update Program
Heat Code Traceability
Heating, Ventilation, and Air Conditioning (HVAC) Duct and Duct Supports
Instrument Lines
Prestart Test Program
QA Records
Q-List
Replacement Items Program
Seismic Analysis
Vendor Information Program
Welding

The Prestart Test Program CAP was rescinded in 1991 after TVA committed to repeat the entire preoperational test program.

Many issues that were either not as broad in scope as CAPs or in which progress toward resolution had already been made (e.g., several reports had been submitted to NRC) were bounded in a number of Special Programs. These programs were not submitted to NRC for prior endorsement of approach because they were not as broad in scope, or because significant progress had already been made in their implementation. However, NRC reviewed these programs along with CAPs. Each SP was briefly described in the Watts Bar Nuclear Performance Plan. The SPs are listed below:

Concrete Quality Program
Containment Cooling
Detailed Control Room Design Review (DCRDR)
Master Fuse List
Environmental Qualification (EQ) of Electrical Equipment
Mechanical Equipment Qualification
Microbiologically Induced Corrosion (MIC)
Moderate Energy Line Break (MELB) Flooding
Radiation Monitoring System
Soil Liquefaction

Use-As-Is Conditions Adverse to Quality (CAQs)

24.4.2.1 NRC Acceptance of CAPs and SPs

In NUREG-1232, NRC evaluated the CAPs, for which TVA requested NRC's prior approval and SPs as a part of its review of TVA's WBNPP. NRC endorsed the general approaches and methods proposed by TVA, and stated that the NRC endorsement was limited to the approach and general methods which, if properly developed and thoroughly implemented, were capable of addressing the identified deficiencies. NRC comments on a number of CAPs resulted in significant changes as documented in NUREG-0847 supplements.

24.4.2.2 NRC Inspections of CAPs and SPs

TVA formulated the Corrective Action Program plans and Special Programs as part of the systematic evaluation by the Watts Bar Program Team. The CAPs and SPs do not encompass all the work necessary to license Watts Bar. However, they do consolidate issues and identify areas in which collective corrective actions can be more effective by use of an integrated plan. TVA developed 18 CAPs and 11 SPs and NRC accepted them. NRC believed that there was a specific need to identify inspection effort for the CAPs and SPs. As a result, temporary instructions (TIs) were written to direct inspection activities for the CAPs and SPs. The TIs were based on a perceived need to conduct both interim inspections and a final inspection to monitor the implementation of each CAP and SP. TVA and NRC agreed that the criterion for determining that TVA was ready for the 75-percent inspections was that TVA's engineering work was 100-percent complete and field work was 50-percent complete. This would allow NRC inspectors to review the engineering approach that would be taken to resolve the identified problems and to observe how that approach was being implemented in the remaining field work. All CAPs have had interim (75%) inspections; most have had just one 75-percent inspection. The 100-percent inspection then concentrated on confirming that the implementation actually achieved the objectives.

Because the CAPs and SPs represent the activities that were directed toward correcting safety problems that posed greatest risk at Watts Bar, NRC decided to inspect or audit the completion of all CAPs and SPs. The total number of CAPs/SPs decreased from 29 to 28 when TVA decided to repeat essentially the entire preoperational test program and withdrew the Prestart Test CAP. The NRC's Office of Special Projects (OSP) conducted early review and closure of these programs; TVA completed the Heat Code Traceability CAP, the Seismic Analysis CAP, and the Concrete Quality SP, and NRC closed the issues in 1990. In 1992, an inspection of the Master Fuse List SP revealed weaknesses in TVA's CAP/SP completion and readiness review process. Also in 1992, due to the many issues that are linked to the CAP/SP—such as employee concerns and open items—NRC asked TVA to submit specific completion information for each CAP and SP. As this process evolved, TVA developed binders or "books" for each CAP and SP. These books were intended to be living documents to be updated periodically with status information and which could be used by both TVA and the NRC to conduct reviews. Before the books were developed, a basic inspection process was established: NRC could conduct inspections against the CAPs/SPs as needed, but TVA would, as a minimum, inform the NRC before conducting its inspection. The status books supplemented this effort for each CAP and SP. The inspections were conducted periodically or at set points in the licensing

process. However, all CAPs/SPs that required field modifications were routinely inspected as the work progressed.

For the most part, after the Master Fuse List inspection, the quality of the status books improved, with some notable exceptions. Although inspected much later than the Master Fuse List (MFL) SP, the inspection of the Vendor Information CAP (1993), the Electrical Issues CAP (1994), and the Radiation Monitor SP (1994) were unsatisfactory in several respects. A recurring theme was incomplete or unsatisfactory work, followed by either a QA document review or a cursory hardware review preceding the NRC inspection. Performance in the other CAPs/SPs ranged between strong and comprehensive in several of the mechanical-related programs (MELB SP, HVAC Duct and Duct Supports CAP, Electrical Conduit and Conduit Supports CAP, Cable Tray and Tray Supports CAP, and the Containment Cooling SP) and the Q-List CAP to mediocre in the Replacement Items Program, Hanger Analysis Update Program, Design Baseline and Verification Program, Equipment Seismic Qualification, Instrument Lines, and Cable Issues CAPs, and the Microbiologically Induced Corrosion SP.
As the schedule for completing construction continued to slip in the early 1990s, the CAPs and SPs, most tied directly to system turnovers, also began to slip. Closure or 100-percent inspection was more difficult to achieve. Scheduling inspections became increasingly difficult. Even with this scheduling problem, several CAPs and SPs have been closed independent of the plant completion schedule. These are Use-As-Is CAQs SP, Soil Liquefaction SP, Q-List CAP, QA Records CAP, Microbiologically Induced Corrosion SP, and Master Fuse List SP. The original intent of the 100-percent inspections was to close the CAPs/SPs when all of the work within the program was finished. As the programs began to slip, most 100-percent completion schedule dates moved to within a few weeks of estimated date of fuel load. After several years of inspecting CAPs/SPs, the NRC decided that it would not be feasible to inspect the majority of the remaining CAPs/SPs before fuel load. The closure process was revised in 1994, so that TVA would periodically send completion status to the NRC and NRC staff would decide when to inspect for closure or perform interim inspections. The NRC agreed to close out the CAPs and SPs for which only a limited amount of work remained and then to review that effort with routine inspection followup, before licensing. This process has enabled the bulk of the CAPs/SPs closure inspections to be spread out over a longer period of time.

24.4.3 Conclusion

NRC reviewed TVA's CNPP and WBNPP, and in NUREG-1232, Volume IV concluded that TVA developed an acceptable framework capable of adequately addressing the management concerns and weaknesses found at Watts Bar in 1985. NRC also found that general methods and various corrective action activities described in WBNPP, if adequately developed into Corrective Action Programs and implemented thoroughly, were capable of correcting the deficiencies identified at Watts Bar.

Sargent and Lundy's VSR was an independent, systematic, structured, and comprehensive evaluation of the adequacy of the design and construction of Watts Bar structures, systems, and components. NRC found that TVA has adequately resolved the issues identified by the VSR.

TVA has adequately developed the Corrective Action Programs and is thoroughly implementing them; and NRC programs for inspection and closure of the

Corrective Action Programs are effective in achieving satisfactory closure of corrective actions. NRC has determined that, as of September 1995, 22 of the 28 CAPs and SPs were completed by TVA and accepted by NRC. The NRC staff is continuing to monitor the status of corrective actions (see Section 1.13 of SSER 16 for status) to close the remaining corrective actions before it decides whether to authorize fuel load and low-power operation for Watts Bar Unit 1.

24.5 Significant Regulatory Issues

24.5.1 Welding

During the mid-1980s, concerns were raised by the NSRS and by various TVA employees through the Employee Concerns Program regarding probable weld deficiencies that could affect the construction quality and the operation of Watts Bar Unit 1. In October 1985, TVA contracted through the Department of Energy, Idaho Operations Office (DOE/ID) for EG&G Idaho, Inc. to review the TVA welding program and assess the significance of the welding concerns at Watts Bar Unit 1 in a program known as the Weld Evaluation Program (WEP).

The specific objectives of the WEP were to (1) assess compliance of TVA's documented weld program with the requirements in the Watts Bar FSAR, (2) assess the applicable TVA employee concerns and quality documents to determine if they identified a problem of quality with the TVA-fabricated, safety-related welds, (3) evaluate TVA's as-constructed plant weld status by examining the welds in the plant, and (4) assess the compliance of the plant welds with applicable welding construction codes.

In 1986 and 1987, the NRC staff comprehensively reviewed the implementation of the WEP and of TVA's weld reinspection activities. The staff held several public meetings with TVA (January 7, 1986; June 25, 1986; and January 21, 1987) and conducted team inspections at the Watts Bar site (IRs 50-390/86-17, 86-26, 87-09, and 87-19). In addition, onsite NRC regional and resident inspectors conducted numerous inspections of welding and associated activities. The NRC staff specifically reviewed the findings on structural, piping, and HVAC welds. In addition, the staff reviewed issues arising from the employee concerns and quality indicators[1]. The inspections discussed above generally confirmed that the WEP was adequate for identifying welding problems at Watts Bar Unit 1 as well as for determining the overall quality of welding within the WEP scope at Watts Bar Unit 1. However, the results of the WEP also revealed that there was a significant breakdown in some of the original welding activities at Watts Bar Unit 1, particularly in the areas of structural (AWS Code) welding, piping (ASME Boiler and Pressure Vessel Code) welding, and HVAC ductwork welding as further discussed below.

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[1] The term "quality indicator" was created by the DOE/WEP after a review of quality-related documents that were written during the construction of Watts Bar Unit 1. Those quality-related documents included Nonconforming Condition Reports, 10 CFR 50.55(e) Reports, Quality Assurance Audit Reports, NRC enforcement items, Discrepancy Reports, Corrective Action Reports, Condition Adverse to Quality Reports, Special Inspection Service Reports, allegations reported to the NRC, NSRS Review Reports, OE Audit Reports, Stop Work Orders, and individual reports.

The WEP reported that of approximately 15,000 AWS welds reinspected, 20 percent failed to meet the acceptance standards for which they were certified. The majority of the welds that failed to meet the WEP acceptance criteria were rejected for weld size, weld profile, and weld length and location. The staff concluded that the identification of such a large number of significant deviant conditions by the weld reinspection was a clear indicator that the original TVA weld inspection program was inadequate and, therefore, the quality assurance program had clearly broken down.

The WEP reported that of 401 ASME piping welds examined by visual reinspection, 19 percent failed to meet the original acceptance criteria. As a result, the NRC concluded that TVA's original construction QA/QC program was ineffective, allowing large numbers of unacceptable welds to be accepted.

For the HVAC ductwork system weldments, the WEP reported that one general and one specific group of safety-related welds on HVAC ductwork systems at Watts Bar Unit 1 were reinspected. TVA subsequently removed the HVAC welding reinspection work from the WEP work scope and incorporated this area into a separate Corrective Action Program (HVAC Duct and Supports CAP). The staff found that TVA had failed to have an effective QA/QC program for safety-related HVAC weldments prior to 1980.

Overall, NRC found that the WEP was an effective sampling effort. Thus, the results of the reinspection were considered an acceptable method to be used to assess the welding at Watts Bar Unit 1. NRC also concluded, on the basis of its inspection activities, that the WEP was adequately implemented. On the basis of its analysis of the WEP report in regard to corrective actions and sample expansion, NRC found that the WEP adequately identified weld deficiencies that required analysis and repairs and identified areas that required TVA to expand the sample inspections to 100 percent. Consequently, NRC concluded that a significant breakdown had occurred in overall compliance with 10 CFR Part 50, Appendix B, relative to the QA/QC inspection aspect of the structural welding program.

In January 1989, TVA submitted the Welding CAP to NRC to address the Unit 1 safety-related welding issues at Watts Bar. NRC accepted the CAP in NUREG-1232, Volume IV. The Welding CAP was designed to address the welding issues identified through the various methods discussed above and included the methods used to expand the sample program to 100 percent, where warranted, and to correct the hardware and associated documentation. An example of problems that required an expanded sample was the structural welds in the control building at elevation 741 ft. The resolution of these welds required a 100-percent reinspection by the licensee and rework of 1,091 of the 1,098 welds located at this elevation.

TVA's evaluation of the welding program was addressed in three separate phases. Phase 1, a comprehensive assessment of safety-related welding, was performed by the Welding Project (WP) with personnel independent of Watts Bar management and with a Department of Energy (DOE) contractor (EG&G). The Phase 1 program was submitted to NRC on February 21, 1989; NRC reviewed it along with associated commitments and found the program acceptable. Phase 2 investigated the as-found condition of the safety-related welds and associated records. The evaluation consisted of a physical reinspection of selected welded structures and components, a review of welding-related employee concerns identified through the Employee Concerns Special Program

(ECSP), and a review and analysis of weld-related quality indicators. The WP, the DOE WEP, and the ECSP performed the evaluation. The Phase 2 report was submitted to NRC on April 10, 1989; NRC reviewed it and found it acceptable.

The Phase 3 program included evaluation and upgrading of welding-related programs and procedures to ensure that future welding activities are conducted in accordance with licensing requirements. The WP final report was submitted to NRC on August 25, 1989. NRC inspected the review of the final report in conjunction with the final review of the TVA Welding CAP. The final Welding CAP was submitted to NRC on January 9, 1993. In Inspection Report 50-390,391/94-79 (January 11, 1995), NRC inspectors concluded that, with the exception of a weld accountability issue and final ASME N-5 Supplement completion, the Welding CAP had been adequately implemented. NRC is following these issues to completion separately from the Welding CAP.

To ensure that welding problems and welding programs were corrected, NRC has conducted 59 welding inspections since 1985. Some of these inspections were major team inspections with NRC headquarters staff, resident inspectors, a regional specialist, and contractor welding specialists. In addition to the team inspections and normal routine welding inspections conducted by the resident inspector staff and regional technical welding personnel, NRC with the use of contractors, reviewed the radiographs for all TVA-fabricated pipe welds (approximately 2,700 welds) made on site between commencement of welding through November 11, 1991. As of November 11, 1991, NRC determined that TVA had adequate corrective actions in place regarding welding and radiographic examinations, and the NRC discontinued 100-percent radiographic reviews. To ensure continued compliance since November 1991, NRC has periodically performed sample reviews of welding activities and the radiographic inspection program. Additionally, since 1986, the NRC has reviewed and closed nine 10 CFR 50.55(e) reports that identified welding problems.

In IR 50-390/94-79, issued January 11, 1995, the staff concluded that the Welding CAP had been adequately implemented. The two open issues discussed above are being followed to completion before fuel load. Ongoing welding activities are being inspected as they occur. Pending successful implementation of the completion of ongoing welding activities and closure of the open issues, NRC concludes that TVA has adequately addressed all welding problems at Watts Bar.

24.5.2 Electrical Cable Damage

Beginning in 1985, concerns were raised by the NSRS (NSRS Report I-85-06-WBN) and by various employees through the Employee Concerns Program regarding the acceptability of Class 1E cables. These concerns focused on cable installation practices that were believed to have resulted in damage to the cables. The NSRS report had concluded that the environmental qualification of the cables could have been invalidated by the cable-pulling practices. TVA initially took the same approach to resolving this issue at Watts Bar that it had taken at Sequoyah and Browns Ferry. That approach was to determine the 15 worst-case conduits for pullby damage and then test them by applying a high-potential signal. That method was developed on the basis of selection of conduits and cables from theoretical pullby damage criteria for gross damage, since no damaged cables had been found.

In June 1989, Watts Bar Unit 2 Class 1E cables were being removed from a conduit to evaluate an employee concern which had raised the potential for heat from welding near the respective conduit (arc strike) to damage cables. When those cables were inspected, no heat damage was observed. However, TVA and NRC did find damaged insulation on several of the cables removed from the conduit. The damage consisted of nicks, cuts, and punctures in the insulation, a sawcut through the cable jacket, and broken cable strands. TVA analyzed the cable damage and concluded that the damage had been caused by cable pullbys (pulling new cables into conduits that already have cables in them; thus increasing sidewall bearing pressures as the cables are being installed). In addition, the pull rope being used to install the new cables can cut into the jacket/insulation of the existing cables if too much pull tension is applied.

Other Class 1E cables were removed from conduits to inspect their condition. This led to the discovery of more cable damage similar to the damage on the original cables. A new plan was prepared to determine the extent of the damage and to correct the damage found. Until the damage was discovered, TVA had resisted pulling cable out of conduits to inspect for damage, but had instead performed the in situ high-potential test to check for insulation damage. The cutting of the cable jacket/insulation by the nylon pull ropes had not been considered in the gross damage criteria used to select the cables that would have been high-potential tested.

The new plan for resolving the issue of cable pullby damage involved replacing approximately 660,000 linear feet of cable, and performing more inspections and high-potential tests. Conduits were categorized into high- and low-risk categories based on the potential for pullby damage using the information that was gathered on cable damage. The high-risk category was defined as the family of conduits in which sidewall bearing pressures and damage could be expected to be found fairly often. Cables in the high-risk category of conduits were replaced. Cables in the low-risk category were accepted by TVA "as is" on the basis of high-potential testing of a worst-case sample from the population. Because of the lower calculated pull tensions in the low-risk category, similar cable damage was not expected, making the high-potential testing an acceptable method.

Operating experience with the non-safety related cables during preoperational and hot functional testing has been satisfactory to-date. The maintenance rule, 10 CFR 50.65, becomes effective on July 10, 1996. Non-safety-related cables whose failures could cause a scram are within the scope of the maintenance rule.

NRC inspections have reviewed the implementation of the corrective actions for the cable pullby issue with acceptable results. TVA estimated that approximately 246,000 linear feet of electrical cable would be replaced because of ampacity concerns. Other cables were replaced in response to other electrical modifications.

Independent of the cable damage issue, TVA determined that cable splices, installed during the construction period, could not be shown as qualified. To correct this problem, TVA committed to replace all 10 CFR 50.49 cable splices and some other splices (approximately 26,000 cable splices). Additionally, TVA installed numerous splices as part of the cable replacement issues discussed above. The additional splices were installed because the cable

pullby damage and cable replacement were generally limited to cables routed in conduits. For example, where cable running through conduits had to be replaced and the cable continued into a cable tray, TVA determined that it was impractical to remove cable in trays because of the Vimasco fire-retardant coating applied over cables in the trays. This led to removing the cable from the conduits and cutting the cable where it enters the tray, then reusing the cable in the tray by splicing the new cable from the conduit to the old cable in the tray. This resulted in additional splices at the tray-to-conduit juncture point.

During this high-potential testing of low-risk cables, several cables failed the testing. The test failures were evaluated and attributed, in part, to cable shorting to ground at junction boxes during the testing. The cables shorted to ground near splices. The failure was caused by ring cuts to the cable conductors at the point at which the cable broke out of its jacket. Ring cuts were introduced when electricians stripped back the cable jacket with a sharp object (e.g., a knife) which penetrated the conductor insulation. TVA developed corrective actions in October 1990 to address the splice deficiencies. The corrective actions included reinspection of all cable splices made between May 1989 and October 1990 (approximately 15,000 splices). The 1989 date represented the start of work to replace all 10 CFR 50.49 cable splices and selected non-10 CFR 50.49 splices. NRC has been inspecting the implementation of corrective actions since the 1991 Watts Bar construction restart.

In the fall of 1994, multiple examples of electrical cable splicing, crimping, and connector problems were found on emergency diesel generator cables (IR 50-390/94-72). These problems arose when work control and field personnel failed to follow procedures and design requirements. Through engineering evaluation and testing, TVA was able to accept most of the deviations in cable splices and crimp connectors. The remaining problems were reworked.

In January 1995, the Watts Bar QA organization was performing a closure review of the adequacy of the implemented corrective actions to resolve the cable splice damage issue. During this assessment, numerous examples of cable damage were identified, such as ring cuts, flattened cables, nicks, scratches, cuts, pinholes, and violations of bend radius. On the basis of these deficiencies, the QA and Engineering organizations concluded that the corrective actions to resolve the previously identified deficiencies were inadequately implemented. The causes of the identified deficiencies included:

- inadequate inspection of cables and splices for damage in 1990
- failure to identify remaining splices required to be reinspected for damage
- reinspection of splices deferred to other work documents which were replacing the cable splice (However, the new work document did not note that the cable and/or splice was suspected of having damage. Therefore, the new work only required making of the new splice and did not require reinspection of the cable as well.)
- failure by construction and plant personnel performing new work activities to uncover any damage

- inadequate personnel training in the recognition of cable damage
- failure by quality control inspectors to identify damaged cables

TVA developed additional corrective actions to reinspect all 10 CFR 50.49 cable splices and terminations for possible cable damage. This reinspection started on March 6, 1995. NRC is closely following TVA's reinspection work on cable splices and terminations and will ensure that the cables meet the NRC requirements when the corrective actions are completed.

24.5.3 Quality Assurance Records

TVA developed the QA Records CAP after NRC questioned the auditability and retrievability of safety-related QA records (IR 50-390/86-24). TVA found indications that records at Watts Bar (1) were not retrievable in a timely manner, (2) were stored improperly, and (3) had quality problems (e.g., were technically or administratively deficient). Initially, the CAP was directed at corrective actions for known records problems which were identified as conditions adverse to quality (CAQs). In IR 50-390/90-08, the NRC expressed concern that the implemented QA Records CAP might not allow Watts Bar to demonstrate to the NRC that TVA had all records required for licensing. In response, the CAP was revised to provide for a systematic evaluation of all Watts Bar records in accordance with ANSI N45.2.9. The systematic evaluation was called the Additional Systematic Records Review (ASRR). The ASRR covered several different types of records reviews: the records quality review assessed the retrievability and quality of all of the ANSI types of records, the records hardware review compared the records to the installed hardware, and the records technical content review compared the design output to the hardware and records.

In 1985 and 1986, TVA began a recovery process to ensure that Watts Bar was adequately constructed (i.e., plant hardware was acceptable). This recovery process has been accomplished through various CAPs and SPs including one on the Q-List, as well as corrective actions to non-conformance reports, resolution of employee concerns, corrective actions and so forth. During each of these corrective actions, records have been developed which document the completion of corrective actions. TVA used these records to supplement the original construction records or, in some cases, to substitute for the original construction records. These corrective actions were termed by TVA as "alternate technical basis," and the records developed by these efforts were termed "alternate records."

As a result of the findings by the ASRR and in an effort to properly document the construction records licensing basis for Watts Bar, TVA developed a series of QA record plans, which described in detail the records that were applicable to each type of system, structure, or component. These record plans made use of the extensive CAPs and served as a "road map" to define which records provided the licensing basis, i.e., original construction records in combination with alternate records. TVA developed 39 of these record plans, and the NRC reviewed them and the associated plant records to verify the technical adequacy of Watts Bar records for licensing.

NRC inspection of the QA Records CAP was performed by a series of team inspections conducted over approximately a 9-month period utilizing an inspection team leader and three contract inspectors. In this series of

inspections, the staff reviewed virtually all types of plant hardware: cables, instrument lines, large-bore piping, small-bore piping, instruments, valves, mechanical equipment, masonry walls, coatings, cable tray supports, HVAC supports, concrete structures, foundations, electrical equipment, instrument line supports, cable raceway, HVAC equipment, structural steel, large-bore pipe supports, small-bore pipe supports, and conduit supports. In each of these inspections, the staff verified the record plan for the area being reviewed for technical adequacy; the staff reviewed the records for a sample of approximately 15 hardware items to verify that the records were retrievable, and properly documented installation in accordance with the record plan; and the staff compared records of a sample of approximately six hardware items with the design output and the hardware in the plant (including a field walkdown), to verify that the items were properly installed in accordance with the design and that the records accurately reflected this installation. In addition, the results of reviews obtained by TVA's ASRR in each area were compared with the inspection team's results, and deficiencies noted by the ASRR were reviewed for adequate corrective action. These inspections revealed only a few minor problem areas which were dispositioned in accordance with normal NRC enforcement practices.

In addition, an NRC team inspected QA Records CAP final closure. The inspection team, which included approximately eight inspectors and an inspection team leader, performed inspections over a period of a month. The inspection was conducted in order to review all areas of the CAP that had not been previously reviewed during the series of inspections discussed above. The inspection included a review of the CAP Final Closure Report, "CAP Actions To Prevent Recurrence of Records Deficiencies," CAP closure documentation (including corrective actions for items which formed the basis for the CAP), the ASRR sampling methodology, the Records Retrievability Guide, the ASRR integrated assessment of records deficiencies, and ASRR actions concerning "Unique Record Types." All of these areas were found to be satisfactory.

Although the ASRR portion of the CAP and NRC inspections found that original construction records in many areas were either missing or technically incorrect, in each case, to supplement or replace the original records, TVA developed a set of alternate records which adequately demonstrated that the hardware installed in the plant would perform its intended safety function. On the basis of these inspections, NRC concluded that the QA Records CAP has been effectively implemented, and the QA records provide assurance of the quality of construction, and are acceptable.

24.5.4 Conclusion

The NRC staff concludes that TVA is adequately addressing the corrective actions identified regarding safety concerns raised about TVA's welding, cables, and quality assurance records at Watts Bar Unit 1 (see Section 1.13 of SSER 16). The NRC staff will conduct further inspections to supplement its conclusions regarding the effectiveness and completion of corrective actions before it decides whether to authorize the fuel load and low-power operation.

24.6 Additional Activities

24.6.1 NRC Corrective Actions To Improve Its Regulatory Oversight

In early 1984, NRC noted deterioration in TVA's nuclear program performance. TVA employees' complaints of significant safety problems, harassment and intimidation, delays in TVA's implementation of generic requirements, a large number of inspection deficiencies at Browns Ferry, significant corporate quality assurance problems, and TVA employees' poor performance in operator licensing and re-qualification examinations indicated serious problems in TVA's nuclear program. NRC attempted to get TVA to address these problems by meeting with TVA's management, escalating enforcement actions, and giving poor SALP ratings. These NRC actions were ineffective in getting TVA to correct the identified problems, and NRC's senior management and TVA's Board of Directors initially failed to recognize the extent of breakdown of TVA's effective management of its nuclear program.

Serious problems of construction deficiencies were also found at several other nuclear projects (other than Watts Bar) during the decade of 1970s and early 1980s. Those problems led the U.S.Congress to direct NRC (Ford Amendment to NRC Authorization Act of 1982) to find out what went wrong at those construction plants, and what should be done in the future to detect and correct serious problems in the nuclear power construction in a timely manner. NRC performed an extensive study to address the concerns raised by the Congress and, in 1984, issued a detailed report of its assessments to Congress.

In a separate study in 1986, NRC continued its self-assessment and also examined the failures of its oversight functions at Watts Bar and TVA's operating reactors to determine what factors caused NRC to be ineffective in getting major problems in TVA's nuclear programs corrected in a timely fashion.

During the decade of 1980s, NRC licensed about 50 nuclear units, and oversaw their successful transition to commercial operation. In general, problems appear to have occurred where the utilities constructing the plants were not experienced or focused on special considerations needed in construction of nuclear power plants, or the utilities were so large that their managements were ineffective in coordinating the multi-disciplinary demands of nuclear power plant construction and operation at multiple sites.

A discussion of NRC's studies in response to the Ford Amendment, NRC's self-assessment study of its oversight of TVA's nuclear program problems, and lessons learned from those and other ongoing studies follows.

24.6.1.1 Quality Assurance Report to Congress

Because of Congressional concerns about major problems in the quality of design and construction at several nuclear power plants in the 1970s and early 1980s, NRC was directed by Congress in the NRC Authorization Act for fiscal years 1982 and 1983 (Public Law 97-415) to conduct a study of existing and alternative programs for improving quality assurance and quality control in the construction of commercial nuclear power plants. The results of the NRC study were documented in NUREG-1055, "Improving Quality and the Assurance of

Quality in the Design and Construction of Nuclear Power Plants," herein called the "QA report," published in May 1984.

In the QA report, NRC recommends actions related to construction oversight including a heavier emphasis on team inspections and resident inspectors, an enhanced review of applicants' capabilities to construct commercial nuclear power plants, more attention to management issues, improved diagnostic and trending capabilities, and improved quality and quality assurance inspection. A principal finding of the QA report was the failure to effectively integrate or synthesize early indications of problems into an overall picture of licensee performance. The 1987 reorganization merging the principal functions of the Office of Inspection and Enforcement with the Office of Nuclear Reactor Regulation improved the coordination and integration of information on plant performance. The SALP process, which aims at synthesizing individual inspection findings into an overall evaluation of licensee performance, has been improved.

The recommendations in the QA report for NRC corrective action relative to NRC oversight of construction activities has been implemented and, where necessary, expanded based upon original problems associated with the construction of Watts Bar Unit 1. NRC comprehensively reviewed the scope of inspection activities and reinspected, where necessary, focused upon line management's ability to self identify quality, problems, and take effective corrective action for construction deficiencies. NRC evaluated the effectiveness of the quality organization's performance based upon the results of QA and QC reviews compared to NRC inspection results. Specific actions taken due to unique problems at Watts Bar are discussed in Section 24.6.1.2.

24.6.1.2 NRC Report on Lessons Learned From TVA's Problems With Its Nuclear Program

Because of problems at TVA's nuclear projects, the NRC staff examined the working relationship between TVA and NRC before TVA's problems with nuclear programs were recognized to find out how NRC could have (1) recognized the overall severity of TVA's deficiencies at an earlier and less serious stage and (2) taken more effective actions to ensure that TVA corrected these deficiencies. The results of that study were reported to the Commission in SECY-86-334 (November 12, 1986). In that Commission paper, the NRC staff developed recommendations for improving NRC's overall regulatory oversight. Lessons learned from that study were, as much as possible, coordinated with other ongoing or planned activities for improving NRC's overall regulatory oversight. The other activities included those reported in the Quality Assurance Report to Congress, discussed above, the 1984 and later revisions to the Inspection Manual from the NRC Executive Director for Operations memorandum of September 29, 1986, to the Commission on new inspection methods, the NRC Commission Paper (SECY-86-317) on performance indicators, and other initiatives to improve regulatory oversight, including lessons learned from Davis-Besse and Fermi plants.

In SECY-86-334, the NRC staff described the following seven preliminary lessons learned:

(1) NRC needs to further develop and implement a systematic process for identification of poorly performing licensees and for focusing agencywide attention on poorly performing licensees. As part of this

attention, at early stages of degraded licensee performance, the regional administrator should meet with senior licensee management to identify problems, using whatever means are required to be sure that the message is clearly understood.

(2) NRC needs to develop a program and the skills for assessing overall licensee management performance and identifying indicators of management and organizational deficiencies.

(3) NRC inspection documents need to include a clear assessment of the programmatic and cumulative significance of the specific deficiencies and violations identified.

(4) Since NRC is heavily dependent on effective licensee design, construction, and self-inspection programs for providing a basis for concluding that a plant is designed and constructed to operate safely, NRC needs to do more to ensure the validity of those programs and their implementation.

(5) NRC needs to ensure that sufficient resources are provided to carry out programmatic efforts as well as increased efforts at poorly performing licensees, and that sufficient resources are devoted to those areas of greatest identified concern.

(6) Efforts, such as those made in the QA programs at TVA, to correct major problems should not have been considered complete until specific deliberate inspections, and evaluation of results over an extended period indicated that similar problems were not still occurring and that previous problems had been corrected.

(7) Perfunctory responses to long-term, resource-intensive regulatory requirements, like fire protection and equipment qualification, and a poor record of surveillance and maintenance indicated a lack of TVA management's effective overall commitment to safety. NRC needs to exert diligence in requiring licensees to promptly complete actions in response to regulatory requirements and commitments.

From these seven preliminary lessons learned, the staff developed 27 recommendations for NRC action and briefed the Commission on its study and recommendations on November 16, 1986. After the briefing, the Commission directed the staff to seek comments on the report of its study from senior TVA executives involved in TVA's nuclear programs during the period of deteriorating TVA performance, and from former senior NRC managers who were involved in the oversight of TVA's nuclear programs. The staff was further directed to modify its recommendations reflecting the comments received, and develop a program for implementing the final recommendations.

The NRC Executive Director for Operations forwarded the preliminary report to a number of former senior TVA and NRC managers, who were personally involved in TVA's nuclear program or its regulation from 1980 to 1985, for their comments. The managers' comments generally supported the thrust and focus of the preliminary paper, and provided valuable perspectives and insights. The NRC staff modified recommendations of the preliminary report to reflect the comments. As a result, 19 final recommendations were outlined in SECY-87-211

as requiring some action, ranging from emphasizing the existing policy and procedures to studying some issues further.

24.6.2 Special Inspections

NRC conducted several special inspections at Watts Bar in response to the findings of lessons-learned studies that NRC should put increased reliance on special team inspections that are capable of integrating the results of the inspections and assessing the programmatic significance of their inspection findings. NRC conducted several Integrated Design Inspections (IDIs) at Watts Bar and also conducted a broad-based Construction Assessment Team inspection.

24.6.2.1 Broad-Based Construction Assessment Team Inspections

NRC performed a broad-based Construction Assessment Team inspection to assess the quality of construction at Watts Bar. The findings of the inspection are documented in NRC Inspection Report 50-390/89-200, dated December 12, 1989.

The inspection team's concerns were (1) the poor general condition of plant equipment, (2) some problems not previously identified by TVA, (3) the site management's lack of understanding of the amount and scope of remaining work, and (4) the lack of control over interrelationships among site programs.

Inspectors found a large number of hardware deficiencies. The potential for further damage because of the poor control of ongoing work activities made the team doubt TVA's ability to protect completed installations of equipment and hardware during the remaining construction. Inspectors found a lack of control of interfaces between onsite programs. The team found that integration and coordination of the various licensee corrective action programs, special programs, and related activities were not adequate to ensure that all required work activities and corrective actions would be correctly performed. The team also found weakness in the integration of activities between site organizations that provide requirements and site organizations that implement those requirements.

24.6.2.2 Integrated Design Inspections

NRC conducted an Integrated Design Inspection (IDI) covering mechanical, electrical, and instrumentation and control systems between January 7 and 18 and February 4 and 8, 1991 (IR 50-390/91-201, dated March 22, 1991). The inspectors examined the design, design basis, calculations, engineering procedures, and records, primarily for the auxiliary feedwater system.

The team determined that TVA was making progress in establishing a complete and comprehensive set of design-basis documents for Watts Bar. The electrical systems calculations regenerated as a part of the Design Baseline Verification Program (DBVP) were of consistently high quality. However, TVA's review of mechanical systems calculations performed as a part of the DBVP had not been effective in ensuring their technical adequacy or consistency with current plant design. TVA had not taken adequate corrective actions in response to the relevant DBVP findings.

On the basis of (1) TVA's response to the inspection report and (2) NRC's followup inspection, the open items were closed (IR 50-390/93-201, dated June 29, 1993).

NRC conducted an IDI covering civil and structural disciplines between July 13 and August 7, 1992 (IR 50-390/92-201, dated September 21, 1992). The primary focus of the inspection was to assess the adequacy of the design control process for selected structures, piping, and supports. The team identified significant concerns that may have generic implications, such as the use of U-bolts rather than clamps to support and restrain piping with pin-connected supports, and missing and loose hardware in pipe and conduit supports. Other concerns were related to a missing conduit support, inadequate consideration of as-built support weld sizes and anchor bolt pullout capacity, incorrect design criteria, failure to follow TVA's design criteria or licensing commitments, and use of potentially nonconservative design approaches in detail designs.

On the basis of TVA's responses to the inspection report and NRC's followup inspection, most open items were closed (IR 50-390/93-201, dated June 29, 1993). Two items required additional NRC staff review: use of U-bolts as pipe clamps and potentially non-conservative seismic loads in HVAC duct support evaluations. In addition, regional followup was required concerning (1) installation deficiencies in pipe supports and conduit supports and (2) missing supports in the field.

In response to the findings from the 1991 IDI and TVA's self-assessments, TVA initiated a mechanical systems nuclear calculation program and assembled a team of corporate specialists and senior industry technical managers to review the program. This program revised existing calculations, generated new calculations in support of the design bases, revised test scoping documents, and closed open items. NRC performed a followup inspection (IR 50-390/93-202, dated June 2, 1993) to evaluate the impact of TVA's program for improving design calculations on the adequacy of mechanical systems design and the design process. The inspection focused on the mechanical system design for the essential raw cooling water and the component cooling systems. The team noted that the system descriptions and calculations were thorough and consistent and adequately supported the design. These documents had improved in terms of content, consistency, accuracy, and completeness compared to those reviewed during the 1991 IDI. The team identified a significant concern regarding the lack of freeze protection for the essential raw cooling water system piping and instrument tubing in the intake pumping station. This issue was the subject of a Notice of Violation.

24.6.3 Conclusion

After extensive studies of and subsequent improvements to its regulatory oversight, NRC has resolved earlier problems of ineffective regulatory oversight; has an improved oversight process in place; expects to uncover any programmatic deficiencies in construction, operational readiness, and future operation of Watts Bar Unit 1; and has an effective enforcement policy in place to ensure that TVA will correct the deficiencies of Watts Bar construction and subsequent operation in a timely manner.

As a result of implementing the lessons learned from NRC's self-assessment studies, NRC's regulatory oversight process is considerably more effective than it was in 1985. NRC has addressed the emerging problems of licensing Watts Bar Unit 1 in a focused manner. For example, since 1990, NRC expended more than 48,000 direct inspection hours and $4.8 million in contract inspection work at Watts Bar Unit 1 in contrast to 2,750 inspection hours

expended on Manual Chapter 2512, "Construction Phase Inspection Program" before 1985. As discussed in Section 24.6.2, NRC is also increasingly conducting special inspections to further bolster its regulatory oversight.

NRC concludes that it has resolved the problems involving ineffective oversight that became evident in the 1980s when design and construction problems arose and went undetected and uncorrected for too long, and NRC has provided comprehensive oversight at Watts Bar Unit 1.

24.7 Construction Stopped

On December 21, 1990, TVA issued a "stop work" order promptly after it verified NRC inspection findings of ineffective work control. On December 14, 1990, an exit meeting was held for Inspection Report (IR) 50-390/90-31, which reported on the Corrective Action Program (CAP). Multiple examples in various work disciplines indicated failures to establish and implement the CAP properly. Failures comprised untimeliness in determining the scope and significance of identified problems, failure to establish adequate criteria for entry into the CAP failures to identify and address recurrent and programmatic deficiencies, failures to address the root causes of deficiencies, and deficient closures of corrective action documents. The apparent violation indicated a programmatic breakdown in the CAP. On December 21, 1990, at the exit meeting held for IR 50-390/90-30, inspectors identified multiple examples of repeated violations in the work control area. These examples spread over many facets of work control, indicating a programmatic breakdown in the work control area. These two inspection reports identified the problems that had plagued TVA since before 1985. They were documented in the Employee Concerns Special Program on Corrective Action Tracking Documents, and TVA management was under the impression that they had been corrected. The inspection indicated that TVA had not resolved the work control problems identified in 1985. As a result, site management at Watts Bar issued the stop work order.

NRC met with TVA on January 15, 1991, to discuss the construction halt at Watts Bar. At that meeting, TVA agreed that the NRC staff would be involved in the decision to restart any construction activity at Watts Bar. NRC sent the summary of that meeting to TVA on January 18, 1991. An enforcement conference was held on April 12, 1991, to discuss the work control and CAP breakdowns. TVA acknowledged at the enforcement conference that, in the past, it had been addressing symptoms of the programmatic deficiencies at Watts Bar rather than their root causes. TVA also outlined, in general terms, the steps being taken to correct the situation, as well as some of the methodology that would be used to judge the success of the corrective actions. These steps consisted of a Quality Improvement Plan (QIP) that detailed 14 areas of improvement. The major thrust of the QIP was to use quality measurement feedback to achieve improvement. Some details of the QIP were quality report cards, procedure/process improvements, craft certification, and training and assessment of management personnel.

TVA began self-assessments shortly after construction stopped in December 1990 to determine the root causes behind the programmatic problems identified by NRC in the work control and corrective action areas. These self-assessments made TVA aware that these were longstanding problems that had been identified during the Employee Concerns Special Program reviews and that extended back to at least the early 1980s. Although these problems had been identified several

times over the previous 10 years, the corrective actions never had focused on the root causes or timeliness of solutions. TVA realized that these problems were widespread over many organizations and disciplines. The key areas of analysis were the construction, quality assurance, and engineering functions. Other areas were assessed as they were affected by these areas, e.g., material controls and integrated scheduling.

TVA focused corrective actions mainly on the key areas. The construction craft work force was laid off, and a contractor was hired to provide the craft labor. The contractor also employed the craft supervisors to perform the work. However, the construction contractor often hired people from the old, TVA construction force. TVA set up an organization that worked with the contractor to finish the plant modifications. This organization performed a project management and work planning function and was similar to the Modifications organization at TVA's operating plants. The work planning function implemented new work control processes that had proved successful at Browns Ferry and elsewhere in the industry. Management was reduced in size, and proven good performers were placed in key positions. Work plans that had been issued were closed out; work that remained to be done was placed on the Remaining Work List. New, simpler work plans were then written for performing the remaining work. It was considered important to have a high-quality work plan in place before construction would start up again. Inherent in changing the work control process was setting up a review of the in-process work plans. TVA put a program in place (safety net) to verify the work completed on the in-process work plans and to close out the work plans; then, under the new process for the remaining work, new work plans would be written.

The Quality Assurance (QA) organization was considered weak in communicating problems to senior management and in establishing quality performance standards. The number of QA personnel was reduced and QA management was changed. In addition, a contractor was hired to supplement the QA organization in the construction inspection area. Performance standards were developed that included the trending of selected attributes. Work plan quality and engineering design output were key performance indicators during the period when construction stopped.

Communications between engineering design functions were only marginal. In addition, TVA had implemented a new, revised, engineering design process before issuing the construction stop-work order and had not had enough time to completely convert all active old-process design documents to the new method; therefore, backlogs were larger than normal. The change impaired engineering performance, generating a large backlog of field changes. The number of engineering personnel was reduced to gain better control and tighter cross-discipline coordination. Additional contractors were hired to perform the engineering evaluations. To ensure that the Engineering organization stayed ahead of the modifications work, backlog reduction became a key focal area during the stop-work period. Quality monitoring and performance measurement became an important factor for the engineering function in providing feedback to Engineering management.

TVA also found that the root causes extended beyond the processes for each organization. The root causes had general performance components, attitudinal components, environmental components, and individual performance components. These four components indicated to TVA that embedded in the root causes were learned-habits barrier to successful behavior and to change below the senior

management level. TVA realized that the root causes indicated an overall problem with the attitude about corrective action. Consequently, the Senior Management Review Team initially acted as the Corrective Action Program Management Review Committee. This was to instill in lower level management the expectation that corrective action must fix the root causes, not just the symptoms, and that corrective action must be timely.

Such changes meant rewriting many procedures and directly implementing corporate standards into standard site practices. This approach had been effective at Browns Ferry.

Inherent in such broad-based changes are a complete retraining of existing workers and the initial training of contractor personnel. Management hoped that the personnel changes (bringing in contractors and placing proven good performers in key positions) would help break through the learned-habit barriers to successful behavior. In addition, a new focus on accountability and responsibility for work quality was emphasized.

In an August 26, 1991, letter to TVA, NRC stated that it could agree to the restart of construction activities if TVA achieved positive results from programs outlined at the enforcement conference. The letter emphasized that corrective actions must be so effectively implemented that, upon completion of construction, all regulatory requirements and TVA commitments specified in the FSAR and other documents are met. The letter also stated that the quality of design and construction at Watts Bar must be fully verified and documented, and that the future performance must be at a higher level than in the past.

NRC focused its inspections of TVA's self-assessments and corrective actions on the adequacy of the self-assessments and on TVA's progress in implementing corrective actions. These changes took approximately 11 months to implement. NRC conducted a construction restart readiness inspection (IR 50-390/91-29) between October 28 and November 15, 1991. The inspectors reviewed the changes that TVA had made since work had been stopped in December 1990 to site procedures, work plans, material controls, organizational interfaces, quality records and document control programs, and the Corrective Action Program. The inspectors concluded that TVA had addressed the root causes of the work stoppage and that NRC concerns associated with the work stoppage had been programmatically resolved.

In a letter to NRC dated November 18, 1991, TVA stated its readiness to restart construction at Watts Bar Unit 1. That position was discussed at a meeting with NRC on November 19, 1991. In a letter dated November 26, 1991, NRC documented its concurrence of November 22, 1991, to the restart of construction at Watts Bar Unit 1. The letter also confirmed several conditions of the concurrence upon which previous agreement had been reached. These included resuming construction slowly with a gradual, deliberate staffing-up of construction forces; informing the resident inspector staff, before the fact, of those work packages selected for implementation; and stating that the processes, procedures, organizations, and controls in place upon concurrence (November 22, 1991) constituted the baseline for work at Watts Bar and there would be no unilateral changes to them. Any changes that could significantly modify how the work was done or the criteria for work, or that could reduce the effectiveness of work controls would be coordinated with NRC before implementation.

Initially, the process was applied to balance-of-plant equipment and later to safety-related equipment. The slow, monitored restart gave TVA management a chance to observe the implementation of the changes and to control the implementation on a small scale. When successes were achieved, as indicated by performance indicators, manpower was increased. NRC conducted inspections during the slow, staffing-up period to assess implementation of the construction programs. Early in the restart effort, the inspections indicated that TVA needed to increase efforts in the areas of management overview and attention to detail (IR 50-390/92-01). Subsequent NRC inspections found the in-process work activities to be of good quality (IRs 50-390/92-05 and 92-08). NRC gave unconditional release for the construction restart on June 11, 1992, and restarted the SALP process for Watts Bar.

24.7.1 Corrective Action Problems After Construction Restart

From construction restart in December 1991 until mid-1994, NRC had documented at least 50 findings related to inadequacies or weaknesses in the Corrective Action Program. The findings were characterized as 27 violations, 2 non-cited violations, 15 unresolved items, 3 inspector followup items (IFIs), 1 IDI deficiency, 1 "concern" (with additional examples in a subsequent report), and an "observation." In addition, based on a trend of corrective action problems from 1993 into 1994 and to address examples being found by NRC, TVA QA conducted an assessment of Corrective Action Program implementation and issued a Significant Corrective Action Report (SCAR) in the spring of 1994.

The findings in the SCAR and the previous and more recent examples of inadequate corrective action prompted NRC to conduct a team inspection in the summer of 1994 to assess the Corrective Action Program implementation (IR 50-390/94-37). The inspection found 35 additional examples of violations that were similar to those found in the SCAR. Also, a notice of violation containing eight examples was issued for cases not similar to those found in the SCAR. Both the inspection and TVA QA review found that the Corrective Action Program was not being properly implemented; however, no direct hardware deficiencies were identified. The report noted that (1) the root causes of problems were not always properly identified; (2) corrective actions did not always address the identified problem; (3) the full extent of problems was not always fully identified, resulting in repetitive problems of similar nature; and (4) numerous deficiencies were identified in corrective action documents.

In the late summer and early fall of 1994, staff inspections of NRC-identified open items did find examples of inadequate corrective actions in which there were hardware-related problems that could have impaired the ability of equipment to perform its function. These included RCP motor unqualified coatings issues (IR 50-390/94-59); electrical cable manhole preventive maintenance problems (IR 50-390/94-72); electrical cable splicing, crimping, and connector problems on emergency diesel generator cables (IR 50-390/94-72); and cable damage to electrical penetration Kapton leads (IR 50-390/94-61).

As a result of these findings, TVA pursued a reverification program to review everything closed for the previous year, including corrective action documents, CATDs, VSR DRs, and NRC open items. The review determined that a small number of packages had closure verification concerns, and that about eight had been rejections. The rejections were the result of inadequate field verification. In addition, a large number of packages (88) needed to be supplemented for such minor problems as unclear wording, inclusion of

additional justification, and typographical errors. After reverifying corrective action documents and NRC open item packages, TVA concluded that it did not have a major breakdown in the closure verification process, but that the process needed to be improved. Additionally, in the late summer of 1994, QA implemented a 100-percent closure review of all corrective action documents.

24.7.2 Strengthening the QA Organization

TVA recognized during the work stoppage that the QA organization was not setting quality performance standards for the site. Although management changes were made and contract QC support was added, NRC inspections after 1991 still indicated that QA was not always identifying and resolving items that were problems. The NRC inspection presence at the site was significant and tended to establish the quality standard when QA did not. In the 1993 SALP report (IR 50-390/93-46), the marginal accomplishment of the QA functions was noted as a weakness. TVA initiated a third-party, independent QA assessment to evaluate the implementation of the QA Program. TVA made additional management changes that strengthened QA, improving the QA functions. In the 1994 SALP report (IR 50-390/94-41), the staff noted improvement in the independent verification of CAPs and SPs. However, it was not until the fall of 1994 that QA established overall leadership for quality. Trending reports on corrective action documents with QA management support are bringing problems to the attention of senior line management. Quality monitoring and audit functions have improved in the identification of programmatic problems. Although some NRC findings are not yet resolved, QA is now taking an active role in resolving the issues and not relying on NRC to identify and expedite resolution of problems. The role of the Quality Assurance organization is now more apparent in daily work activities and at site meetings. The QA organization is now setting the quality standard and continues to improve in this area. The NRC staff concludes that the problems that led to the 1990 stop-work order are being resolved.

24.7.3 Conclusion

The overall trend in the quality of TVA's corrective actions has improved since construction work was stopped in December 1990, although some problems have been identified at points along the way. The improved quality of the design output documents, the improved work control process, and improved attitudes about quality control have resulted in a general trend of significant improvement in construction quality. However, during the summer of 1994, the staff pointed out that there were still some problems with the effectiveness of corrective actions. These findings matched those of TVA's Quality Assurance organization. There were several specific cases identified in late summer and the early fall of 1994 in which work that TVA considered complete was either found to have been undone or to be deficient. After discussions between the staff and TVA management on the implications of these problems, TVA took effective action to stop the problems and to preclude the recurrence of similar ones. TVA's Quality Assurance organization is now identifying problems and is proactive in engaging management's attention to correct the problems. The poor attitude that led to barriers in acknowledging problems and addressing them has significantly improved. Implementation of corrective actions is proceeding satisfactorily. However, further NRC inspections are planned to confirm the adequacy of Corrective Action Programs before fuel load and low-power operation are authorized.

24.8 Integrated Assurance of Acceptable Construction Quality

24.8.1 Preoperational Testing

TVA's CAP contained a corrective action plan for modifying its preoperational test instructions (PTIs) to comply with its Preoperational Test Program in Chapter 14 of the FSAR. In a letter of February 13, 1992, TVA informed NRC that it will abandon this CAP and would essentially re-perform the entire Preoperational Test Program, based on new preoperational testing instructions that it was planning to prepare.

To write its new PTIs, TVA hired contractors with previous preoperational testing experience at various power plants. The contractors began writing PTIs in late 1992. Testing according to the new PTIs began in early 1993, although much construction and repair work was still in progress. In the early stages of the program, NRC inspectors encountered deficiencies in the quality of the preoperational test procedures. Deficiencies were found in the test program when the program was compared to the test scope and methods described in Chapter 14 of the FSAR.

Starting in late 1992 and through early 1993, TVA established another series of documents called the Test Scoping Documents (TSDs). These TSDs were TVA-controlled documents that described the preoperational test methods and acceptance criteria for each system. During inspections, NRC found numerous contradictions among the FSAR, TSDs, DBDs, and the newly finished PTIs submitted to NRC for review. The causes of these quality problems were all related to a lack of thoroughness and attention to detail in preparing and reviewing the PTIs.

By the fall of 1993, NRC had compiled a significant history of violations, deviations, and problems with PTIs. As a result of these inspection findings, TVA decided to halt the Preoperational Test Program, and hired a new contractor, as startup manager, who had extensive (and successful) testing experience in the industry.

The new startup manager prepared the Start-up Manual Procedures (SMPs), completely overhauling the administrative procedures manual for writing, approving, conducting, and documenting results of preoperational tests. TVA's contractor hired, indoctrinated, and trained additional staff. TVA decided to retire the intermediate documents (TSDs). However, as a result of NRC's expressed concerns that design information would be lost by merely discarding the TSDs, TVA agreed to add the design information from the TSDs to the design-basis document (DBD). NRC's reviews in early 1994 indicated that the new PTIs produced were of substantially better quality. However, TVA continued to experience some problems in achieving consistency among the FSAR, the DBD, the PTIs, and the as-built plant.

In the late spring of 1994, TVA replaced the startup manager again. The new startup manager was a TVA employee from Browns Ferry, who brought several experienced testing staff from Browns Ferry to Watts Bar. NRC continued to review at least a sample of each PTI produced, and issued violations where appropriate. In NRC's view, the corrective actions had become effective, and the quality of PTIs had improved to an adequate level, although it never reached a level of consistent excellence.

TVA essentially completed the preoperational test program by early 1995. The first Hot Functional Test (HFT-1) resulted in significant equipment failures. The staff asked TVA to perform a full dress rehearsal retesting during a second Hot Functional Test (HFT-2) to demonstrate successful testing of the components that did not meet their performance requirements during HFT-1. The HFT-2 took place in July and August 1995, and successfully retested the selected equipment and systems.

24.8.2 Program for Assurance of Completion and Assurance of Quality

TVA established the Program for Assurance of Completion and Assurance of Quality (PAC/AQ) to confirm that Watts Bar Unit 1 was constructed in accordance with licensing commitments and that the facility is operationally ready. Specifically, PAC/AQ involved the detailed identification of commitments made from the date the construction permit was issued until November 18, 1991. PAC/AQ also established the functional correlation of these commitments with implementing documents and confirmed the technical adequacy of the process controls.

To achieve these objectives, PAC/AQ was structured into the following five distinct phases:

Phase I **Identification of Commitments**—Commitments were researched and tabulated in both database and hard-copy format. Source documents were: the Final Safety Analysis Report (FSAR) up to and including Amendment 68; safety evaluation reports (SERs), including all supplements through SSER 8; inspection findings; generic communications; and miscellaneous TVA correspondence through November 18, 1991. This effort is complete; more than 13,000 commitments were identified.

Phase II Matching Commitments With Implementing Documents—A site procedure, drawing, specification, and/or calculation that implemented each commitment was identified. This effort is complete.

Phase III **Confirmation of Technical Adequacy of Implementing Documents**—This activity focused on Corrective Action Programs (CAPs), Special Programs (SPs), and selected processes to gain objective evidence that the commitments were properly implemented. This effort is complete.

Phase IV **Vertical Slice Reviews**—TVA performed Vertical Slice Reviews on the essential raw cooling water system, 6.9-kV unit power system, the component cooling system, and the control air system to ensure that implementing documents were correctly developed and adequately reflected the plant hardware configurations. This effort is complete.

Phase V **Oversight of Operational Readiness**—TVA will use PAC/AQ-identified commitments and implementing documents to address overall operational readiness of Watts Bar preceding fuel load. This effort is complete.

The NRC documented its evaluation of PAC/AQ activities associated with Phases I through III in IR 50-390/93-203, dated October 19, 1993. The results of this inspection effort indicated that, in general, Phase I, II, and III activities of PAC/AQ were effective in assuring the identification of regulatory commitments and the translation of those commitments into the corresponding implementation documents. It was also determined that TVA's process for capturing commitments under PAC/AC was comprehensive and well implemented and that the process for identifying implementing documents and the confirmation of their technical adequacy was acceptable.

Phase IV PAC/AQ activities which involved TVA's Vertical Slice Reviews of the essential raw cooling water system, 6.9-kV unit power system, component cooling system, and control air system were evaluated and the results were documented in IR 50-390/94-204, dated June 21, 1994. The Phase IV Vertical Slice Reviews were performed to ensure that the implementing documents have been properly reflected in plant hardware configurations. On the basis of the evaluation of the PAC/AQ process, NRC has concluded that Phase IV activities were effective in the identification and substantiation of system design and installation requirements. PAC/AQ Phase IV fulfilled TVA's established requirement, and NRC identified the PAC/AQ as a program strength.

The PAC/AQ Phase V (Oversight of Operational Readiness) was evaluated by the NRC's operational readiness assessment team in July and August 1995. Results will be published in an inspection report.

24.8.3 TVA's Integrated Design Inspection

In Volume IV of the Nuclear Performance Plan, TVA committed to perform an in-depth technical audit similar to NRC Integrated Design Inspection (IDI). TVA selected the auxiliary feedwater system to demonstrate adequate implementation of the Corrective Action Program at Watts Bar. NRC inspection staff developed and reviewed an audit plan. TVA has completed its audit without finding any new significant safety issues.

24.8.4 Licensing Review

The licensing review for Watts Bar was essentially complete in 1985. TVA certified that Watts Bar Unit 1 was ready for licensing in February 1985. Subsequently, TVA concluded that Watts Bar Unit 1 was not ready for licensing, withdrew its certification, and embarked on the extensive program described in the Nuclear Performance Plan. Corrective actions led to the reevaluation of numerous previously approved issues which resulted in 27 amendments to the FSAR.

The staff has reviewed these changes, and has issued 16 supplements to the Safety Evaluation Report (SER). The staff's review of the FSAR and development of the Technical Specifications for Unit 1 are nearing completion.

The Final Environmental Statement (FES) for Watts Bar was issued in 1978. In 1994, the staff decided to prepare a supplement to the FES. The draft supplement was issued for public comment. The comments have been addressed, and the final supplement was issued in April 1995 (NUREG-0498, Supplement No. 1).

In addition, the staff prepared a biological assessment of impact of operation of Watts Bar Units 1 and 2 on endangered and threatened species. The biological assessment was submitted to the Fish and Wildlife Service, which issued a biological opinion concluding that operation of the two units will not adversely affect the endangered species and threatened species near the plant.

24.8.5 Reconstitution of Construction Inspection Program

The objective of NRC Inspection Manual Chapter (MC) 2512, "Construction Phase Inspection Program," is to ensure that a facility is constructed in accordance with NRC-approved design and construction standards. In 1985, NRC completed the initial MC 2512 inspection program for Watts Bar Unit 1 construction which began in 1973. NRC performed further inspections, under Temporary Instructions (TIs), of construction activities associated with TVA's corrective actions (CAPs and SPs) for resolving the problems identified in 1985 and by subsequent inspection findings and allegations. Because of the complexity of the rework done by TVA, NRC decided, in 1994, to verify that construction-related inspections conducted under TIs and other inspection procedures after 1985 complied with the overall requirements of the MC 2512 inspection program. The verification program was named "MC 2512 Reconstitution Program."

To the extent possible, the inspection program was reconstituted using the results of post-1985 inspection activities. Post-1985 documents were reviewed to compare the scope and results of inspections performed at Watts Bar after 1985 with the inspection procedure requirements. Also in this phase, post-1985 allegations were reviewed to determine if they affected the use of post-1985 inspection results for completing inspection procedure requirements.

When the inspection requirements could not be verified to be completed by the post-1985 inspections, additional inspection was performed (if possible) to complete the inspection requirements.

When inspection procedure requirements were not verified to be complete and when direct inspection was not feasible, pre-1986 inspection information was evaluated and, where necessary, audits and inspections were performed of the as-built plant.

For inspection procedure requirements which could not be completed by any of the methods discussed, a case-by-case determination was made by alternate means of inspections and analyses to establish that the inspection procedure requirements were met.

Using this approach, the staff completed 70 percent of the MC 2512 inspection requirements using post-1985 inspections. An additional 28 percent were validated by inspections conducted before 1986. The remaining 2 percent of the requirements were satisfied by alternate means of inspections and case-by-case analyses.

The reconstitution program report, with its appendices detailing how each inspection requirement was met, are published as NRC NUREG-1528. The reconstitution program results will be addressed in the Regional

Administrator's 94300 report to the Director of the Office of Nuclear Reactor Regulation and will be addressed in a future SER supplement.

24.8.6 Conclusion

The various extensive corrective actions described above provide integrated assurance that the plant is designed, constructed, and tested in accordance with the FSAR, other design documents, and applicable codes.

The applicant has completed the preoperational testing. The staff expects that the Watts Bar Unit 1 systems, components, and equipment tested will perform to their design-basis requirements.

Effective corrective actions completion and quality have been confirmed by TVA's PAC/AQ Program.

NRC's licensing reviews of amendments to the FSAR are nearing completion. The staff has issued the final supplement to the Watts Bar Final Environmental Statement (NUREG-0498, Supplement No. 1).

NRC has successfully completed the reconstitution of its construction inspection program and concludes that it has achieved the objective of verifying that post-1985 construction inspections adequately meet the Watts Bar Unit 1 operating license requirements. To the extent evaluated, the results of the Phase I post-1985 document reviews confirmed that the applicant's Corrective Action Programs are being adequately completed.

The NRC staff has supplemented its conclusions in NUREG-1528 which addresses the completion of the NRC construction inspection reconstitution program.

24.9 TVA's Recent Performance

TVA's performance from late 1994 through August 1995 has been satisfactory and has, on many occasions, exceeded satisfactory. TVA's closure packages for NRC open items have been of good quality. The CAPs and SPs are proceeding to completion in an overall satisfactory manner. TVA has identified problems concerning the quality of some electrical work of the past and is addressing these problems through the Corrective Action Program. The staff's review of the applicant's fire protection report required TVA to submit additional information. The staff expects to complete its review of the Watts Bar Unit 1 fire protection program before issuing a low-power license.

The quality of room and area turnovers has been good. As of September 1995, 300 out of 362 room and area turnovers were completed; and 132 out of 134 system turnovers were completed.

The Quality Assurance organization has been proactive in identifying problems. QA's trending of the line organization has resulted in improved CATD package quality.

NRC has found that TVA has successfully implemented 22 out of the 28 CAPs and SPs.

Preoperational tests were conducted in accordance with procedures. Record packages for the tests were improved as the result of additional review

efforts. Some problems were noted with test deficiency disposition justifications (IR 50-390/95-25). The specific cases identified are being adequately corrected. Power ascension and escalation test procedures and surveillance instructions are of acceptable quality. System operating instructions are generally acceptable. However, the order of equipment listing for verification in the valve and breaker alignment checklists has not been optimal, resulting in operator action inefficiency and potential ALARA and human factors problems. TVA is discussing this weakness with the procedure writers. QA audits and assessments have been adequate to identify programmatic problems in the operations area.

A late September 1995 team inspection of the implementation of corrective actions program for both construction and operation further revealed that the implementation processes are working well. The inspection team closed the violations identified by similar team inspections in 1990 and 1994 (see Section 24.7).

Conclusion

The staff has concluded that the current performance indicates that TVA has overcome significant weaknesses noted in the past.

24.10 TVA's Reasonable Assurance Assessment Report

In order to gain an operating license, TVA senior management must certify to NRC that Watts Bar Unit 1 is ready to load fuel and begin operation. To help it arrive at a certification decision, TVA initiated an assessment of Watts Bar readiness. The assessment is essentially complete, and TVA submitted the "Reasonable Assurance Assessment Report" (RAAR) to NRC by letter dated June 28, 1995. TVA subsequently supplemented the report by completing the ongoing Independent Design Inspection (IDI) of the auxiliary feedwater system and the full dress rehearsal second Hot Functional Test (HFT-2).

The report evaluated Watts Bar Unit 1 from three perspectives:

(1) *A regulatory completion review which assessed compliance with NRC regulations and TVA commitments as documented in the Nuclear Performance Plan (NPP).* TVA concluded that Watts Bar is designed and constructed in accordance with regulatory requirements, and there is reasonable assurance that the commitments in the WBNPP will be effectively addressed.

(2) *A "vertical" review of five critical activities: design, construction, startup testing, operational readiness, and oversight.* TVA concluded that there is reasonable assurance that the design and construction of Watts Bar have been verified to be adequate, that the startup test program has been adequately implemented, that there is an ongoing "cultural" transformation at Watts Bar to an "operations mentality," and that the Watts Bar Nuclear Assurance organization will effectively support plant operation.

(3) *A review of selected significant programs (e.g., employee concerns programs).* TVA concluded that the employee concerns programs have effectively addressed the employee concerns raised in the past, and the current Concerns Resolution Program is responsive to employee concerns

today. Further, TVA indicated that significant progress has been made to reduce the number of concerns raised outside the management chain by increasing the level of communication within the line organization.

TVA integrated the findings from the three perspectives described above to produce a comprehensive picture of Watts Bar Unit 1 readiness to load fuel and operate safely. TVA concluded that upon satisfactory completion of scheduled ongoing activities and associated corrective actions, there will be reasonable assurance from a design, construction, and operational perspective that Watts Bar Unit 1 will be ready to load fuel and begin operations.

Further, the report made the following significant observations:

- The extent and diversity of the oversight at Watts Bar has been unprecedented. For example, since 1988, there have been 13 Vertical Slice Reviews of 12 different systems conducted by six different organizations. Thus, TVA considers that problems that could preclude safe operation of Watts Bar have been detected.

- TVA believes that the quality of work at Watts Bar Unit 1 has improved since it withdrew the 1985 certification letter. TVA concluded that the problems that have arisen since 1985 have been progressively less significant in terms of scope, safety impact, and the requisite corrective action and the performance at Watts Bar is now consistent with other projects of similar magnitude and complexity.

- TVA's operational readiness process and earlier corrective actions minimize the potential for adverse conditions or performance problems in the future. If problems do arise, TVA believes that its corrective action process to support operation will be capable of ensuring resolution.

- Of particular concern has been the perception, and at times the reality, that NRC was identifying TVA's problems at Watts Bar. TVA believes that recent audits have found improvements in its oversight function at Watts Bar Unit 1, and the oversight process has ultimately become effective.

Conclusion

The staff has reviewed the RAAR and found it to be a thorough and comprehensive review of the issues associated with the licensing of Watts Bar Unit 1. Although, the findings in the RAAR differ in some ways from the findings reached by the staff in this report, the differences are not significant and do not affect the overall conclusion about the completion of construction at Watts Bar, and TVA's readiness to operate Watts Bar Unit 1 safely.

24.11 TVA's Operational Readiness

24.11.1 TVA's Activities To Demonstrate Operational Readiness

TVA's Operational Readiness Program consisted of several elements. TVA identified each area/department that was needed to support site operations. The responsible organization wrote the program descriptions needed to support site operations. The program descriptions were compared to the TVA

operational readiness model criteria. Once the programs were in place and sufficiently implemented, self-assessments were prepared to evaluate how well the criteria had been met. When the self-assessments were complete, the QA organization performed an independent verification to verify that the self-assessments were accurate in determining program readiness for site operations and that corrective actions identified in self-assessments were being tracked. The overall results were then reviewed by a management review team to establish site readiness for a final overall review. The final operational readiness review team (Operations Readiness Review phase II) will perform the final assessment of the readiness of the site for operations. An Operational Readiness Report is given to the plant manager at completion, which certifies the plant's readiness for licensing. The report consists of licensing-basis verification (FSAR, TS, SER, PAC/AQ), physical plant completion (system and area turnover programs), and the independent quality verification performed by the QA organization. Performance has been tracked by area through a fuel load readiness matrix (windows report) by the Nuclear Assurance organization. The matrix easily shows which areas have adequate performance and which are weak or need improvement. It also tracks the trend in a particular area to show management whether a particular area is improving.

NRC has reviewed the program description of the TVA Operational Readiness Program (IR 50-390/94-42 and 94-52) and concluded that the program is adequate. The quality of the self-assessments, independent verifications, and team building meetings associated with the Operational Readiness Review Program that NRC has reviewed or observed have been adequate.

TVA's Lessons Learned Program

TVA has benefited from the lessons learned from the problems with Sequoyah and Browns Ferry since those plants were shut down in 1985. Those lessons have been incorporated through a variety of mechanisms into the TVA system since 1985. These include corporate standards, the Corrective Action Program, the Nuclear Experience Review Program, and the transfer of experienced successful managers from the operating plants to Watts Bar Unit 1. The operational readiness review results for the Sequoyah and Browns Ferry startups have been reviewed and incorporated into the Watts Bar Operational Readiness Review Program. In addition, as part of the Operational Readiness Review Program, TVA reviewed the NRC Operational Readiness Assessment Team findings for other utilities for the last several years; of these, the only near-term operating license (NTOL) was issued for the Comanche Peak Steam Electric Station of Texas Utilities. TVA concluded that the Watts Bar Lessons Learned Program adequately addressed the problems uncovered from the other operational readiness reviews.

NRC has reviewed the Watts Bar Lessons Learned Program (IRs 50-390/94-18, 94-58, 94-80, 95-05, 95-11, and 95-18). Initially, some problems were identified in relation to documentation of the lessons learned review and NRC raised several concerns on technical issues. A later review concluded that the program was, in general, being acceptably implemented. Issues identified from the Lessons Learned Program were being reviewed at Watts Bar Unit 1 for applicability, and previous NRC concerns were appropriately addressed.

24.11.2 NRC's Activities To Substantiate Operational Readiness

The NRC process for assessing operational readiness is independent of the TVA process and is conducted through the numerous inspection procedures contained in NRC Manual Chapter 2513, "Preoperational Testing and Operational Preparedness Phase Inspection Program." These inspections are conducted to ensure that TVA is appropriately prepared to operate Watts Bar Unit 1. These inspection procedures cover system preparation and testing through the preoperational test program, review of the various organizations necessary to support site operations, review of procedures required to support plant operations, and review of self-assessments including review of QA independent verifications. Included is an Operational Readiness Assessment Team inspection procedure. The performance of these inspection procedures provides a means for the NRC to assess if TVA's Operational Readiness Program was successful. The results of those inspections are documented in NRC inspection reports.

NRC has inspected TVA's emergency and abnormal operating procedures and has noted progress in completion of the procedures. The procedures that remained to be done were incomplete primarily because of system turnover delays.

The status of NRC's reviews and conclusions pertaining to TVA's readiness to operate Watts Bar Unit 1 are contained in the "Status of Facility Completion" memorandum (94300 memorandum) prepared under NRC Manual Chapter Inspection Procedure 94300. The 94300 memorandum is the vehicle that the NRC regional office uses to document the completion and plant readiness status to the Office of Nuclear Reactor Regulation pertaining to an application for an operating license. This memorandum discusses problem areas and issues that must be resolved before a plant can be licensed.

Inspection Procedure 94300 requires that the regional administrator determine whether Watts Bar Unit 1 construction and preoperational testing have been completed in accordance with the FSAR, other docketed commitments, and regulatory requirements; and whether organization and procedures in place at Watts Bar Unit 1 give reasonable assurance that the Quality Assurance program referenced in Chapter 17 of the FSAR can be adequately implemented. The regional administrator then recommends whether Watts Bar Unit 1 should be licensed and determines the conditions of the license.

24.11.2.1 Quality of Startup and Power Ascension Procedures

NRC has reviewed a sample of the Watts Bar Unit 1 operating procedures, including those for startup, and found them to be generally of good quality. NRC reviews have included the system operating instructions for starting the systems to make them operable for mode changes, surveillance instructions that verify technical specification operability requirements, and the general operating instructions which are the controlling instructions for the startup of the plant. Some TVA open items had not been resolved at the time of the reviews. NRC comments were typically of a minor nature. However, some technical improvements were identified.

NRC has reviewed more than 10 of the 52 procedures associated with the power ascension testing program. In general, the technical content of the procedures, the required scope of testing, and the acceptance criteria were consistent with the design documents and FSAR commitments. The power ascension test procedures are being adequately prepared. Some supporting surveillance instructions remain to be completed, and some TVA items for

procedures remained open at the time of NRC review. When those open items are closed, the procedures should be adequate to control the power ascension testing program.

24.11.2.2 Operating Organization's Qualifications To Operate Watts Bar Unit 1

NRC has reviewed the operating qualifications of Watts Bar Unit 1 plant staff and concluded that the plant is adequately staffed with qualified personnel who meet ANSI Standard N18.1-1971, "Selection and Training of Nuclear Power Plant Personnel" (IRs 50-390/94-58 and 95-37). All of the managers exceeded the requirements and most had gained experience working at operating plants. In addition, management has assigned shift advisors who are experienced operations personnel from other utility operating plants to provide additional experience in the control room during plant startup.

NRC reviewed training programs required by 10 CFR 50.120 for licensed operators and non-licensed staff personnel (IR 50-390/95-01) and concluded that people were adequately trained to support operation of the plant. The licensed operators were initially licensed around 1985. However, because of the time that had passed since then, NRC chose not to administer requalification exams; instead, it readministered the full initial license certification in 1993-1995. Only those who have passed the current license exam will be allowed to perform licensed duties for plant startup and operation.

24.11.2.3 Operational Readiness Assessment Team Inspections

The Phase I Operational Readiness Assessment Team (ORAT) inspection was performed during the integrated safeguards test and assessed the Operations Department's readiness to assume ownership of plant systems (IR 50-390/94-202, December 28, 1994). The inspection found that only a small number of operating and surveillance procedures had been issued and few systems and plant areas had been turned over to Operations. Operator command and control and equipment labeling were considered strengths. Configuration control was adequate. However, operator compliance to administrative procedures requires attention. A deficiency was identified involving improper circuit breaker alignments resulting from failure of operators to follow configuration control procedures.

A Phase II Operational Readiness Assessment Team (ORAT) inspection was performed during TVA's second Hot-Functional Test (HFT-2) in July-August 1995. Among the areas observed were facilities management, operations, maintenance, surveillance, safety assessment and quality evaluation, and health physics.

The team concluded that control room demeanor was professional and operator performance was formal, deliberate, and prudent. Shift turnover briefings were structured, comprehensive, and well controlled. Operator responses to two events that required immediate operator response were timely and in accordance with approved procedures. The plant response revealed minor equipment deficiencies in each event. Weaknesses were also noted in control of procedure changes, configuration control, and system alignments. One member of the shift crew demonstrated weakness in control room formality and communications.

Plant management and QA personnel were actively involved in all areas covered by the inspection. Health physics ALARA planning was good, and there is ample state-of-the-art, portable health physics equipment available to facilitate sound radiation exposure control.

24.11.3 Lessons Learned From Startup of Other NTOLs Applied to Watts Bar Unit 1

The NRC staff reviewed the inspection activities and subsequent plant performance following startup for NTOLs to develop lessons learned and applied those lessons to the inspection program at Watts Bar Unit 1. The results of those reviews were documented in the NRC's May 1984 report to Congress (NUREG-1055) and a 1995 report of study of the South Texas project. Lessons learned from those studies related to preoperation have been implemented in NRC inspections at Watts Bar Unit 1.

At Watts Bar Unit 1, NRC put in place Operations Resident Inspectors well before the projected licensing date and developed a plan to monitor the transition from the special Watts Bar project organization to the normal organization. Senior Resident Inspector for Operations at Watts Bar Unit 1 has been in place since August 1993. An Operations Resident Inspector has been onsite since May 1995. Additionally, the Region will detail an additional experienced Operations Resident Inspector at Watts Bar to oversee fuel load, initial criticality, and power ascension. During the transition from licensing to commercial operation, the Watts Bar Unit 1 site will be manned at the "N+2" resident inspector level.

The NRC staff is preparing a comprehensive inspection plan specifically for Watts Bar Unit 1, reflecting the lessons learned from NTOL plants experience during transition from licensing to commercial operation. The plan is being built around the NRC Inspectors Manual Chapters 2514 and 2515 requirements and will address the specific NRC inspection activities, tests to be witnessed, 24-hour inspection coverage to be provided, and NRC senior management oversight to be provided. The plan will be approved by the NRC Regional Administrator and sent to the Director of the Office of Nuclear Reactor Regulation. It will be updated, as necessary, based upon progress of testing and operations at Watts Bar Unit 1. The results of inspection activities and NRC management assessment of plant performance during startup and power ascension (if approved) will be provided to the Director, Office of Nuclear Reactor Regulation and placed in the PDR.

24.11.4 Conclusion

As a part of its operational readiness activities, TVA evaluated the readiness of its staff, and the procedures and programs necessary for Watts Bar Unit 1 operation, and found the plant staff and systems ready for operation.

On the basis of independent observations, including observation of HFT-2 testing, the NRC staff found that the operational readiness was adequate, programs were in place and functioning adequately, and the plant staff was ready to support fuel load and operation of Unit 1. The NRC staff concludes that TVA is making satisfactory progress toward operational readiness.

The NRC staff has reviewed the lessons learned from recent NTOLs in a report to Congress and the South Texas Project study and will implement a

comprehensive plan to oversee the Watts Bar Unit 1 startup and power ascension (if approved).

24.12 NRC's Overall Assessment

24.12.1 TVA's Employee Concerns Program

In its June 1995 reasonable assurance assessment study, TVA concludes that its Employee Concerns Programs have effectively addressed the concerns raised in the past, and that the present Concerns Resolution Program is responsive to current employee concerns.

NRC's inspections show that the number of employee concerns has decreased significantly and that a large percentage of TVA employees have confidence in TVA's nuclear programs.

NRC concludes that TVA has an effective employee concerns program, which is responsive to its employees' safety concerns.

24.12.2 Construction Quality of Watts Bar Unit 1

TVA made extensive modifications to Watts Bar Unit 1 to address the many problems related to construction quality and quality assurance identified since 1985. Sections 24.2 through 24.9 of this assessment describe actions taken by TVA and NRC to address these problems. These problems had a number of root causes, including organizational and learned-behavior type causes. Because these causes had existed for a long time, it was very difficult for TVA to correct, at the same time, both the root causes and the many hardware deficiencies that resulted from them. Although TVA was proficient in developing plans to correct problems of construction quality and quality assurance, implementation of these plans was not initially effective. The task proved to be too large and resulted in TVA's having to stop work in 1990 to correct the root causes of the hardware deficiencies. Corrective action for the identified hardware deficiencies could then be restarted with a realistic expectation of success.

The quality of TVA's corrective actions has been steadily improving since 1991. The improved quality of the design output documents, the improved work control process, and improved attitudes about quality have resulted in significant improvement in construction quality. From late 1994 to the present, TVA has been performing at a satisfactory level. TVA's Quality Assurance organization is identifying problems and is proactive in engaging management's attention to correct the identified problems. The poor attitude that led to barriers in acknowledging problems and addressing them has significantly improved. Implementation of CAPs and SPs is proceeding satisfactorily and as of September 1995, 22 out of the 28 CAPs and SPs have been implemented, indicating that the problems identified in the 1980s are being adequately corrected. The quality of the rooms and areas turned over to the operating organization has been good. The systems turned over are essentially complete, functional, and match the design documents. Preoperational testing indicates that systems should perform as described in the FSAR.

The NRC staff has concluded that substantial progress has been made in completion of work to correct the problems of construction of Watts Bar Unit 1

and to assure that the plant has been built in accordance with the design documents, applicable codes and standards, and the FSAR. Although substantial progress has been made, all work necessary for fuel load and low-power authorization is not yet complete. The NRC staff plans to supplement its conclusions after further inspection following completion of work.

24.12.3 TVA's Qualifications To Operate Watts Bar Unit 1 Safely

In Section 24.11, the NRC staff evaluated TVA's operational readiness and found that programs and procedures, including Emergency Operating Procedures, are in place and considered adequate to support startup and operation of the plant. The plant staff has been adequately trained and is qualified to support plant operations. Operators have been recently tested and are properly licensed to operate the plant. Operator performance during HFT-2 was adequate and improved during the several weeks of testing as the operators gained knowledge from the simulated startup activities. The Operations organization has demonstrated the proper safety attitude in evaluating and resolving the problems during HFT-2. The Quality Assurance organization is adequately staffed with qualified personnel to support plant startup and operation. Self-assessments have been objective, producing results consistent with NRC findings. NRC concludes that the staff of the Operations organization is capable, and that adequate programs are in place for operation of Watts Bar Unit 1.

24.12.4 Conclusion

In Section 24.12.2, the NRC staff concluded that substantial progress has been made in completion of work to correct the problems of construction of Watts Bar Unit 1 and to assure that the plant has been built in accordance with the provisions of NRC requirements in 10 CFR 50.57 (a)(1). That conclusion was based on the significant amount of NRC oversight expended during the last 10 years.

In Section 24.12.3, the NRC staff concluded that the staff of the Operations organization at Watts Bar Unit 1 is satisfactory and capable of operating the plant safely. Through the preoperational test program, TVA demonstrated that the safety systems will operate and perform their required safety functions. The procedures necessary for operating the systems during normal operation and in emergency situations are in place and are adequate. In addition, the Operations organization has demonstrated a sufficient proficiency and a satisfactory attitude of ownership in operating the plant systems during the recent hot functional testing to permit the staff to conclude that TVA meets the staff's expectations.

The NRC staff concludes that management and safety problems which led to TVA's withdrawal of certification that Watts Bar Unit 1 was ready to load fuel in 1986 are being corrected. Although substantial progress has been made, all work necessary to certify readiness to load fuel is not yet complete. The NRC staff plans to supplement its conclusions after the remaining work has been completed.

The NRC staff is developing detailed plans to inspect the applicant's performance closely during the transition from licensing to commercial operation of Watts Bar Unit 1. The transition inspection plans will reflect

the lessons learned from NRC studies of NTOL plants and will assure that the operational programs developed by the applicant are effectively implemented.

APPENDIX E

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11. ABSTRACT *(200 words or less)*

Supplement No. 17 to the Safety Evaluation Report for the application filed by the Tennessee Valley Authority for license to operate Watts Bar Nuclear Plant, Units 1 and 2, Docket Nos. 50-390 and 50-391, located in Rhea County Tennessee, has been prepared by the Office of Nuclear Reactor Regulation of the Nuclear Regulatory Commission. The purpose of this supplement is to update the Safety Evaluation with (1) additional information submitted by the applicant since Supplement No. 16 was issued, and (2) matters that the staff had under review when Supplement No. 16 was issued.

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