UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 16, 1995

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THRU: Frederick J. Hebdon, Director
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FROM: Mohan C. Thadani, Senior Project Manager
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SUBJECT: DAILY HIGHLIGHT - FORTHCOMING MEETING WITH TENNESSEE VALLEY AUTHORITY

DATE & TIME: June 20, 1995, 1:00 PM

LOCATION: Two White Flint North
11545 Rockville Pike, Room 2C4
Rockville, Maryland

PURPOSE: Meeting with TVA to discuss the Factual Content of Draft Watts Bar Quality and Quality Assurance Report. Agenda and NRC Unedited Draft (Incomplete) are enclosed.

PARTICIPANTS*: NRC

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TVA

M. Medford, et al.

[Original signed by M. Thadani]

Mohan C. Thadani, Senior Project Manager
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Docket No. 50-390

Enclosures:
1. Agenda
2. Draft of NRC's Watts Bar Quality and Quality Assurance Assessment (Unedited)

cc: See next page

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*Meetings between NRC technical staff and applicants or licensees are open for interested members of the public, petitioners, intervenors, or other parties to attend as observers pursuant to "Open Meeting Statement of NRC Staff Policy," 43 Federal Register 28058, 6/28/78.

DISTRIBUTION - Meeting Notice Highlight for Watts Bar dtd June 16, 1995

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AGENDA

NRC/TVA MEETING

REASONABLE ASSURANCE ASSESSMENTS

JUNE 20, 1995

- NRC Opening Remarks
- TVA Opening Remark
- TVA Discussion of Preliminary Results of Assessment
  - Overview of Assessment
  - Assessment of Design
  - Assessment of Construction
  - Assessment of Oversight
  - Assessment of Programmatic Improvement
  - Open Discussion of Other Areas of Assessment
  - Status and Schedule
- Discussion of Factual Content of Draft NRC Assessment
  - NRC Discussion
  - TVA Comments
- Concluding Remarks

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UNEDITED DRAFT (INCOMPLETE)

JUNE 16, 1995

OVERALL ASSESSMENT OF WATTS BAR QUALITY AND EFFECTIVENESS OF QUALITY ASSURANCE

CONTENTS

UNEDITED DRAFT (INCOMPLETE)

OVERALL ASSESSMENT OF WATTS BAR QUALITY AND EFFECTIVENESS OF QUALITY ASSURANCE

1. INTRODUCTION

1.1 Purpose

In this supplemental safety report (SSER), NRC examines the significant problems of Watts Bar Nuclear Plant (WBN), Unit 1, construction quality and quality assurance (QA) that resulted in the Tennessee Valley Authority's (TVA) April 1986 withdrawal of its certification that WBN Unit 1 was ready to load fuel, as well as examining the breakdown of its nuclear program in general. It outlines the extensive actions taken by TVA to correct these problems. This report also outlines the improvements made by NRC since the early 1980s to correct the causes of its failure in regulatory oversight to act effectively in a timely manner.

This report assesses TVA's efforts to correct the root causes of its problems with regard to WBN Unit 1 and the success achieved by the NRC in correcting the root causes of the problems in regulatory oversight in the construction quality and quality assurance of WBN Unit 1.

Finally, this report assesses the TVA program for WBN operational readiness to determine whether WBN, if licensed, can be expected to operate safely and not pose an undue risk to public health and safety and the environment.

1.2 Organization of the Report

The report is organized to first describe historical perspective (Chapter 2) and problems identified and addressed between 1985 and 1991. TVA's plans and NRC actions to recover from the problems of breakdown of WBN construction quality and quality assurance programs in mid-1985 are discussed in Chapters 3,4, and 5. Significant regulatory issues, such as employee concerns programs (Chapter 3), welding, electrical cables, and quality assurance records (Chapter 5) are discussed beyond 1991 to maintain cohesion of the material. NRC actions to improve its regulatory oversight are discussed in Chapter 6. The problems of WBN construction and corrective actions that occurred after 1991 restart were of different character than the ones that occurred in 1985 time frame, and are discussed separately in Chapter 7. Chapter 8 discusses TVA's and NRC's integrated approach to assure that present WBN construction quality is acceptable. NRC is closely monitoring TVA's recent activities assess TVA's latest performance and its trend. NRC assessment of the recent performance and its trend is discussed in chapter 9. Chapter 10 describes the TVA's qualifications and readiness to operate WBN, Unit 1. NRC's overall assessment of

this study is provided in Chapter 11.

2. HISTORICAL OVERVIEW OF WATTS BAR CONSTRUCTION PROBLEMS

On January 23, 1973, NRC issued a construction permit for WBN, Unit 1. Twelve years later, on February 20, 1985, TVA certified that WBN, Unit 1 was ready to load fuel. In the February 20, 1985 letter TVA certified that the design, construction, testing, and preparation for operation of WBN, Unit 1 had essentially been completed in accordance with descriptions contained in the FSAR and other licensing documents. During the spring of 1985, a number of TVA employees informed NRC and selected members of Congress of safety concerns, primarily related to WBN. 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 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 requested that TVA provide a compilation of all reviews which supported TVA's conclusion that the WBN facility met 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 WBN to collect and systematically investigate employee concerns relating to the design and construction of WBN 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 conduct confidential interviews of all TVA employees associated with WBN. QTC also allowed TVA employees from other TVA nuclear sites that had worked at WBN site to provide concerns to the Watts Bar program.

During the 1985 period when these events were happening, NRC conducted the Systematic Assessment of Licensee Performance (SALP) for all the TVA plants. In the September 17, 1985 letter that transmitted the SALP for all TVA sites, NRC identified that TVA had demonstrated ineffective management of its nuclear program by its continued poor performance. 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 operating units 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 of WBN.

During late 1985 and early 1986 time frame, employee concerns about the construction of WBN continued to arise. Some of these had come directly to NRC, but many were being expressed to QTC. The NSRS, which was 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 did inspections of the TVA nuclear plants to advise the TVA Board on nuclear safety.

In December 1985, the NSRS staff was asked by an NRC Commissioner to brief him on its perception of Watts Bar's readiness for an operating license. The NSRS staff expressed concerns that collectively and specifically claimed that WBN did not meet the requirements of 10 CFR 50 Appendix B, which is the NRC quality assurance program regulation that is intended to assure that nuclear power plants are properly constructed. The concerns expressed were very significant and as a result in January 1986, NRC requested 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 was not ready for fuel load and confirmed that TVA was not seeking an operating license for Watts Bar at that time.

In January 1986, the TVA Board of Directors contracted (from outside TVA) Steven White (a retired U. S. Navy Admiral) as a new Manager of Nuclear Power to oversee all aspects of the nuclear power program. Admiral White brought in a new management 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 regain employee confidence and to develop a revised Corporate Nuclear Performance Plan to address the programmatic and management deficiencies. The new employee concerns program was initiated on February 1, 1986. The revised Corporate Nuclear Performance Plan was submitted to NRC on March 10, 1986. The employee concerns that had been received by QTC at WBN prior to February 1, 1986, were placed into a separate employee concerns program called the Employee Concerns Special Program (ECSP). The Employee Concerns Special Program contained approximately 6000 employee concerns dealing with specific aspects of construction; engineering; operations; material control; welding; intimidation and harassment (I&H), and misconduct; management and personnel; quality assurance; and industrial safety. Most of these concerns were specific to WBN.

On March 19, 1986, TVA established a special Watts Bar Task Force, consisting 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, Institute for Nuclear Power Operation (INPO), outside contractors, and various corporate and site quality-assurance processes. 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 previously completed 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 met regulatory requirements. In addition questions 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, the Senior Vice President of Nuclear Power established an independent Watts Bar Program Team to perform an integrated systematic evaluation of Watts Bar. The objective of the Program 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 WBN. 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 included an engineering review, a construction review, and a records review. Its purpose was to detect problems that had not yet been identified through previous discovery programs and, at the same time, confirm that the corrective actions planned were adequate to resolve the identified problems. An extensive number of deficiencies were identified by the VSR.

The Program Team developed the Watts Bar Nuclear Performance Plan and recommended 18 Corrective Action Program plans (CAPs) and 11 Special Programs (SPs) to TVA management for approval. The CAPs and SPs did not include all the work necessary to license Watts Bar. They identified those areas where TVA wanted early review and approval by NRC of their proposed approach because NRC's disagreement with TVA's approach was likely to have adverse consequences to Watts Bar licensing. The CAPs are general in nature, and include plans to identify, scope, and resolve technical issues. The resolutions described in CAPs include 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.

In December 1990, TVA voluntarily stopped physical construction work due to work control problems. During the work stoppage, TVA decided to hire a contractor to perform all future construction/modification work. 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 a decision was made to perform again essentially the entire pre-operational testing program before certifying ready to load fuel. This was to demonstrate and confirm that the safety systems would perform as designed. Limited construction work was restarted in November 1991, with full construction resuming in June 1992. Since construction restart, almost all work performed has been on Unit 1 and those Unit 2 systems necessary to support Unit 1 operation.

3. EMPLOYEE CONCERNS PROGRAMS

3.1 The Employee Concerns Special Program

The Employee Concerns Special Program (ECSP) was established to resolve the approximately 6000 employee concerns received prior to February 1, 1986. Some of the employee concerns received were applicable to other TVA nuclear plants besides Watts Bar. The ECSP included concerns: obtained from the confidential interviews conducted by QTC; NSRS identified concerns that were still open; concerns generated from the SWEC review of

incoming NRC correspondence; and concerns 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 each category 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 found that: some concerns could not be substantiated (Class A); in some cases that concerns were substantiated but did not represent a problem (Class B); in some cases the corrective actions were underway but not completed (Class C); and in some cases corrective action needed to be initiated (Class D and E). The collective results of the investigations for all the plants were published in category reports and subcategory reports, which were submitted to NRC on February 6, 1989.

The ECSP issued Corrective Action Tracking Documents (CATDs) for validated issues in which the ECSP believed that additional corrective actions were needed (Class D and E). Approximately 700 CATDs were issued that were applicable to Watts Bar (approximately 600 in safety-related categories). Corrective actions for the issues identified in the CATDs were developed by the responsible line organization and concurred in by ECSP. 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 corrective action plans 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 based on safety significance and established criteria for when NRC concurrence was needed. Level I deviations were defined as deviations from technical specifications, deviations from the design basis, deviations from 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 realized that they had not adequately documented the ties between the Class D/E employee concerns and the CATDs that resolved them. As a result, ECSP initiated the overview process to accomplish a final review to ensure the corrective actions resolved the associated employee concerns. This included making the ties between the employee concerns and the associated CATDs.

3.1.1 NRC Review of Employee Concerns Special Program

The programmatic aspects of the TVA ECSP were accepted by NRC in a letter dated

October 6, 1987. NRC approach was to review the implementation for each plant as the corrective actions were identified and implemented. The results of the investigations for Sequoyah were initially published by TVA in element reports. To support the restart of Sequoyah, NRC documented its reviews of the Sequoyah specific element reports in letters to TVA dated March 11, 1988 and November 11, 1988. This was an initial look at the ECSP implementation since later, the collective results for all the plants were published in category reports and subcategory reports, which were submitted to NRC on February 6, 1989. The initial sample review results for the subcategory reports were published by NRC for Browns Ferry Unit 2 restart (15 of 107) on May 31, 1990. A deviation process to approve corrective action changes was submitted to NRC and accepted by NRC in a letter to TVA dated April 15, 1991.

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

NRC inspection of the ECSP corrective action implementation at WBN is being accomplished under TI 2512/15. Many of the CATDs reviews are preformed in conjunction with the CAP/SP inspections. Initially NRC inspection was focussed on the CATD process. In mid-1993, these inspections indicated that approximately 10% of the CATD corrective actions had not been adequately accomplished to resolve the associated employee concern(s) and that 15% - 20% of the CATD closure packages contained deficiencies. In addition, NRC inspections indicated that some of the corrective actions which were already in place prior to ECSP investigation but not complete (Class C employee concerns) may not have been completed (IR 390,391/93-24). As a result of NRC inspection findings, TVA initiated the "Lookback Project" discussed below.

3.1.2 Lookback Project

As a result of NRC inspection findings, TVA initiated the Lookback Project to ensure that all employee concern corrective actions (Class C and CATDs) were completed and the employee concerns were adequately resolved. The Lookback Project review of Class C concerns revealed that some Class C employee concern corrective actions were being tracked to closure by CATDs. CATDs were intended by the ECSP to be initiated for Class D and E concerns where no corrective action was in place, not 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 followed resulted in TVA expanding the Lookback Project to also review the classification of Class A and B employee concerns. The Class A and B review results confirmed that the original ECSP classifications did not always meet the classifications described in the subcategory reports. The Lookback Project reclassified the Class A and B concerns into legitimate and not legitimate, upgrading approximately 1/3 of

the unsubstantiated concerns reviewed. The basis for the upgrade was that 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, that corrective action was being taken through a similar CATD or Class C concern or that 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.

The overall review effort of the Lookback Project has retouched all employee concerns in the ECSP program to ensure that corrective action was being accomplished for those that were determined to need corrective action. Although the original intent of the Lookback project was to address only CATDs and Class C concerns, the program was expanded by TVA to ensure that all employee concerns that needed corrective actions were getting corrective action and were being properly closed. This included a verification through sample review that the post 1986 employee concern program was properly classifying and resolving concerns as well.

Initial NRC inspection of the Lookback Project effort on Class C employee concerns (IR 390,391/93-83) identified 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 by the Lookback Project for CATDs and the same documentation method was used. A later NRC inspection (IR 390,391/94-10) identified that the level of detail in the CATD documentation was improved compared with that observed in the 93-83 inspection of Class C reviews and was adequate. NRC inspection of the Class A & B review (390/94-30) revealed that some Lookback reviews were shallow in depth and missed the proper classification also. However, no issues were found missed by ECSP since in the cases where classifications were missed other documents (CATDs or Class C concerns) were addressing the same issue. NRC review during the QA Records CAP inspection (IR 390,391/94-40) of some Class A and B concerns indicated that Lookback was having some problems with classification and the links to the associated corrective actions when investigations into wrongdoing were involved. This appeared to be an organizational interface problem due to the sensitive nature of wrongdoing investigations. Later inspections have indicated that this problem was corrected by CRS management.

In late 1994, the Quality Assurance organization began trending CATD closure package quality based on using the QA and Lookback review results as quality indicators. Initial trends indicated less than satisfactory results for the line organization. However, this focussed management attention on improvement and quality indicators now indicate acceptable quality packages.

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

verification process.

3.2 Concerns Resolution Program

TVA established the Employee Concerns Program (ECP) for all employee concerns raised after February 1, 1986. Those concerns that were received before that date were contained in the Employee Concerns Special Program discussed in section 3.1 above. This program was a first step in the TVA recovery program to bridge the gap between senior management and employees, and to regain the trust of the employees. The program reported directly to the new Manager of Nuclear Power, bypassing the management chain that the ECSP employee concerns 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) is composed of a concerns resolution manager, located at the corporate office in Chattanooga, and a site representative at each of the TVA nuclear sites. Each site and the corporate location have a small staff to take and investigate employee concerns. The 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 and assisting in the resolution of employee concerns. 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. A transition began in 1988 to referring some concerns to line management to investigate, without providing the concerned individual's identity. After 1990, essentially all employee concerns were referred to the line organization for investigation. Certain guidance is given in the Standard for the referral, including 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 results of 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 have their own employee concerns programs as part of the contract language. CRS performed audits of these contractor programs and closely monitors their performance and the concerns being received. Intimidation and harassment concerns received by the contractors are immediately reported to CRS. In addition, the TVA's Inspector General (IG) audit of the Concerns Resolution Program also reviewed the contractor program implementation.

The number of employee concerns received per year by the program has decreased from 551 in 1986 to less than 75 per year during the past several years.

3.2.1 NRC review of Concerns Resolution Program

NRC reviewed and documented acceptance of the Employee Concerns Program in NUREG 1232 Volume I dated July 1987 (now called Concerns Resolution program). Recent NRC inspections of the program in 1990, 1992, and 1993 indicated that the program was adequately resolving the technical issues raised by the employees. Issues dealing with intimidation and harassment are referred by the CRS 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 exiting the site were receiving exit interviews with an employee concern representative (either CRS or contractor ECP). This was required by the Corporate and Site procedures. It resulted from misinterpretation of the checkout form by managers and employees. As a corrective action, TVA clarified how to use the checkout form and sent questionnaires by mail to the individuals who had been missed.

In the 1993 inspection a significant number of employees (378) were interviewed by NRC. A very large percentage expressed confidence in the program and the need for it to continue. The inspection also found strong support for the program from the senior managers.

Conclusion:

4. RECOVERY PLAN

4.1 Nuclear Performance Plans

The Nuclear Performance Plans were TVA's response to NRC's September 17, 1985, requesting information pursuant to 10 CFR 50.54(f). In the September 17, 1985 letter NRC stated that TVA had demonstrated ineffective management of its nuclear program by its continued poor performance which was only marginally acceptable. Pursuant to 10 CFR 50.54(f), NRC requested 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 of WBN. TVA approached this request 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 provided the TVA's Nuclear Performance Plan for correcting the WBN construction and other problems.

The Corporate Nuclear Performance Plan addressed the requests for information about actions planned by the TVA Board to remain informed and involved in improving nuclear

plant performance; any management changes made to strengthen regulatory performance, including experience and qualifications of personnel filling new assignments; corporate controls established to ensure that the status of TVA commitments to NRC is tracked; and on the program for escalating action on QA audit findings, to ensure problems are quickly resolved. TVA reorganized to place all nuclear power functions under one manager reporting directly to the TVA Board of Directors. Previously nuclear functions were fragmented under several organizations with engineering, construction, security, and nuclear power under separate managers reporting to the TVA Board, and the quality control function split under many departments. TVA considered part of its problem to be a lack of experienced managers. To correct that problem TVA contracted retired Admiral Steven White to fill the new Manager of Nuclear Power position. Other contract managers were also hired to fill key positions. Other corporate changes under this plan included a new employee concerns program, increasing upper management awareness of nuclear activities, improving management systems and controls, and improving the corrective action program. An important function of the management systems and controls was the corporate procedures system which governed and standardized activities for the 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 a lack of confidence in TVA management by employees regarding the adequacy of construction at Watts Bar Nuclear Plant. TVA formed an independent Watts Bar Program Team to perform an integrated systematic evaluation of Watts Bar. The objective of 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 with the objective being to perform a systematic evaluation of Watts Bar design and construction, to develop corrective actions, and to prepare the Watts Bar Nuclear Performance Plan.

The systematic evaluation included the development of 80 elements and 3300 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 & Lundy Company, to independently verify that the design and construction of Watts Bar 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 their 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.

4.1.1 NRC Acceptance of Corporate Nuclear Performance Plan

NRC reviewed the Corporate Nuclear Performance Plan and, in July 1987, issued an SER (NUREG 1232, Volume I) on the TVA: Revised Corporate Nuclear Performance Plan. 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 underway, if implemented properly, were sufficient to resolve the problems at the corporate level that led to issuance of the 10 CFR 50.54(f) letter dated September 17, 1985, and to support continuing TVA nuclear activities, including plant operations.

4.1.2 NRC Acceptance of WBN Nuclear Performance Plan

NRC reviewed the Watts Bar Nuclear Performance Plan (WBNPP) and issued an SER (NUREG 1232, Volume IV) on the TVA: Watts Bar Nuclear Performance Plan in January 1990. In NUREG-1232 NRC endorsed the general approaches of various corrective actions described in 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 should address the identified deficiencies. A revised WBNPP (Revision 1) was issued in September 1991 but the NRC staff determined that it did not provide any significant changes.

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 WBN 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 base documents to design output documents (e.g., drawings and construction specifications) and finally to 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 was reviewed by NRC in August 1988. A total of 507 discrepancy reports (DRs) resulted from the VSR.

Each of the open DRs was tracked and controlled in an administrative control program documented by on-site procedures. The objective of the on-site program was to ensure that all corrective actions were accurately identified, tracked and provided with a closure review to ensure that commitments were met.

4.1.4 NRC Inspection of Vertical Slice review

Two NRC team inspections of the VSR effort were conducted by the NRC staff at the S&L corporate office in Chicago, Illinois. The first inspection, conducted November 28 through December 2, 1988, included inspection of 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. The inspection results were reported in NRC Inspection Report 390/88-09, issued on February 27, 1989.

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

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

NRC inspections have revealed some deficiencies in the TVA resolution and closure process of the outstanding VSR DRs. However, generally, the various team inspections and on-going on-site inspections have determined the VSR review performed by S&L was thorough and adequate. Also, TVA has generally adequately resolved the issues identified by the VSR. At present, of the 507 DRs, TVA has 233 remaining to be closed. NRC has an open tracking item to assure that all DRs are closed before fuel load.

4.2 Corrective Action program Plans and Special Programs (CAPs and SPs)

The systematic evaluation conducted by the Watts Bar Program Team resulted in the identification of a number of non-conformance. The broad scope, generic, or programmatic issues formed the basis of the Corrective Action Program plans (CAPs). Other significant issues formed the basis of the Special Programs (SPs). Portions of these issues had been previously identified in the corrective action programs, the ECSP, the Vertical Slice Review, and NRC open items. These specific items (CATDs, VSR DRs, CAQa, NRC open items) were identified 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
Fire Protection
Hanger and Analysis Update Program
Heat Code Traceability
Heating, Ventilation, and Air Conditioning Duct and Duct Supports
Instrument Lines
Prestart Test Program
QA Records
Q-List
Replacement Items Program
Seismic Analysis
Vendor Information Program
Welding

TVA rescinded the Prestart Test Program CAP in 1991 after committing to perform the entire pre-operational test program again.

Many significant issues, which were not as broad in scope as CAPs, or where substantial progress had already been made toward their resolution with several reports 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. A brief description of each Special Program was contained in the Watts Bar Nuclear Performance Plan. The Special Programs are listed below:

Concrete Quality Program
Containment Cooling
Detailed Control Room Design Review
Master Fuse List
Mechanical Equipment Qualification
Microbiologically Induced Corrosion (MIC)
Moderate Energy Line Break Flooding
Radiation Monitoring System
Soil Liquefaction
Use-as-Is CAQs

4.2.1 NRC Acceptance of CAPs and SPs

In NUREG-1232 NRC evaluated the CAPs 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 NRC endorsement was limited to the approach and general methods which, if properly developed and thoroughly implemented, should address the identified deficiencies.

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 WBN Program Team. The CAPs and SPs do not encompass all work necessary to license WBN. However, they consolidate issues and identify areas where collective corrective actions can be more effective by use of an integrated plan. 18 CAPs and 11 SPs were developed by TVA and accepted by NRC. NRC believed that there was a specific need to identify inspection effort for the CAPs and SPs. As a result Temporary Inspection Instructions (TIs) were written to direct inspection activities for the CAPs and SPs. The TIs perceived that both interim inspections and a final inspection would be necessary to effectively monitor the implementation of CAPs and SPs. TVA and NRC agreed that the criterion for determining when TVA was ready for the 75% inspections was that TVA's engineering was 100% complete and field work was 50% complete. This would allow NRC inspections 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. Several CAPs have had several interim (75 %) inspections while most have had just one 75% inspection. The 100% inspection then concentrated on confirming that the implementation actually accomplished the objectives.

As the CAPs and SPs represent those activities at greatest risk at Watts Bar, NRC decided to inspect or audit the completion of each. The total number of CAPs/SPs decreased from 29 to 28 when TVA decided to repeat essentially the entire pre-operational test program and withdrew Prestart Test CAP. Early review and closure of these programs was conducted by the Office of Special Programs (OSP), with the Heat Code Traceability, and Seismic Analysis CAPs and the Concrete Quality SP being completed by TVA and closed by NRC in 1990. In 1992, an inspection of the Master Fuse List (MFL) SP revealed weaknesses in TVA's CAPs/SPs completion and readiness review process. Also in 1992, due to the numerous issues that interface with the CAPs/SPs such as employee concerns, and open items, NRC requested TVA to provide specific completion information for each CAP and SP. This process eventually evolved into TVA developing binders or "books" for each CAP and SP. These books were intended to be living documents that are updated periodically with status information and which could be used by both TVA and NRC to conduct reviews. Before the books were developed, a basic inspection process was established, whereby NRC could conduct inspections against the CAPs/SPs whenever needed, but that TVA would, as a minimum, inform NRC before conducting its inspection. The status books supplemented this effort for each CAP and SP at the 75% and 100% completion points. Several of the CAPs and SPs were not inspected at 75%, either because a book was not developed (Welding CAP, Use-As-Is CAQs SP, Soil Liquefaction SP, DCDR SP) or the programs were either unique (QA Records CAP) or inspected as part of the ongoing inspection process (Fire Protection CAP and EQ CAP and Mechanical Equipment SP). These have been inspected periodically or at set times in the licensing process. Most of the remaining CAPs/SPs were coordinated

for multi-inspector reviews around the 75% completion schedule. Also, as part of the on-site resident inspector efforts, all CAPs/SPs that required field modifications were routinely inspected as the work progressed.

For the most part, after the MFL inspection, subsequent status books and resulting inspections improved, with some notable exceptions. Although inspected much later than the master fuse list (MFL) SP, the 75% 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 prior to NRC inspection. Performance in the other CAPs/SPs was spread between strong and comprehensive in several of the mechanical-related Programs (MELB SP, HVAC Duct and Duct Supports, Elect. Conduit/Supports CAP, Cable Tray/Supports CAP, and the Containment Cooling SP) and the Q-List CAP to mediocre in the RIP, HAAUP, DBVP, Equipment Seismic, Instrument Lines and Cable Issues CAPs, and the MIC SP.

As the construction completion schedule continued to slip in the early 1990s, the CAPs and SPs, most tied directly to system turnovers, began to slip also. Closure or 100% inspections was more difficult to attain. 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, MIC SP and MFL SP. The original intent of the 100% inspections was to close the CAPs/SPs when all of the work within the program was accomplished. As the programs began to slip, most 100% completion schedule dates moved to within a few weeks of estimated fuel load. After several years of CAPs/SPs inspections, NRC decided that inspection of the majority of the remaining CAPs/SPs just prior to fuel load would not be feasible. The closure process was revised in 1994, whereby TVA would provide periodic completion status to the NRC and NRC staff would decide when to inspect for closure or perform interim inspections. NRC agreed to close out the CAPs and SPs with a limited amount of work remaining and would then review that effort with routine inspection follow-up, prior to licensing. This process enables the bulk of the CAPs/SPs closure inspections to be spread out over a longer period of time. As of April 1, 1995, Welding CAP was successfully closed in late-1994, using this process. The NRC staff continues to monitor CAPs/SPs status, conduct interim inspection and review completion status to schedule closure before licensing WBN, Unit 1.

4.3 Conclusions

5. SIGNIFICANT REGULATORY ISSUES

5.1 Welding

During the mid-1980's, concerns were raised by the NSRS and by various employees through the employee concerns program regarding probable weld deficiencies that could affect the construction quality and the operation of WBN-1. In October 1985, TVA contracted through the Department of Energy, Idaho Operations Office (DOE/ID) with EG&G Idaho, Inc. to perform a review of the TVA welding program and assess the significance of the welding concerns at WBN-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 to the requirements in the WBN FSAR, (2) assess the applicable TVA employee concerns and quality documents to determine if they identified quality problems with the TVA-fabricated, safety-related welds, (3) evaluate TVA's as-constructed plant weld status by conducting an examination of 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 performed a comprehensive review of 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 (NRC Inspection Reports 50-390/86-17, 50-390/86-26, 50-390/87-09, and 50-390/87-19). In addition, numerous inspections regarding welding and associated activities have been conducted by the on-site NRC regional and resident inspectors. The NRC staff specifically reviewed the findings regarding structural, piping and HVAC welds. In addition, the staff reviewed issues arising from the employee concerns and quality indicators[1]. The results of the inspection efforts discussed above generally confirmed that the WEP was adequate for identifying welding problems at WBN-1 as well as for determining the overall quality of welding within the WEP scope at WBN-1. However, the results of the WEP revealed that there was a significant breakdown in some of the original WBN-1 welding activities, particularly in the areas of structural (AWS Code) welding, piping (ASME Boiler & Pressure Vessel Code) welding and HVAC ductwork welding as further discussed below.

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, a clear breakdown of the quality assurance program had occurred.

The WEP reported that of 401 ASME piping welds examined by visual reinspection, 19

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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 the WBN-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.

percent failed to meet the original acceptance criteria. As a result, NRC concluded that TVA had an ineffective original construction QA/QC program which allowed acceptance of large numbers of unacceptable welds.
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 WBN-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 was considered an acceptable method to be used to assess the welding at WBN-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 regards to corrective actions and sample expansion, NRC found that the WEP adequately identified weld deficiencies that required analysis and repairs and/or areas that required TVA to expand the sample inspections to 100 percent. Consequently, NRC concluded that a significant breakdown in overall compliance with 10 CFR Part 50, Appendix B, relative to the QA/QC inspection aspect of the structural welding program had occurred.

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%, where warranted, and correct the hardware and associated documentation. An example of identified problems that required an expanded sample was the structural welds at elevation 741 of the control building. The resolution of these welds required a 100% re-inspection by the licensee and re-work of 1091 of the 1098 welds located at this elevation.

Evaluation of the welding program by TVA was addressed in three separate phases. Phase 1 was a comprehensive assessment of safety related welding and was performed by the Welding Project (WP) with personnel independent of Watts Bar management and a Department of Energy (DOE) contractor (EG&G). The Phase 1 program was submitted to NRC on February 21, 1989. The Phase 1 program and associated commitments were reviewed by NRC and found to be acceptable.

Phase 2 investigated the as-found condition of the safety related welds and associated records. The evaluation consisted of: physical reinspection of selected welded structures and components, evaluation of welding related employee concerns identified through the Employee Concerns Special Program and review and analysis of weld-related quality indicators. The evaluation was performed by the WP, the Department Of Energy Welding Evaluation Project and the ECSP. The Phase 2 report was submitted to NRC on April 10, 1989. The report was reviewed by NRC and found 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. The review

of the final report was inspected by NRC in conjunction with the final review of the TVA Welding CAP. The final Welding CAP was submitted to NRC on January 9, 1993. On January 11, 1995, NRC inspection of the Welding CAP and associated programs concluded that, with the exception of a weld accountability issue and final ASME N-5 Supplement completion, the Welding CAP had been adequately implemented. These issues are being followed to completion by NRC separately from the Welding CAP.

To assure welding problems and welding programs were corrected, NRC has conducted 59 welding inspections since 1985. Some of these inspections were major team inspections with NRR, Resident Inspectors, Region II Specialist and contractor welding specialists involved. In addition to the team inspections and normal routine welding inspections conducted by the resident inspector staff and Region II 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 NRCs 100 percent radiographic reviews were discontinued. To assure continued compliance since November 1991, NRC has periodically performed sample reviews of welding activities and the radiographic inspection program. Additionally, since 1986 NRC has reviewed and closed nine 10 CFR 50.55(e) reports that identified welding problems.

NRC Inspection Report 50-390/94-79, issued January 11, 1995, concluded that the Welding CAP had been adequately implemented. Two open issues discussed above are being followed to completion prior to fuel load. On-going welding activities are being inspected as they occur. Pending successful implementation of the completion of on-going welding activities and closure of the open issues, NRC believes TVA has adequately addressed all welding problems at Watts Bar.

Conclusion:

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 which were believed to have resulted in damage to the cables. The NSRS report had concluded that there was the potential that the environmental qualification of the cables could have been potentially invalidated due to the cable pulling practices. TVA initially took the same approach to resolution of this issue at Watts Bar that they had previously taken at Sequoyah and Browns Ferry. That approach was to determine the fifteen worst case conduits for pull-by damage and then test them by applying a high potential signal. That method was developed based on selection of conduits/cables from theoretical pull-by damage criteria for gross damage, since no damaged cables had been found.

In June 1989, Unit 2 Class 1E cables were being removed from a conduit to evaluate an existing employee concern which had identified the potential for cable damage due to heat from welding near the respective conduit (arc strike). During the inspection of the removed

cables, no heat damage was observed. However, cable insulation damage was found by NRC on several of the cables removed from the conduit. The identified damage consisted of nicks, cuts, punctures, damaged insulation, a sawcut through the cable jacket, and pieces of broken cable. TVA performed laboratory analysis of the identified cable damage and concluded that the damage occurred as a result of cable pullbys. Cable pullbys occur when new cables are pulled into conduits which have existing cables. Pulling new cables into conduits with existing cables results in increased 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 the pull tension is too high.

Other Class 1E cables were removed from conduits for inspection to determine the extent of condition. This resulted in the discovery of more cable damage similar to the damage on the original cables. A complete new plan was prepared to determine the extent of condition and correct the cable damage problems found. Up until the discovery of the damage TVA had resisted pulling cable out of conduits to perform cable damage inspections, having chosen to perform the in-situ high potential testing instead. The cutting of the cable jacket/insulation by the nylon pull ropes had not been factored into the gross damage criteria used to select the cables that would have been high potential tested.

The new resolution plan for the cable pullby damage issue involved cable replacements of approximately 660,000 linear feet of cable, inspections, hi-pot testing, and use-as-is dispositions. Conduits were categorized into high and low risk categories based on the potential for pullby damage using the known cable damage analysis information. The high risk category was defined as the family of conduits in which sidewall bearing pressures and damage could be expected to be found with considerable frequency. Cables in the high risk category conduits were replaced.

Cables in the low risk category were accepted as-is based on 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. NRC inspections have reviewed the implementation of the corrective actions for the cable pullby issue with acceptable results. TVA also estimated that approximately 246,000 linear feet of electrical cable would be replaced due to ampacity concerns. Other cable replacement occurred due 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 selected non-10 CFR 50.49 splices (approximately 26,000 cable splices). Additionally, TVA installed numerous splices as part of the cable replacement issues discussed above. The additional splices resulted because the cable pull-by damage and cable replacement was generally limited to those 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 cable removal in trays was impractical due to the vimasco fire retardant coating applied over cables in the trays. This resulted in removing the cable from the conduits and cutting the cable where it enters the tray, then re-using 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 the above discussed hi-pot testing of low risk cables, several cables were observed to fail hi-pot testing. The test failures were evaluated and partly attributed to cable shorting to ground at junction boxes during the testing. The cables shorted to ground near splices. The cause of the failure was due to ring cuts to the cable conductors at the point where the cables broke out of the cable jacket. Ring cuts were introduced by electricians stripping back the cable jacket by use of 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 re-inspection 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 inspections of the implementation of corrective actions have been performed since the Watts Bar 1991 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 94-72). These problems resulted from work control and field personnel not following procedures and design requirements. Through engineering evaluation and testing, TVA was able to accept most of the deficient cable splices and crimp connectors. The remaining ones were reworked.

In January 1995, the Watts Bar QA organization was performing a closure review assessment 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 which included ring cuts, flattened cables, nicks, scratches, cuts, pinholes, and bend radius violations. Based on the identified deficiencies, QA and Engineering 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 re-inspected for damage.
- Re-inspection of splices deferred to other work documents which were replacing the cable splice. However, the new work document did not identify 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 re-inspection of the cable as well.
- Damage was not identified during new work activities by construction and plant personnel.
- Personnel training inadequate in the recognition of cable damage.
- Quality control inspectors failed to identify damaged cables.

TVA has developed additional corrective actions to re-inspect all 10 CFR 50.49 cable splices for possible cable damage. This re-inspection started on March 6, 1995. NRC is closely following TVA work on cable splices to assure compliance is achieved.

Conclusion:

5.3 Quality Assurance Records

The QA Records CAP was developed by TVA after NRC questioned the auditability and retrievability of safety-related QA records (390/86-24). Follow-up actions by TVA found indications that records at Watts Bar (1) were not retrievable in a timely manner, (2) were maintained in improper storage, 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 CAQs. In NRC inspection 390/90-08 NRC expressed concern that the implemented QA Records CAP may not allow Watts Bar to demonstrate to 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 included 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 1985/1986 TVA began a recovery process to ensure that Watts Bar was adequately constructed (i.e., plant hardware was acceptable). This recovery process has been and continues to be accomplished by 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 for CDRs, etc. During each of these corrective actions, records have been developed which document the completion of corrective actions. These records were used by TVA to supplement the original construction records, or, in some cases, serve as a 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 document properly the construction records licensing basis for Watts Bar, TVA developed a series of QA record plans, which described in detail the records which 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 thirty nine (39) of these record plans. NRC completed a review these record plans and the associated plant records to verify technical adequacy of Watts Bar records for licensing. Some of these record plans were reviewed as a part of the associated CAP, however, the largest portion of these plans were reviewed as a part of the closeout of the QA Records CAP.

NRC inspection of the QA Records CAP was performed by a series of team inspections conducted over approximately a nine month period utilizing an inspection team leader and three contract inspectors. This series of inspections included review of virtually all types of plant hardware. The hardware areas reviewed included 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. Each of these inspections included the verification of the record plan for the area reviewed for technical adequacy; the records for a sample of approximately fifteen hardware items to verify that the records were retrievable, and properly documented installation in accordance with the record plan; and the records for a sample of approximately six hardware items were compared to the design output and the hardware in the plant (including a field walk-down), to verify that the items were properly installed in accordance with the design and the records accurately reflected this installation. In addition, the results of reviews obtained by TVA's ASRR in each area were compared to the inspection teams results, and deficiencies noted by the ASRR were reviewed for adequate corrective action. These inspections resulted in the identification of only a few minor problem areas which were dispositioned in accordance with normal NRC enforcement practices.

In addition, a QA Records CAP final closure team inspection was performed. This inspection involved the input of approximately eight inspectors and an inspection team leader over the period of one month. The inspection was conducted in order to review all areas of the CAP, which had not been previously reviewed during the series of inspections discussed above. The inspection included a review of: the CAP Final Closure Report, the 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.

Conclusion:

6. ADDITIONAL NRC ACTIVITIES

6.1 NRC Corrective Actions to Improve Its Regulatory Oversight

During 1984, NRC noted deterioration in the TVA's nuclear program performance. TVA employees' complaints of 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, all should have indicated serious problems at TVA's nuclear program and triggered NRC's agency-level response. But no such response occurred. While NRC took actions to get TVA's attention to address these problems through meetings with TVA's mid-level management, escalated enforcement actions, and poor SALP ratings, the actions were not taken at NRC's senior management and TVA's Board level to prevent subsequent breakdown of effective TVA management of nuclear program.

By mid 1985, TVA employees voiced significant safety concerns, and reported there

concerns to NRC and to U.S.Congress. TVA, realizing that it had lost the confidence of its employees in its management's ability to manage its nuclear program, shut down it's Browns Ferry and Sequoyah units. In April 1986, TVA withdrew its certification that Watts Bar, Unit 1 was ready to load fuel. TVA's actions had a common root cause; a realization by TVA that it had a serious management breakdown throughout the TVA nuclear organization.

In SECY-86-334, NRC found that the TVA's management breakdown had its roots in its fundamental organizational structure and attitudes of its managers at the time. From its earliest days TVA was divided into two separate groups; one to construct facilities, and other to operate them. With this structure TVA built one of the largest utilities in the world and had won praise for its innovative engineering, construction, and operation of a highly reliable and inexpensive power system based on hydroelectric and fossil power stations. However, its structure and success created management attitudes which were precursors of subsequent failures of its nuclear program.

In the nuclear area, TVA's management was fragmented. No one below the Board of Directors and General Manager could exercise authority over its employees. The construction of nuclear plants was the responsibility of its construction group, which functioned independent of the operating group. The operating group staff, which planned outages, maintenance, and modification installations functioned independent of the operating plant managers, rendering the plant managers ineffective. The quality assurance organizations were fragmented into up to seven independent organizations. Beyond the structural fragmentation, cooperation between construction group and operating group was very poor because each had its own, often conflicting goals, priorities, and procedures.

A position taken by NRC as a result of lessons learned from Three Mile Island accident reviews was to take a hands off approach to self initiated independent safety reviews that were not conducted under specific NRC requirements. The position was taken to encourage licensees to independently initiate safety evaluations whose findings would not be used by NRC against the licensees. The position allowed licensees to have broad independent reviews accomplished whose findings could alert the licensees of programmatic problems within their organizations including assessments of the effectiveness of the independent QA function, without fear of NRC's enforcement actions. The position was intended to encourage licensee management to assess the effectiveness of their own organizations without relying solely on NRC as an evaluator of their QA function.

The independent safety reviews accomplished by INPO and NSRS had discovered weaknesses in the TVA construction program. INPO had conducted construction reviews at the Bellefonte site in 1984 and at Watts Bar in 1985. The findings from both reviews were applicable to Watts Bar. It is not clear that NRC ever reviewed or used this information in relation to whether or not Watts Bar was ready to receive an operating license. In relation to NSRS, Region II had taken the position that since NSRS reported directly to the TVA Board of Directors, they were not part of the line QA function required by 10 CFR 50 Appendix B. Region II took the position that NSRS was similar in nature to INPO and therefore applied the same hands off approach to the NSRS findings. NSRS was assigned additional responsibilities in 1985 in relation to the Employee Response Team. These responsibilities

included investigation of the many employee concerns being received by the independent contractor that was interviewing the Watts Bar employees. From the many construction reviews conducted by NSRS from 1981 until 1985 and the employee concern investigations conducted in 1985-86, NSRS was able to assimilate a broad based perception of the lack of WBN, Unit 1 readiness operate. These reviews and perceptions were not used by NRC in making its assessment of the readiness of Watts Bar for an operating license in 1985. As NRC learned later in 1985, these perceptions were contrary to NRC perception in very early 1985 that Watts Bar was progressing successfully toward an operating license.

NRC had not staffed the Watts Bar site with a strong construction resident staff after the senior construction resident left in 1983 and the other construction resident inspector died in August 1984. NRC did not assign another construction resident inspector to the site until mid 1986, after licensing was delayed due to allegations of inadequate construction. Instead, NRC decided to staff the site with operations residents beginning in 1983. By 1984 there were three operations residents at the site. The construction inspection program was completed by the NRC's inspection staff. However, after anonymous allegations were received by Congressional staff in early 1985, NRC management realized that significant construction problems existed at Watts Bar.

NRC paid little attention to employee concern programs prior to 1985. NRC only investigated and followed employee concern resolution if the employee concerns were brought directly to NRC. Although TVA had an employee concerns program, it was not effective, but NRC was not aware of that fact until allegations were received in 1985.

NRC's inspection staff appears to have recognized the TVA's fundamental problems. But, while inspection staff was able to persuade TVA's mid- management to institute major corrective programs, it was unable to persuade TVA that its problems were rooted in its fundamental and long-established fragmented management structure.

NRC's senior management did not begin to elevate the TVA's problems for agency-wide action until the middle of 1985. It is possible that earlier concerted action by TVA's Board and/or agency-wide NRC action could have brought about the fundamental structural changes and prevented the nuclear program breakdown.

As discussed above, under its Corporate Nuclear Performance Plan, TVA reorganized to correct its management structural problems by placing all nuclear power functions under one manager reporting directly to the TVA Board and, as discussed in Chapters 3 and 4, put in place a variety of corrective actions addressing human performance problems and WBN hardware problems.

Also, as a result of serious Congressional concerns about the construction deficiencies found at several nuclear projects (other than WBN) U.S.Congress directed NRC (Ford Amendment to NRC Authorization Act of 1982) to perform a study to assess what went wrong that caused serious problems at some construction plants, and what should be done to detect and correct nuclear power program problems in a timely manner.

A discussion of NRC studies and actions in response to the Ford Amendment study and the

study of lessons learned from TVA's breakdown of its nuclear programs and WBN construction problems follows.

6.1.1 Quality Assurance Report to Congress

As a result of Congressional concerns about major problems in the quality of design and/or construction at several nuclear power plant construction projects in the 1970s and early 1980s, NRC was directed by Congress in 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. Projects having received widespread attention in this regard included Marble Hill, Midland, Zimmer, South Texas, and Diablo Canyon. Because of the those quality-related problems and others in the U.S. nuclear industry, many in the public and in Congress questioned (1) the nuclear industry's ability to design, construct, and operate reactors in a manner consistent with maintaining public health and safety, and (2) NRC's ability to provide effective regulatory oversight of those activities.

The results of the NRC's 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. A primary focus of the study was to determine the underlying causes of major quality-related problems in the construction of some nuclear power plants and the untimely detection and correction of these problems. The study conclusion that actions were needed to avoid recurrence had broad implications for the NRC's licensing and inspection approaches as well as for the agency's oversight of licensee QA organization performance.

The QA report recommended a number of improvements in industry and NRC programs. For industry, the QA report recommended self-imposed rising standards of excellence, treatment of quality assurance as a management tool rather than as a substitute for management, improved trend analysis and identification of root causes of quality problems, and a program of comprehensive third party audits of present and future construction projects. For NRC, the QA report recommended a heavier emphasis on team inspections and resident inspectors, an enhanced review of new applicant's capabilities to construct commercial nuclear power plants, more attention to management issues, improved diagnostic and trending capabilities, improved quality and quality assurance for operating reactors, and development of guidance to facilitate the prioritization of quality assurance measures commensurate with the importance of plant structures, systems, and components to the achievement of safetY.

One problem identified in the QA report was that although early indications of quality problems were present from a variety of sources, neither licensees nor NRC effectively integrated or synthesized those indications 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. A QA-specific performance indicator program was subsumed by NRC's plant-wide Performance Indicator Program, a tool by which the agency maintains a perspective on selected, significant aspects of each nuclear power plant's performance. The SALP process, which aims at synthesizing individual

inspection findings into an overall evaluation of licensee performance, has been improved. The Performance Evaluation Branch was established to independently integrate and assess the ongoing aspects of the performance of each operating plant, and the Events Assessment Branch was organized to review and assess plant events. These groups provide performance information to senior NRC managers on a case-by-case and periodic basis. Additionally, a process wherein senior NRC management periodically meet to assess licensee performance, identify problem plants, and settle on needed follow-up actions has improved the agency's ability to draw conclusions and take action based on inspection findings.

The QA report concluded that, in part, quality problems reached a critical stage because licensee and NRC auditing and inspection techniques were not effective in detecting problems early, and because NRC inspections were programmatic in nature~ Recommendations implemented in the area of inspections and diagnostic ability follow. The resident inspector program was expanded, putting at least two inspectors at construction sites, and the inspection program resources are now allocated as needed according to operating plant performance. In contrast to previous inspections which were mainly concerned with procedural and paper aspects of licensee programs, inspections such as the construction appraisal team inspections and integrated design inspections examined in greater detail the quality of actual products to identify whether the quality program had been effectively implemented.

The increased use of inspection teams was emphasized. The team inspections such as safety system functional inspections and safety system outage/modifications inspections, now look at products and performance. In depth inspections are accomplished by performance appraisal teams and the large, multi-disciplinary Diagnostic Evaluation Teams directed to a site as a result of a decision of the senior managers at their twice-yearly meeting. Very importantly, a significant feature of these and other inspection teams is that the multi-disciplinary team approach provides a strong mechanism for integrating findings in individual areas into a comprehensive picture of a licensee's programs to achieve and assure safety and quality.

Lack of top utility management understanding and involvement in their programs and in dealing with problems was identified in the QA report as a significant contributor to quality breakdowns. To some extent, this resulted from NRC's ineffectiveness in communicating to utility management the significance and seriousness of problems being identified. Enforcement actions are an important part of communicating NRC concerns to utilities. Orders, confirmatory orders, and other enforcement options, including civil penalties, are examples of enforcement tools which are being used more aggressively to send strong messages to licensees when significant and/or repetitive problems are identified.

Another significant problem contributing to quality breakdowns was the NRC's approach to quality assurance. In the past, quality assurance plans were often approved without adequate consideration given to implementation experience. Inspections of quality assurance programs tended to place emphasis on the review of records. Thus the industry was pointed toward a paper heavy program rather than generating good quality in the product - with suitable documentation. This has sometimes been characterized as an overemphasis on the programmatic aspects of quality assurance at the expense of the measuring the actual performance of quality-related functions. In the mid-1980s, NRC started to changed their

inspection focus to a "performance-based" posture. Training was developed to support this, and the Standard Review Plan was revised by adding Chapter 17.3, "Quality Assurance Program Description."

The Readiness Review concept was identified in NUREG-1055 as a means of helping to correct the problem. A licensee-initiated pilot Readiness Review program was successfully completed for Vogtle Unit 1, and Georgia Power Company used a similar program for licensing Vogtle Unit 2. NRC has supported and encouraged the Institute of Nuclear Power Operations, the Nuclear Utility Management and Resources Council, now Nuclear Energy Institute, and owners' groups initiatives to implement a recommendation of the QA report aimed at recognizing and endorsing, as appropriate, proven industry programs for improving quality through better utility management. Such initiatives include those in areas such as training, maintenance, and fitness-for-duty. Recognition and endorsement of industry initiatives has been and continues to be a specifically defined agency-wide policy and objective. A few examples of industry programs which NRC endorsed include limited recognition of the American Society of Mechanical Engineers Accreditation Program for N Stamp Holders, Georgia Power Company and Washington Public Power Supply System initiatives to conduct readiness review pilot programs, and Ed;son Electric Institute Nuclear Supplier Quality Assurance Committee's utility cooperative supplier audit program.

Efforts to develop guidance to facilitate the prioritization of quality assurance measures commensurate with the importance of plant structures, systems, and components to the achievement of safety are continuing. Initial efforts in this area focused on the use of probabilistic risk assessments (PRAs). Because few plants had completed a plant-specific PRA, the efforts to implement graded QA were postponed. With the completion of the plant specific risk assessment studies, the staff is now working on the regulatory requirements for graded QA. The plant system risk ranking efforts that licensees have implemented to fulfill the Maintenance Rule have provided a starting point for risk ranking in the QA environment. Based on PRA insights, as further evaluated by an expert panel, decisions can be made as to the relative importance of plant equipment. QA controls can then be tailored based on the importance of the equipment and the safety function that it performs. The staff initiated discussions with Nuclear Energy Institute (NEI) on its initiative to develop industry guidance for grading quality controls. While the staff and NEI have not reached full agreement on the implementation details, the staff is now working with three licensees that are continuing to refine the process whereby the QA!controls can be applied in a manner commensurate with equipment safety significance.

6.1.2 NRC Report on Lessons Learned from TVA's Nuclear Program Problems

As a result of serious problems at TVA's nuclear projects, the NRC staff examined the interactions between TVA and NRC before recognition of the TVA's nuclear programs problems to identify means by which NRC could have: (1) recognized the overall severity of the 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 of November 12, 1986. In that Commission Paper the NRC staff developed recommendations for improving NRC's regulatory oversight. Lessons learned from that study were, as much as possible, coordinated with other ongoing

or planned activities for improving NRC's regulatory oversight. The other activities included those reported in the above discussed Quality Assurance Report to Congress, the 1984 and later revisions to the inspection manual, 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 identified the following 7 preliminary lessons learned:

1. NRC needs to further develop and implement a systematic process for identification of poor performing licensees and for focusing agency-wide attention on poor 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 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 assure the validity of those programs and their implementation;

5. NRC needs to ensure that sufficient resources are provided not only to carry out programmatic efforts as well as increased efforts at poor performing licensees but 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, evaluation of results over an extended period indicated that similar problems were not still occurring and that previous problems had been corrected; and

7. Perfunctory responses to long-term, resource-intensive regulatory requirements, like fire protection, and equipment qualification and a poor record of surveillance and maintenance were indicative of 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 the above seven preliminary lessons learned the staff developed 27 recommendation 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 TVA's nuclear programs' oversight. The staff was 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 with TVA's nuclear program or its regulation from 1980 to 1985, for their comments. The comments received generally supported the thrust and focus of the preliminary paper, and provided valuable perspectives and insights. The NRC staff modified 27 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.

NRC has implemented several of the lessons learned. In 1987 NRC reorganized to integrate its inspection functions into its nuclear reactor regulation functions, thereby promoting the coordination and integration of information on licensees' performance. Agency's Performance Indicator program was expanded to include QA-specific indicators. NRC's SALP process was improved to enhance synthesizing inspection findings and improve overall oversight of licensees' programs. Performance Evaluation Branch and Event Assessment Branch were established to independently integrate and assess operating plant licensees' performance. NRC's senior management meets periodically to assess licensee performance, identify problems, and set the course of follow-up actions. Although Senior Management Meetings primarily focus on poor performing operating plants, major construction projects such as WBN are also considered for agency-wide actions. These meetings have been effective in forcing NRC attention on licensees' performance to assure that problems are detected and corrected early, and negative trends in licensees' performance are subject to new NRC enforcement policy and are promptly directed to senior licensee management. NRC has adopted increased use of special team inspections. Team inspections, such as safety systems functional inspections and safety system outage/modification now look at products and performance. In-depth inspections are accomplished by performance appraisal teams; and the large, multi-disciplinary diagnostic evaluation teams are directed to a site as a result of decisions taken at NRC senior management meetings. These initiatives have significantly improved NRC's oversight of TVA's nuclear programs in general; and employee concerns, implementation of corrective actions, and quality assurance of WBN, Unit 1 in particular.

6.2 Special Inspections

NRC conducted several special inspections at WBN site as a response to lessons-learned studies findings that NRC should put increased reliance on special team inspections that are capable of integrating the results of the inspections and assess the programmatic significance of their inspection findings. At WBN site NRC conducted several IDIs and a broad-based CAT inspections discussed below.

6.2.1 Broad-Based Construction Assessment Team Inspections

NRC performed a Broad-Based Construction Appraisal Team (CAT) inspection to assess the quality of WBN construction. The findings of the inspection are documented in NRC inspection report 50-390/89-200 of December 12, 1989.

The inspection team's general concerns were (1) the poor general condition of plant equipment, (2) a number of 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, and the potential for further damage because of the poor control of on-going work activities which made the team doubt TVA's ability to protect completed equipment and hardware installations during the remaining construction. Inspectors found a lack of control of interfaces between on-site 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.

6.2.2 Integrated Design Inspections

NRC conducted an Integrated Design Inspection (IDI) covering mechanical, electrical, and instrumentation & control during January 7 through 18 and February 4 through 8, 1991 (Inspection Report No. 50-390/91-201 dated March 22, 1991). The inspection examined the design, design basis, calculations, engineering procedures, and records, primarily for the auxiliary feed-water 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 basis verification program (DBVP) were of consistently high quality. However, TVA's review of mechanical system 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 implemented adequate corrective actions in response to the relevant DBVP design findings.

Based on TVA's response to the inspection report and NRC's follow-up inspection, the open items were closed(Inspection Report No.50-390/93-201 dated June 29,1993).

NRC conducted an IDI covering civil and structural disciplines during July 13 through August 7, 1992 (Inspection Report No(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, specifying incorrect design criteria, failure to follow TVA's design criteria or licensing commitments,

and use of potentially nonconservative design approaches in detail designs.

Based on TVA's responses to the inspection report and NRC's follow-up inspection, most open items were closed (Inspection Report No. 50-390/93-201 dated June 29, 1993. Two items requiring additional NRC staff review were use of U-bolts as pipe clamps and potentially non-conservative seismic loads in HVAC duct support evaluations. In addition inspector follow-up was required concerning installation deficiencies in pipe supports and conduit supports and missing supports in the field.

In response to the findings from the 1991 IDI and TVA's self-assessments, TVA initiated a mechanical nuclear calculation program and assembled a team of corporate specialists and industry senior 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 follow-up inspection (Inspection Report No. 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.

6.3 Conclusions

7. CONSTRUCTION STOP WORK 1990-1991

On December 21, 1990 TVA issued a stop work order on construction activities. The stop work was issued as the result of NRC inspection findings. On December 14, 1990, an exit for IR 390/90-31 on the corrective action program indicated that there were multiple examples in various work disciplines of failures to establish and implement the corrective action program properly. These included untimeliness in determining the scope and significance of identified problems, failure to establish adequate criteria for entry into the corrective action program, 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 identified a programmatic breakdown in the corrective action program. On December 21, 1990, at the exit for IR 390/90-30, inspectors identified a multiple example, repeat violation in the work control area. The multiple examples included many facets of work control, indicating a programmatic breakdown in the work control area. These two reports identified the problems that had plagued TVA since before 1985. They were documented in the Employee Concern Special Program on Corrective Action Tracking Documents and were believed by TVA to have been corrected. The inspection results indicated that TVA was no further along in 1990 in the control of construction activities than they had been prior to 1985. As a result Watts Bar site management issued the stop work order.

A meeting was held on January 15, 1991, to discuss TVA's construction stop work at Watts Bar. During that meeting NRC requested and received a commitment that the NRC staff would be involved in the decision to restart any construction activity at Watts Bar. The summary of that meeting was sent by NRC to TVA on January 18, 1991. An enforcement conference to discuss the work control and corrective action program breakdowns was conducted on April 12, 1991. TVA acknowledged in the enforcement conference that their past efforts to correct programmatic deficiencies at Watts Bar addressed primarily the symptoms of the problems rather than their root causes. TVA also outlined in general terms the steps that TVA was taking 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 included a Quality Improvement Plan (QIP) that included 14 areas of improvement with the major thrust being to use quality measurement feedback to achieve improvement. Some examples of the QIP included Quality Report Cards, Procedure/Process Improvements, craft certification, training and assessment of management personnel.

TVA began self assessments shortly after the construction stop work 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 showed TVA that these problems were long standing problems that had been identified during the Employee Concerns Special Program reviews and extended back to at least the early 1980s. Although these problems had been identified several times over the previous ten years, the corrective actions did not focus 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 the interfaces related to these areas, i.e. material controls and integrated scheduling.

TVA's corrective actions were focused 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 provided the craft supervision to perform the work. However, people from the old, TVA construction force were often hired by the construction contractor. TVA provided an interface organization that worked with the contractor to finish the plant modifications. The interface organization consisted of 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 been proven successful at Browns Ferry and in the industry. Management was downsized with known good performers placed in key positions. Work plans issued were closed and remaining work was identified on the Remaining Work List (RWL). New, simplified work plans were then written to perform remaining work. Work plan quality was considered an important element that should be attained before construction was to restart. 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 them; then write new work plans under the new process for the remaining work.

The Quality Assurance organization was considered weak in the communication of problems to senior management and in establishing quality performance standards. Quality Assurance personnel changes were made including down sizing and management changes. In addition, a contractor was brought in to supplement the 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 construction stop work period.

Engineering design interfaces between functions were marginal. In addition, TVA had implemented a new, revised engineering design process prior to the construction stop work and had not completely converted all active old process design documents to the new method which resulted in higher than normal backlogs. This resulted in poor engineering performance, including a large number of field changes. Engineering was downsized to provide better control and cross discipline coordination. Additional contractors were used to perform the engineering evaluations. Backlog reduction became one of the key focus areas during the stop work period. This was to ensure that engineering stayed ahead of the modifications work. 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 they had embedded, learned cultural barriers to successful behavior and 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.

The above changes included rewriting many procedures and directly implementing corporate standards into site standard practices. This approach had proved effective at Browns Ferry.

Inherent in such broad based changes are a complete retraining of existing workers and initial training of contractor personnel. Management's hopes were that the personnel changes, bringing in contractors and placing known TVA good performers in key positions, would be able to break through the learned cultural barriers. In addition, a new focus on accountability and ownership of work quality was emphasized.

In an August 26, 1991 letter to TVA, NRC stated that although a significant civil penalty would normally be proposed for the work control and corrective action program breakdowns, its decision was to exercise enforcement discretion. The justification provided was that although many past attempts at fixing root causes by TVA had failed, only positive results from the programs outlined at the enforcement conference would cause NRC staff to agree that the restart of construction activities at Watts Bar was appropriate. The letter emphasized that corrective actions must be effectively implemented such 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 level of future performance required substantial improvement.

NRC inspection of TVA's self assessments and corrective actions were performed during the stop work period. The inspections focussed on the adequacy of the self assessments and TVA's progress in implementing their corrective actions. These changes took approximately 11 months to implement. NRC conducted a construction restart readiness inspection (IR 91-29) from October 28 - November 15, 1991. The inspection reviewed the changes that TVA had made since the stop work in December 1990 to site procedures, work plans, material controls, organizational interfaces, quality records and document control programs, and the corrective action program. The inspection concluded that the root causes of the stop work had been addressed and NRC's concerns associated with the stop work were programmatically resolved.

In a letter to NRC dated November 18, 1991 TVA stated they were ready to restart construction at Watts Bar. That position was discussed during a meeting with NRC on November 19, 1991. NRC's letter to TVA dated November 26, 1991 documents NRC's concurrence of November 22, 1991 to the restart of construction at Watts Bar. The letter confirmed several conditions of the concurrence upon which previous agreement had been reached. These included resumption on a slow start basis 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 the processes, procedures, organizations, and controls in place upon concurrence (November 22, 1991) constituted the baseline for WBN work and there would be no unilateral changes to those. Any changes that could significantly change the way work was done, the criteria for work, or reduce the effectiveness of work controls would be coordinated with NRC prior to implementation.

Initially the process began on balance of plant equipment, and later it was applied to safety equipment. The slow, monitored restart gave TVA management a chance to observe the implementation of their 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 92-01). Subsequent NRC inspections found the in-process work activities to be of good quality (IR 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.

7.1 Corrective Action Problems after Construction Restart (1994)

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, two non-cited violations, 15 unresolved items, three IFIs, one IDI deficiency, one "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 that resulted in a Significant Corrective Action Report (SCAR) being issued by TVA in spring 1994.

The findings of the SCAR and the previous and current 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 94-37). The inspection found 35 additional examples of violations that were similar to those found in the SCAR. Also, an 8 example violation was issued for cases not similar to those found in the SCAR. Both the inspection and TVA QA review had similar findings, that the corrective action program was not being properly implemented; however no direct hardware deficiencies were identified. The report noted that: the root causes of problems were not always properly identified; corrective actions did not always address the identified problem; the full extent of problems was not always fully identified, resulting in repetitive problems of similar nature; and numerous deficiencies were identified in corrective action documents.

In the late summer and early fall of 1994, NRC inspections of NRC open items did identify examples of inadequate corrective action in which there were hardware related problems that could have impaired the ability of the equipment to perform its function. These included RCP motor unqualified coatings issues (94-59); electrical cable manhole preventive maintenance problems (94-72); electrical cable splicing, crimping, and connector problems on Emergency Diesel Generator cables (94-72); and cable damage to electrical penetration Kapton leads (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, with about 8 being identified as rejections. The rejections were the result of inadequate field verification. In addition, a large number of packages (88) packages needed to be supplemented for minor problems such as unclear wording, inclusion of additional justification, typographical errors, etc. TVA's conclusions after reverification of corrective action documents and NRC open item packages were that they did not have a major breakdown in the closure verification process, but improvement was needed. Additionally, in late summer of 1994, QA implemented a 100% closure review of all corrective action documents.

7.2 Strengthening of QA Organization

TVA recognized during the stop work period 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. NRC inspection presence on the site was significant and tended to establish the quality standard when QA did not. In the 1993 SALP report (390/93-46) the marginal accomplishment of the QA functions was noted as a weakness. TVA initiated a third party, independent QA assessment to provide an evaluation of the QA Program implementation. TVA made additional management changes that strengthened QA. The changes resulted in improvement in the QA functions. The 1994 SALP report (390/94-41) noted improvement in the independent verification of CAPs and SPs. However, it was not until fall 1994 that QA established overall leadership for quality. Trending reports on corrective action documents with QA management support are bringing problems to the attentions of senior line management. Quality monitoring and audit functions

have improved in the identification of programmatic problems.

Conclusion:

8. INTEGRATED ASSURANCE OF ACCEPTABLE CONSTRUCTION QUALITY

8.1 Pre-operational Testing

TVA's CAPS included a corrective action plan for modification of its pre-operational test instructions (PTI) to comply with its Pre-operational Test Program in Chapter 14 of the FSAR. By a letter of February 13, 1992, TVA informed NRC that it will abandon its CAP and will essentially re-perform the entire pre-operational test program, based on new pre-operational testing instructions that it was planning to prepare.

To write its new PTIs, TVA hired contractors with previous pre-operational testing experience at various power plants. The contractors began writing PTIs in late 1992. Testing according to new PTIs began in early 1993, although there was much construction and repair work still in progress. In the early stages of the program, NRC inspectors encountered deficiencies in the quality of the pre-operational test procedures. Deficiencies in the test program were found 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 (TSD). These TSDs were TVA controlled documents that described the pre-operational 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 fall 1993, NRC had compiled a significant history of violations, deviations, and problems with PTIs. As a result of the NRC's inspection findings, TVA decided to halt the pre-operational test program, and hired a new contractor, as start-up manager, with extensive (and successful) testing experience in the industry.

The new start-up manager completely overhauled the administrative procedures manual for writing, approving, conducting, and documenting results of pre-operational tests, called the Start-up Manual Procedures (SMPs) TVA contractor hired, indoctrinated, and trained Additional staff. TVA decided to retire the intermediate documents called TSDs, following NRC's expressed concerns that design information would be lost by merely discarding the TSDs, TVA agreed to include the design information from the TSDs into the DBD.

According to NRC's reviews, the new PTIs produced in early 1994 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 late spring of 1994, TVA replaced the start-up 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. Consequently, NRC was able to conclude that the inspection of the preparation of procedures, the conduct of testing, and the documentation of results were accomplished well above the minimum program goals.

TVA essentially completed pre-operational test program by early 1995, except for a full dress rehearsal;retesting planned for a second Hot Functional Test (HFT 2).

8.2 Program for Assurance of Completion and Assurance of Quality (PAC/AQ)

TVA established Program for Assurance of Completion and Assurance of Quality (PAC/AQ) to confirm that WBN 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 accomplish 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 included: 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, with over 13,000 commitments 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 Operations Readiness** - TVA will use PAC/AQ-identified commitments and implementing documents to address overall operational readiness of WBN prior to fuel load. This effort is scheduled ~or completion in 1995.

NRC documented its evaluation of PAC/AQ activities associated with Phase I through III in Inspection Report 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 the identification of 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

documented in Inspection Report 50-390/93-204 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. Based on the results of the evaluation of the PAC/AQ process NRC has ascertained 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 remaining PAC/AQ activities involving Phase V (Oversight of Operational Readiness) will be evaluated during NRC's operational readiness assessment process prior to 'fuel load.

8.3 TVA's Reasonable Assurance Assessment TBD

8.4 TVA's IDI TBD

In Volume 4 of the NPP, TVA committed to perform an indepth technical udit similar to an NRC Integrated Design Inspection (IDI). By letter dated March 20, 1995, TVA informed the staff that it still intends to complete this audit on a system that is essentially complete and at or near acceptance by the operaing staff. An audit plan will be developed after the system is selected, and will be available onsite for NRC review.

8.5 FSAR Licensing Review TBD

8.6 Reconstitution of MC 2512 Inspection Program TBD

The objective of NRC Inspection Manual Chapter (MC) 2512 Reconstitution Program is to ensure adequate completion of the construction inspection program for Watts Bar Unit 1 and to determine TVA's readiness to operate WBN, Unit 1. The MC 2512, Construction Phase Inspection Program was initially completed for WBN, Unit 1 in 1985. NRC continued to perform inspections of construction activities associated with licensee corrective action programs for the resolution of the problems identified in the 1985 and by subsequent allegations. The reconstitution program addresses the potential impact of the problems identified in the 1985 time frame on the adequate completion of the construction inspection program. Since 1985 construction-related activities have been documented primarily against construction inspection temporary instructions. As such, post-1985 inspections have not been correlated to MC 2512 inspection procedures. Therefore, the current MC 2512 Inspection Program is being re-evaluated with the objective of assuring that the requirements of program procedures established to ensure the quality of construction have been satisfied. To the greatest extent possible, program reconstitution will be accomplished using results of post-1985 inspection activities. Where the program review procedures or field verification procedures of commodities can not be verified complete based on post-1985 inspections, records inspections and/or pre-1986 inspection effort will be used as appropriate.

The inspection program;requirements to be verified as complete by the WBN, Unit 1 reconstitution program are contained in NRC MC 2512 dated December 17, 1986. Applicable inspection procedures are identified in MC 2512 Appendix I, dated August 25, 1994. The reconstitution program process consists of four phases.

Phase I, Post-1985 Document Reviews, compares completion of inspection procedure requirements for construction to the scope and results of inspections performed at WBN after 1985. This phase also contains a review of post-1985 allegations to determine if they impact on the use of post-1985 inspection results for completing inspection procedure requirements. If inspection requirements are met and there is no residual impact resulting from allegations, the results are reviewed and accepted by management. If all requirement are completed by Phase I, the reconstitution is then considered as complete for the procedure.

For procedure requirements not completed during the Phase I review and where physical inspection is feasible, a Phase II (reconstitution) Inspection is performed to complete the remaining inspection requirements. A similar management review to Phase I is also completed at the end of this phase

If direct inspection is not feasible, or all inspection requirements were not satisfied by Phase II, Phase III is performed, during which pre-1986 inspection information is evaluated for use. Specifically, the objective of this phase is to determine if issues impacting on the use of pre-1986 inspection result's have been adequately resolved and what additional inspection of records may be needed to satisfy the remaining inspection requirements. First, a review is performed of the status of resolution of allegations and employee concern issues (CATDs) and of the extent of their residual impact, if any, on the use of pre-1986 inspection results. A Phase III, Pre-1986 Document Review and Record Inspection, is then performed. The results of the Phase III effort determines if the specific pre-1986 NRC effort serves to complete inspection requirements in impacted areas of the inspection program. If achieved, the reconstitution of the procedure is considered completed.

For inspection procedure requirements not completed by use of Phase I-III alternatives, a Phase IV, Case-by-Case action and review by management is used to address and document their disposition.

Qualified NRC inspectors have been assigned to complete the reconstitution of inspection procedure requirements for each program area. The performance of reconstitution assignments is managed and tracked consistent with the process described above. To accommodate the numerous document searches needed to verify completion of inspection program requirements, all prior and current Watts Bar inspection related documentation has been assembled, converted into electronic format, and incorporated into a ZYINDEX computer data base. Staff at Region II, NRR, and the Watts Bar site have access to the computer data base. In addition, allegation related information has been included in the Region II data base.

Oversight of the Region's implementation of the reconstitution program is performed by the NRR program office. The reconstitution program will be completed prior to the Watts Bar Unit 1 fuel load date.

8.7 Conclusions

9. TVA's RECENT PERFORMANCE TBD

10. OPERATIONAL READINESS TBD

10.1 TVA's Activities to Demonstrate Operational Readiness TBD

10.2 Quality of Start-up and Power Ascension Procedures TBD

10.3 Operating Organization's Qualifications to Operate WBN, Unit 1 TBD

10.4 Lessons Learned from Recent NTOL Operational Readiness Reviews TBD

10.5 HFT 2 "Dress Rehearsal" TBD

10.6 Summary of TVA's Operational Readiness TBD

10.7 Conclusions TBD

11. NRC's OVERALL ASSESSMENT TBD