From a review of the test procedures, several discrepancies were found between the study and the procedures. See Table II for more details, test name, and systems. NCS-21 had been completed in September of 1980 with no interface points installed while the study called for five. W-10.9 had no interface points included but the study had listed seven. The test had not been completed. TVA-28 had no interface points included, but the study indicated there should be six. The test was partially complete. TVA-10 had no interface points in the procedure, but two were listed in the study. W-2.2 included the required electrical interfaces, wire lifts, and jumpers; but the valves listed in the study were not included as interface control points. All pumps for this system had been transferred to NUC PR so the interfaced points were possibly no longer needed. TVA-1 did not include the nine valves listed in the study as interface control points. The test instruction had closed them using System Operating Instruction SOI-65.1, "Emergency Gas Treatment System," but did not have them controlled as interface points. During the week of the NSRS review, the test directors were told by their supervisor to write change sheets to include the omitted interface control points.

Also, in W-2.2, interface control points requiring wire lifts and jumpers were to be installed according to the procedure without the required two-part signoff. These operations were to be performed as temporary conditions which required the two-party verification. Interfaces were to be installed in steps 5.11.1 through 5.11.6. Step 5.11.7 stated, "Implement the administrative procedures necessary to identify, document, and maintain these interface points." The NSRS does not feel that this statement replaces the double signoff required for temporary conditions and which were found in an appendix to the procedure in most preoperational test procedures reviewed which installed interface control points.

AI-1.6 required that the test director submit a set of marked drawings to the shift engineer when interface points were established. In reviewing documents in the shift engineer's office, the NSRS found that 15 HOs and 11 TACFs had been issued to control interface hold points. Only one marked-up drawing from a preoperational test director was available in the shift engineer's office.

From the review of the interface study, it was noted that several points had been deleted and several more had been added. The points were included in the test procedure, and the changes were coordinated between the test director and the interface coordinator and included in the interface log. Also, it could be seen that many of the points overlooked in the test procedures were valves that should have interface HOs put on them. Instead of using interface HOs, the test directors were relying on the simple statement that the valve be closed as sufficient to control the interface point.

Hold Order 20004 was reviewed. It was installed on the essential raw cooling water (ERCW) system. Several valves were included on the HO. It had been partially removed twice (one valve opened each time), and each time a workplan was used. It was also noted that all changes to interface points were made with a safety-related change sheet. These parts of the interface control appeared to be working properly. The interface program coordinator in the Preoperational Test Section stated that he had committed to plant management that a walk through of the physical interface control points would be conducted two weeks prior to fuel loading. In a conversation with plant management, it was estimated that there would be a period of approximately two years between unit 1 and unit 2 fuel load. From that it could be seen that the interface points installed now would remain in place for up to two years. Thus, it is important that the program control points be installed and that they remain in place.

In conversations with the Safety Section Supervisor, it was determined that a review had been conducted by that section of the fire protection system. Their study found locations where the fence between units obstructed access to fire hoses. Because of this obstruction, extra fire hoses have been provided. Also, emergency and fire drills were successfully conducted to prove their ability to respond to an emergency situation.

In summary, it appeared that AI-6.1 is adequate to control the interface program if it were implemented correctly. The interface log in the interface study should be reviewed against test procedures and updated. The preoperational test directors should be better informed about the interface control program. Hold Orders on valves appear to be a point of confusion. Many valves which should be interface valves are closed with no documented interface control. Most preoperational test engineers properly used the TACFs as interface controls, but the HOs were not widely used.

VI. DOCUMENTS REVIEWED

1. TVA Topical Report, TVA-TR75-1A R7

2. N80A27, "Interdivisional Procedure ID-QAP-2.5 R1, "Major Modifications," 6/29/82

3. DPM-1300, "Field Services," 3/14/83

4. N-OQAM, Part II, Section 3.1, "Plant Modifications: Before Issuance of the Operating License," 3/18/82

5. N-OQAM, Part II, Section 3.2, "Plant Modifications: After Licensing," 6/3/83

6. N-OQAM, Part II, Section 5.3, "Maintenance and Modification Inspection Program," 6/23/82

7. N-OQAM, Part II, Section 5.3A, "Training and Certification Program for Quality Control Inspectors," 8/9/83

8. N-OQAM, Part III, Section 3.1, "Control of Measuring and Test Equipment," 1/23/84

9. WBN-AI-5.4 R7, "Material Issue, Transfer, and Traceability," 3/1/84

10. WBN-AI-7.1 R5, "Quality Control (QC) Inspection Program," 7/26/83

11. WBN-AI-8.5 R9, "Control of Modification Work on Transferred Systems Before Unit Licensing," 2/9/84

12. WBN-AI-8.1 R0, "Control of Modification Work After Unit Licensing," 8/9/83

13. WBN-AI-9.2 R9, "Maintenance Program," 1/27/84

14. WBN-TI-10 R19, "Calibration Program for Measuring and Test Equipment," 2/2/84

15. FSGL-A16 R4, "The Handling of Field Services Group Measuring and Test Equipment," 5/28/83

16. QA-SIL-4.2 R7, "Quality Control (QC) Inspection Program," 1/20/84

17. FQE-SIL-5.1 R16, "Survey Program," 3/7/84

18. Informal memorandum from W. T. Cottle dated March 10, 1982, "Watts Bar Nuclear Plant - Maintenance and Field Services at Watts Bar Nuclear Plant"

19. Memorandum from T. G. Campbell to Those listed dated August 18, 1982, "All Nuclear Plants - Design Change Request Processing and Modification Control" (L35 820804 858)

20. Informal memorandum to W. T. Cottle dated March 27, 1984, "Independent Safety Engineering Group Report - Plant Training on Administrative Procedures"

21. Memorandum from J. F. Bledsoe to W. T. Cottle dated June 3, 1983, "Employee Training" (OQA 830614 700)

22. Memorandum from T. L. Howard to W. T. Cottle dated March 14, 1984, "Watts Bar Nuclear Plant - FQE Section Monthly Report"

23. Memorandum from G. W. Killian to J. A. Coffey dated March 19, 1984, "Office of Quality Assurance Audit Report No. SQ-8400-03 - Plant Staff Performance Training and Qualification" (OQA 840319 702)

24. OQAB Surveillance Report No. XWB-S-84-0013, "Preop Test/Workplan Control," 3/29/84

25. FQE Survey Report No. 13MT(F)-82-1 "M&TE (Field Services)," 4/2/82

26. FQE Survey Report No. 13MT(F)-83-1, "Field Services Measuring and Test Equipment," 6/2/83

27. WBN-CAR-84-06, WBN-CAR-84-08

28. WB-DR-84-12-R, WB-DR-84-37-R, WB-DR-84-38-R, WB-DR-84-39-R, WB-DR-84-40-R, WB-DR-23-R, WB-DR-24-R

29. MR-224689

30. Workplans - 2393, 2419, 2432, 2441, 2443, 2682, 3704, 3837, 2332, 4173, 3762, 3384, 3665, 494, 720, 3906, 2749, 3230, 3915, 3578, 2827, 2294, 2637, 2440, 2683, 3292, 4124, 3293, 2860, 3126, 2706, 3656, 1738, 2797, 3441, 3911, 3918, 2897, 4163, 4154, 4051, 4132, 2023, 3593, 3590, 3652, 2870, 3270, 3901

31. WBN-QCI-1.30 R5, "Control of Work in Transferred Systems, Equipment, and Architectural Features," 9/17/82

32. WBN-AI-4.1 R6, "Quality Assurance Records"

33. 10CFR Part 50, "Domestic Licensing of Production and Utilization Facilities"

    Appendix A - General Design Criteria for Nuclear Power Plants
    Appendix B - Quality Asurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants

34. 10CFR Part 70, "Domestic Licensing of Special Nuclear Material"

35. DPM WB79E1 (1806.01), "Fuel Exposure and Isotopic Accounting for WBN," 9/18/81

36. WBN Final Safety Analysis Report (FSAR)

37. Regulatory Compliance Program Manual

38. WBN Draft Technical Specifications

39. WBN Fuel Handling Instruction Manual (FHIM)

40. WBN Technical Instruction TI-2, "SNM Control and Accountability System"

41. WBN Technical Instruction TI-28, "Physical Verification of Core Load Prior to Vessel Closure"

42. WBN Technical Instructions TI-2, "Initial Fuel Receipt and Storage"

43. WBN-AI-2.8.7 R2, "Report of Accidental Criticality or Loss or Theft or Attempted Theft of Special Nuclear Material"

44. WBN-AI-2.8.8 R2, "Report of Unaccounted for Shipments, Suspected Theft, Unlawful Diversion of SNM or Industrial Sabotage"

45. WBN-AI-5.2 R3, "Receipt Inspection of Materials, Parts, or Components"

46. WBN-GOI-2 R5, "Plant Startup from Cold Shutdown to Hot Standby"

47. WBN-SOI-99.1 R4, "Reactor Protection System"

48. WBN-SI-3.1.1 R3, "Functional Test of Manual Reactor Trip Channels (Prior to Startup)"

49. AOI-1 R5, "Reactor Trip"

50. EOI-12, "Emergency Shutdown Procedure"

51. MI-57.2 R5, "Annual 480-Volt Switchgear Inspection"

52. IE Information Notice 83-81, "Failures of the Undervoltage Reactor Trip System Breakers"

53. Westinghouse WATM-10709 Field Change Notice

54. Regulatory Guide 1.13, Revisions 1 and 2

55. Regulatory Guide 1.33, "Quality Assurance Program Requirements"

56. ANSI N18.7/ANS-3.1, "Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants"

57. N-OQAM, Part III, Section 1.1, "Document Control"; Section 5.0, "Periodic Review of Procedures and Instructions"; and Section 8.1, "Preparation, Maintenance, and Implementation of the Manual"

58. WBN-AI-3.1 R4, "Plant Instructions - Control and Use"

59. SI-3.3.3-I R4 and SI-3.3.3-II R4, "Radiation Monitoring Instrumentation Fuel Pool Radiation Monitors, Channel Calibration"

60. SI-3.3.4-I R4 and SI-3.3.4-II R4, "Radiation Monitoring Instrumentation Fuel Pool Radiation Monitors Changel Functional Test"

61. SI-4.0.5.3.C.3, "Check Valve Testing During Refueling Outage - Feedwater System"

62. ID-QAP-2.3 R1, "Physical Interfaces Between Licensed and Unlicensed Units"

63. Area Plan 1103.01, "Physical and Functional Interfaces," 9/27/83

64. WBN-AI-1.6 R2, "Interface - Establishment and Control"

65. Preoperational Test Section Instruction Letter No. 9, IL-9, "Preoperational Test Program - Unit Interface Program"

66. Operations Section Instruction Letter, OSLA-36 R1, "Interface Controls"

67. Interface Study Report, September 1980

68. FQE Survey NSI-84-50

69. Preoperational Test Instructions:

    a. TVA-9A, "Auxiliary Gas Treatment System and Door Status Indication and Interlock"

    b. TVA-10, "Control Building Air Conditioning System"

    c. TVA-28, "Sampling System"

    d. W-10.9, "Ice Condenser Reactor Containment System"

    e. W-2.2, "Boric Acid System"

    f. TVA-1, "Shield Building Inleakage Rate Tests, Emergency Gas Treatment System"

70. Hold Orders 20001, 20002, 20004, 20009, 20010

71. Temporary Alterations Control Forms 2-2000-70, 2-2002-82, 2-2003-82, 2-2004-83, 0-2005-80, 2-2006

72. Memorandum from H. G. Parris to G. F. Dilworth, "Nuclear Safety Review Staff Review No. R-83-22-NPS on Training of Plant Management" (GNS 830907 100)

73. Memorandum from H. G. Parris to G. F. Dilworth, "Nuclear Power Position Regarding Training Plant Management - NSRS Report No. R-83-22-NPS" (GNS 830809 050)

74. NUC PR Procedure No. 0202.07, "Shift Technical Advisor (STA) Training," 9/15/83

75. NUC PR Procedure No. 1202S01, "Shift Technical Advisor (STA) Program Responsibilities," 10/5/83

76. WBN-AI-2.16, "Shift Technical Advisors"

77. WBN Engineering Section Instruction Letter No. ENSL R1, "Reactor Engineering Unit Personnel Training"

78. WBN Engineering Section Instruction Letter No. ENSL R4, "Shift Technical Advisor Plant Familiarization Walk Throughs"

79. 10CFR50.34 and .36-1982

80. NUREG-0737, "Clarification of TMI Action Plan Requirements"

81. 10CFR50.54M, "Conditions of Licenses"

82. Regulatory Guide 1.8 R1-R-75, "Personnel Selection and Training"

83. ANSI 18.1-1971, "Standard for Selection and Training of Personnel for Nuclear Power Plants"

84. Area Plan 9, Procedure No. 0901.01, "Organization and Staffing"

85. N-OQAM, Part III, Section 6.1, "Selection and Training of Personnel for Nuclear Power Plants"

86. NUC PR Nuclear Training Program Area Plan No. 2, Procedure 0202.05, "Nuclear Plant Operator Training Programs," 8/8/83

87. OP-QAP-2.6 R0, "Selection and Training of Nuclear Power Plant and Support Personnel"

88. WBN-AI-2.1 R8, "Authorities and Responsibilities for Safe Operations and Shutdown"

89. WBN-AI-2.4 R5, "Shift Manning and Recall of Personnel to Plant"

90. WBN-AI-10.1 R3, "Plant Training Program"

91. NSRS Report No. R-81-03-WBN

92. NSRS Report No. R-82-16-WBN

93. NSRS Report No. R-83-07-WBN

94. NSRS Report No. R-83-22-WBN

95. SQN-AI-4 R41, "Plant Instructions - Document Control"

96. BFN Standard Practice, BF 2.3, "Review, Approval, and Use of Instructions," April 11, 1984

VII. LIST OF PERSONNEL CONTACTED

Name/Title	Attended Entrance Meeting	Contacted During Review	Attended Exit Meeting
Rita Aikens, QCRU CONST Engineer		X	
James G. Adair, Civil Engineer, Civil Support Branch		X	

Name/Title	Attended Entrance Meeting	Conducted During Review	Attended Exit Meeting
Daniel L. Anderson, Electrical Maintenance Engineer		X	
Robert H. Anderson, Contracts Civil Engineering Branch		X	
J. H. Ballard, CONST Engineer		X	
R. A. Beck, Health Physics Supervisor		X	
J. F. Bledsoe, OQAB Site Representative			X
Ralph J. Blevins, Document Control Staff		X	
Vincent M. Burzese, OMMM Engineer		X	
W. L. Byrd, Compliance Section Supervisor	X	X	
L. N. Calahan, OMMM Engineer		X	X
C. Richard Cook, Operations Section - SRO		X	
Dennis Collins, OMMM Engineer		X	
J. L. Collins, Mechanical Maintenance Supervisor		X	
W. T. Cottle, Plant Manager	X	X	X
M. E. Cutlip, Compliance Engineer			X
Grady Davis, Operations SRO		X	
W. C. Delk, Reactor Engineering Supervisor		X	X
G. T. Denton, Operations Section Supervisor		X	X
J. E. Englehardt, Compliance Engineer	X	X	X
E. R. Ennis, Assistant Plant Manager			X
Craig S. Faulker, Reactor Engineer/STA		X	
Randall R. Gibbs, Reactor Engineer/STA		X	
R. J. Griffin, Mechanical Engineering Supervisor		X	
C. A. Hearr, Preoperational Test Engineer		X	
D. S. Heidwich, OMMM Engineer			X

Name/Title	Attended Entrance Meeting	Contacted During Review	Attended Exit Meeting
George R. Hendricks, Engineering Aide		X	
J. E. Hoffert, OMMM Engineer		X	
T. L. Howard, Field Quality Engineering Supervisor		X	X
Mario Hug, National Nuclear Corporation, California		X	
T. F. Huth, Reactor Engineer/STA		X	
Joseph Inger, OQAB Engineer		X	
G. L. Johnson, Mechanical Engineer		X	
Ken Jones, Engineering Supervisor		X	X
G. T. Jordan, OMMM Engineer			X
William S. Karsner, Reactor Engineer/STA		X	
Dale Kaulitz, Preoperational Test Engineer		X	
M. E. King, Chemical Engineer		X	
J. T. Kirkpatrick, OMMM Assistant Supervisor		X	
H. F. Koehler, Preoperational Test Engineer		X	
L. B. Kuehn, Test Section Supervisor		X	X
V. P. Law, OMMM Engineer		X	X
James E. Lee, Instrument Maintenance Engineer		X	
D. L. Lester, Preoperational Test Group Supervisor		X	
Jim Loud, Safety Section Supervisor		X	
Ziata I. Martin, Reactor Analysis Group		X	
Robert T. McCollom, Compliance Section Engineer		X	
L. N. McIntosh, OMMM Superintendent		X	X
Ben Mears, Preoperational Test Engineer		X	

TABLE I

WATTS BAR
OPERATIONAL READINESS REVIEW

Phase	Review Area
I 2/13/84 - 2/17/84 (Completed - Report R-84-02-WBN Issued)	1. General Employee Training 2. Employee Awareness of Regulatory and TVA Requirements and Policies Relating to Nuclear Safety Issues and Expression of Staff Views 3. Preoperational Testing (Partial)
II 3/26/84 - 4/6/84 (Completed - Report R-84-05-WBN)	1. Organization 2. Qualifications of Personnel in Key Management Positions 3. Shift Technical Advisers 4. Control of Licensed Activities 5. Plant Procedures (Partial) 6. Unit Interface Control 7. Reactor Safety and Criticality Control (Partial) 8. Modifications and Outage Control
III 6/19/84 - 6/28/84	1. Mini Hot Functional Test - Operations Section and Test Section personnel activity will be reviewed during this time. Adequacy of and adherence to instructions and procedures will be stressed. 2. Maintenance 3. Reactor Safety and Criticality Control
IV 7/24/84 - 7/27/84	Initial Fuel Load

Note 1. Plant staffing and organization will be further evaluated during subsequent reviews due to changes caused by the reorganization.

Note 2. Regulatory compliance is a part of all reviews.

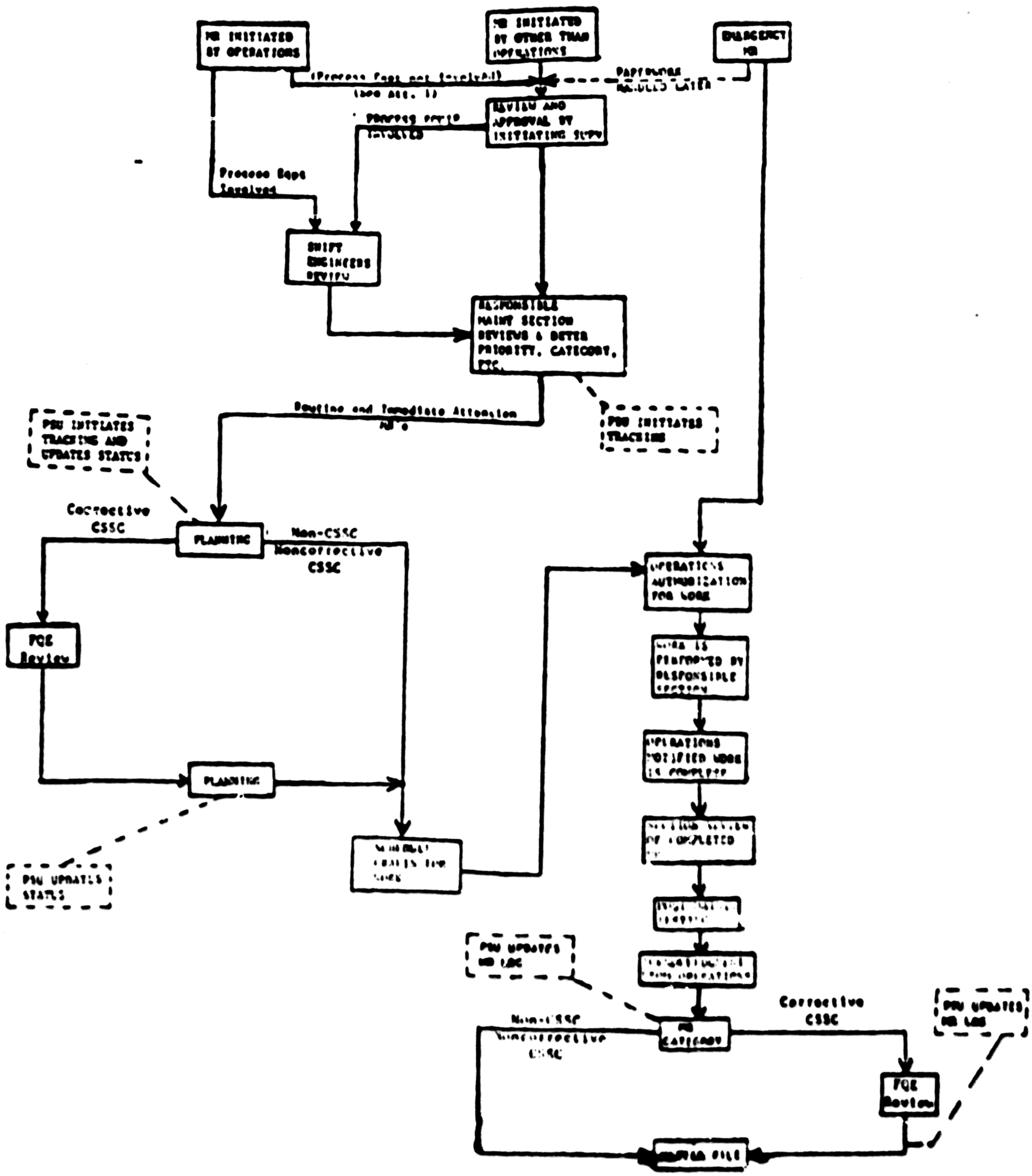
Name/Title	Attended Entrance Meeting	Contacted During Review	Attended Exit Meeting
Redford Norman, Assistant Operations Section Supervisor		X	
H. L. Pope, FQE Engineer		X	X
Thomas A. Shelton, Nuclear Engineer, Nuclear Engineering Branch		X	
L. J. Smith, FQE Engineering Supervisor		X	X
James Swallows, FQE Engineer		X	
G. V. Tippens, FQE Quality Control Supervisor		X	
Bill D. Varga, Training Officer		X	
Lynn Wallace, FQE Engineer		X	
R. L. Warren, Reactor Engineer/STA		X	
Luther Welsh, National Nuclear Corporation, California		X	
J. R. Werkler, Preoperational Test Engineer		X	
Steve Woods, Acting Instrument Maintenance Supervisor		X	
Joe Yarborough, FQE Engineer		X	

<u>TABLE II</u>

Test No.	Title	System	Points Installed	Points to be Installed	Total
TVA-9A	Auxiliary Gas Treatment System & Door Status Indication & Interlock	30	6		6
TVA-18C	Essential Raw Cooling Water Flow Balance	67	39	10	49
TVA-20A	Component Cooling System	70	9	9	18
TVA-44A	Liquid Waste Drains, Collection, & Transfer Facilities	77	1	17	18
TVA-14E	Diesel Generators and Supporting Auxiliaries	81	2		2
SUBTOTAL			57	36	93
TVA-10	Control Building Air Condition System	31		10	10
NCS-21	Gland Seal Water System	37		5	5
TVA-28	Sampling System	43		6	6
W-10.9	Ice Condenser Reactor Containment System	61		7	7
W-2.2	Boric Acid System	62		19	19
TVA-1	Shield Building Inleakage Rate Tests, Emergency Gas Treatment System	65		11	11
TVA-46	Primary Makeup Water System	81		5	5
TVA-51	Flood Protection Provisions	84		3	3
SUBTOTAL				66	66
TOTAL			57	102	159

ATTACHMENT A

MAINTENANCE REQUEST ROUTING



ATTACHMENT B

WORKPLAN CONTROL FORM

I. Identifying Information

Prepared by ______________________ Date ____________ Phone ______________

Outstanding Work Item Number: ____________ ____________ ____________
Unit System Type - Number

II. Prework Review

A. Originating Section

Technical specification change required? Yes ____ No ____

☐ Technical verification and review complete.

☐ Affected section supervisors considered and listed in II.C below.

☐ Instructions and/or vendor manuals requiring revision listed on page 5.

☐ The CSSC list needs revision as a result of this modification.

☐ If work affects the pressure boundary of an ASME code component on which the N-5 Code Data form is signed, an ANI Instruction Review sheet is included.

______________________/__________
Section Supervisor Date

B. Workplan Coordinator

Tracking numbers assigned, appropriate reference documents included.

______________________/__________
Workplan Coordinator Date

ATTACHMENT A (CONTINUED)

C. Affected Sections (excluding Operations, Safety, and QA)

Review for technical accuracy; instructions and/or vendor manuals requiring revision listed on page 5 of attachment A.

Section	Supervisor's Signature	Date
* Preop		

D. Safety Engineers Review (may be performed by fire brigade captain in absence of the safety engineer).

Safety Engineer / Date

E. Reviewed for effect on operating systems (check one block in paragraph III.B).

/ / Operating instruction requiring revision listed on page 5 of attachment A.

Operations Supervisor / Date

* F. For CSSC [illegible], initial review by:

Supv, Field QE Section / Date

G. For CSSC [illegible] recommended for approval of this modification.

PORC Chairman / Date

H. This modification [illegible] authorized to be performed when appropriately scheduled.

Power Plant Superintendent / Date

ATTACHMENT B (CONTINUED)

III. Performance of Work

A. Workplan has been scheduled at daily meeting and work may begin.

_____________________ / _______
Modification Coordinator Date

B. Removal of equipment from service. Signature on this paragraph is required before equipment is taken out of service. Other work (prefabrication, hangers, non-equipment-related work, etc.) may proceed without further authorization.

- [ ] This workplan required no equipment to be removed from service.
- [ ] This workplan requires equipment to be removed from service.

_____________________ / _______ _______
Shift Engineer Date Time

C. List equipment removed from service.

1. _______________ 2. _______________ 3. _______________

IV. Work Completion

A. Field work, including functional tests, is complete. Shift engineer's control copy drawings updated by cognizant engineer to show modifications.

_____________________ / _______
Cognizant Engineer Date

B. This signoff required only if equipment was removed from service.

- [ ] Operator training on modified systems completed, if required.
- [ ] Temporary/permanent revisions have been made to affected operating instructions (see list on page 5).

Item IV., A. and B., above must be complete before returning equipment to service.

_____________________ / _______ _______
Shift Engineer Date Time

C. Drawing requirements complete and verified for correctness on attachment D.

_____________________ / _______
Cognizant Engineer Date

ATTACHMENT B (CONTINUED)

D. Vendor manual and/or instruction changes listed on page 5 complete.

_________________ / _______
Cognizant Section Supervisor Date

E. Spare parts inventory revised as required for modified equipment, spare parts ordered for new equipment.

_________________ / _______
Cognizant Section Supervisor Date

F. Nameplate data collected for each component affected on Nameplate Data Form, Attachment F.

_________________ / _______
Cognizant Engineer Date

G. ASME Section XI Summary Report filled out, if required.

_________________ / _______
Cognizant Engineer Date

H. Post-modification test required by EN DES scoping document has been evaluated and given field approval. Copies of test results have been sent to EN DES as required.

_________________ / _______
Cognizant Section Supervisor Date

I. Workplan complete.

1. L-DCR file copy with marked-up drawings transmitted to EN DES if appropriate.
2. Nameplate data form transmitted in accordance with instructions.
3. CSSC list revised as necessary.
4. Section XI Summary Reports filed in appropriate places.
5. Workplan reviewed by ANI when required in accordance with attachment I.
6. OWIL updated.

_________________ / _______
Modification Coordinator Date

TVA 64 (OS-9-68)

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

GNS '840406 050

TO : H. G. Parris, Manager of Power, 500A CST2-C

FROM : H. N. Culver, Director of Nuclear Safety Review Staff, 249A HBB-K

DATE : April 6, 1984

SUBJECT: SPECIAL REVIEW OF NCR WBNSWP8303 RELATED TO MISSING PIPE SUPPORT CALCULATIONS - WATTS BAR NUCLEAR PLANT - UNITS 1 AND 2 - NUCLEAR SAFETY REVIEW STAFF REPORT NO. R-84-07-WBN

The final report of the subject review is attached for your information and action. The review was initiated when the subject NCR disposition was sent to NSRS for review. This occurred after the independent review of the corrective action was completed.

We believe this review indicates a lack of independence in the classification of NCRs as to whether they are adverse to quality or not. We also believe the requirement for maintaining quality records is a fundamental part of the TVA Quality Assurance (QA) program. The approach should be to meet all requirements of the QA program and not take them lightly when the result will be an admission of incorrect decisions or error.

The report contains two specific recommendations concerning this particular NCR. You are requested to provide us with your plan for resolving the two recommendations within 30 days of the date of this memorandum. It is expected that appropriate action to correct these conditions will be completed in a timely manner.

If you have any questions concerning the report, please contact P. R. Washer at extension 6860.

HNCulver

H. N. Culver

PRW:LML
Attachment
cc (Attachment):
J. W. Anderson, M155G MIB-K
R. W. Cantrell, W11A9 C-K
MEDS, W5B63 C-K

NSRS FILE

GNS '840406 051

TENNESSEE VALLEY AUTHORITY

NUCLEAR SAFETY REVIEW STAFF

NSRS REPORT NO. R-84-07-WBN

SUBJECT: WATTS BAR NUCLEAR PLANT - UNITS 1 AND 2 - SPECIAL REVIEW OF NCR WBNSWP8303 RELATED TO MISSING PIPE SUPPORT CALCULATIONS

DATES OF REVIEW: MARCH 5 - MARCH 13, 1984

REVIEWER: P R Washer
P. R. WASHER

4/5/84
DATE

APPROVED BY: J. F. Murdock
J. F. MURDOCK

4/5/84
DATE

MEDS, W5B63 C-K

TABLE OF CONTENTS

I. SCOPE

The purpose of this review was to evaluate NCR WBNSWP8303, which identifies missing pipe supports calculations that were performed by EDS on safety-related systems in the reactor building at Watts Bar Nuclear Plant (WBN) units 1 and 2. The review was to determine whether the calculations were to be retained for the life of the plant as quality records as defined in TVA's QA program and ANSI Standard N45.2.9-1974. The review also included an evaluation of whether this condition should be classified as "significant condition adverse to quality" and reported to NRC under 10CFR50.55(e).

II. BACKGROUND

This item was brought to the attention of NSRS on March 5, 1984, when a copy of NCR WBNSWP8303 was sent to NSRS for review of the proposed disposition. The document was sent to NSRS after the independent review of the proposed corrective action was completed by T. C. Cruise on March 2, 1984. The NCR was written on February 23, 1983, and has been open since that time.

III. CONCLUSIONS AND RECOMMENDATIONS

The following paragraphs contain the conclusions followed by recommendations, if applicable.

A. R-84-07-WBN-01

The calculations for pipe supports on safety-related systems must be kept as quality records for the life of the plant. These are required as permanent records to meet the TVA QA program as defined in Topical Report TR75-1A and the quality records requirements as defined in N45.2.9-1974.

Recommendation

The calculations for the pipe supports on safety-related systems should be recreated and stored as a part of quality records. During the creation of these design calculation, if any pipe supports require changes, then a copy of the calculations for those supports should be sent to NSRS. See IV.A for details.

B. R-84-07-WBN-02

This NCR is a "significant condition adverse to quality" since it reflects an overall breakdown in the Watts Bar QA program related to records retention.

Recommendation

The NCR should be upgraded to a "significant condition adverse to quality" and reported to NRC as a deficiency under 10CFR50.55(e)(1)(i). See IV.B. for details.

IV. DETAILS

A. R-84-07-WBN-01

EDS Nuclear, Incorporated, was contracted by TVA to do piping analysis and pipe support design on safety-related systems at WBN and Sequoyah Nuclear Plant (SQN). In reference (1), EDS wrote to TVA to confirm verbal instructions to destroy the stored records of this work. In reference (2), TVA confirmed that EDS could destroy all stored records except for "hard copy code compliance computer runs." OQA concurred with this letter based on the understanding that a seperate copy of the calculations existed at TVA. They would not have agreed to destroy the calculations if they had known that EDS had the only copy of the calculations. As a result of that direction, EDS destroyed all the record engineering calculations on the pipe supports that they had done. The only thing that exists is the input loads from the piping analysis and the end product, pipe support drawings. In reference (3), EDS documented several conversations between EDS and TVA personnel. TVA had requested that EDS estimate the costs to provide TVA with a copy of the support calculations. EDS confirmed in this reference that they had carried out TVA's direction and destroyed the calculations.

An NCR regarding the missing calculations was transmitted by reference (4) from the project to CEB. After stating lack of knowledge of ever having received the NCR, CEB transmitted the NCR by reference (5) back to the project for processing. In the process of dispositioning the NCR, the project, after an independent review, sent the NCR to NSRS for review.

NSRS, during their review, came to specific conclusions and recommendations based on the following information. Chapter 17 of the WBN FSAR states that the QA program for WBN shall be as presented in TVA Topical Report TVA-TR75-01, section 17.1A. In TVA-TR75-1A, paragraph 17.1.17, "Quality Assurance Records," it is stated that "the typical types of records to be generated and retained are listed in Appendix A to ANSI N45.2.9-1974." In Appendix A to N45.2.9, design calculations and records of checks are shown to be stored for the lifetime of the plant, if they are classified as "Life-time Quality Assurance Records."

In paragraph 2.2.1 of ANSI N45.2.9, there are four criteria, any one of which qualifies records as lifetime records. The pipe support calculations for safety-related systems qualify under the first three of these criteria. Since these calculations meet the criteria for lifetime records, as defined in the TVA QA program, the calculations must be kept for the life of the plant. Since the calculations have been destroyed, they must be recreated and stored as quality records.

B. R-84-07-WBN-02

The destruction of the safety-related piping support calculations is a major breakdown in the TVA QA program for vendors. This is a breakdown in the implementation of the requirements of TVA Topical Report TVA-TR75-1A, Paragraph 17.1.17., "Quality Assurance Records." It is also a nonconformance to Criterion 1 of the NRC General Design Criteria. As such, this NCR should be upgraded to a "significant condition adverse to quality" and reported to NRC as a deficiency under 10CFR50.55(e)(1)(i).

V. REFERENCES

1. EDS letter 0060-300-090, S. B. Hosford to R. O. Barnett dated June 4, 1981, "SNP, WBNP, Disposition of Backup Documentation" (CEB 810609 273)

2. TVA letter R. O. Barnett to EDS Nuclear, Incorporated, dated August 19, 1981, "Disposal of Records Stored by EDS Nuclear, Incorporated (EDS)." (CEB 810819 023)

3. EDS letter 0060-30-182, S. B. Hosford to R. O. Barnett dated November 1, 1982, "Watts Bar Nuclear Plant, Copies of Support Calculations"

4. Memorandum from J. C. Standifer to R. O. Barnett, C. Bonine, L. J. Cooney, R. A. Costner, J. C. Key, J. J. Nash, and G. Wadewitz dated February 22, 1983, "Watts Bar Nuclear Plant Units 1 and 2 - Nonconformance Report WBNSWP8303" (SWP 830225 060)

5. Memorandum from R. O. Barnett to J. C. Standifer dated July 11, 1983, "Watts Bar Nuclear Plant Units 1 and 2 - EDS Nuclear Engineering, Incorporated (EDS), Support Calculations - NCR WBNSWP8303" (CEB 830711 027)

OPTIONAL FORM NO. 10 (REV. 7-76)

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

GNS '840627 053

TO : H. G. Parris, Manager of Power, 500A CST2-C

FROM : H. N. Culver, Director of Nuclear Safety Review Staff, 249A HBB-K

DATE : June 27, 1984

SUBJECT: BELLEFONTE NUCLEAR PLANT (BLN) - NUCLEAR SAFETY REVIEW STAFF (NSRS) REVIEW OF INPO FINDING QP-5.1 - NSRS REPORT NO. R-84-09-BLN

Attached is the NSRS report for the review conducted at BLN concerning INPO finding QP-5.1. This review consisted of an examination of the three conditions identified by the INPO reviewer: (1) some inspectors were being encouraged not to write nonconformance reports (NCRs), (2) nonconforming conditions had been dispositioned by invalidating or voiding the NCR, and (3) NCRs closed before corrective action had been completed.

NSRS found that there was no indiciation to support the position that inspectors were being encouraged not to write NCRs. Some administative or procedural problems with the NCR process may have caused some of the inspectors to perceive a problem. With regard to the other two identified conditions, NSRS found sufficient indication to support the INPO finding.

Four recommendations were made in the report for BLN response. NSRS requests a written response by August 1, 1984. If there are any questions concerning this report, please contact C. M. Key at extension 4815 in Knoxville.

H N Culver

H. N. Culver

CMK:LML
Attachment
cc (Attachment):
W. R. Brown, 102 ESTA-K
MEDS, W5B63 C-K

NSRS FILE

GNS '840627 054

TENNESSEE VALLEY AUTHORITY

NUCLEAR SAFETY REVIEW STAFF

REVIEW

NSRS REPORT R-84-09-BLN

SUBJECT: REVIEW OF INPO FINDING QP-5.1

DATES OF REVIEW: APRIL 23-27 AND MAY 10-11, 1984

REVIEWER: C. M. Key — C. M. KEY — 6/27/84 DATE

APPROVED BY: M. S. Kidd — M. S. KIDD — DATE

MEDS, W5B63 C-K

TABLE OF CONTENTS

I. BACKGROUND

During the Institute of Nuclear Power Operations (INPO) review (CP-84-02) of Bellefonte Nuclear Plant (BLN), item QP-5.1 was identified by an INPO evaluator. This finding was in the area of "corrective actions." The evaluator's recommendation was that "controls need to be implemented to ensure that conditions adverse to quality are being identified and resolved in an effective manner." Three conditions that required attention were cited:

1. Some inspectors were being encouraged not to write nonconformance reports (NCRs).

2. Nonconforming conditions had been dispositioned by invalidating or voiding the nonconformance report.

3. Nonconformance reports had been closed before the corrective action had been completed.

Due to the possibly serious nature of this item, W. R. Brown, BLN Project Manager, requested that the Nuclear Safety Review Staff (NSRS) perform an independent review of this finding. Per this request, the NSRS initiated a review that commenced on April 23, 1984, and was concluded on May 11, 1984.

II. SCOPE

The review involved examination of the three cited conditions: some inspectors were being encouraged not to write NCRs; nonconforming conditions had been dispositioned by invalidating or voiding the NCR; and NCRs had been closed before the corrective action had been completed. The review was conducted by interviewing personnel, reviewing procedures and records, and using other established review techniques. The NSRS review was limited to interviewing personnel from the Electrical Quality Control (EQC) and Instrumentation Quality Control (IQC) Units. This limitation was imposed based on information received from the INPO evaluator and W. R. Brown.

III. CONCLUSIONS AND RECOMMENDATIONS

A. R-84-09-BLN-01, <u>Inspectors Encouraged Not to Write NCRs</u>

<u>Conclusion</u>

The NSRS found no evidence to indicate that there was a pervasive, systematic attempt by BLN management to discourage the reporting of nonconforming conditions. Some administrative or procedural problems with the NCR process may have caused some of the inspectors to perceive a problem. See section IV.A for details.

Recommendation

The NSRS recommends that: (1) definitive guidelines be issued to provide instructions for the usage of "Reply" memos, (2) appropriate action be taken to emphasize to all employees the importance of proper identification and handling of nonconformances, and (3) the nonconformance procedure be revised to require the NCR be numbered prior to the review and approval cycle.

B. R-84-09-BLN-02, Nonconforming Conditions Dispositioned by Invalidating or Voiding the NCR

Conclusion

Nonconformance reports had been invalidated or voided improperly. See section IV.B for details.

Recommendation

NSRS recommends that all invalidated NCRs be reviewed to determine action necessary to correct nonconformances that have been improperly invalidated or voided. For action to prevent recurrence, the NSRS recommends that the nonconformance procedure be revised to provide a detailed explanation of the invalidation process and to require an independent review of all invalidated NCRs. Also, appropriate action (e.g., training) should be taken to ensure that all personnel have a thorough understanding of what constitutes a valid NCR.

C. R-84-09-BLN-03, NCRs Closed Before Corrective Action Completed

Conclusion

Nonconformance reports have been closed before corrective action to rectify the nonconforming condition has been completed. See section IV.C for details.

Recommendation

NSRS recommends that this condition adverse to quality be documented on a nonconformance and that appropriate corrective action (e.g., a sampling program) be taken. NSRS recommends that the nonconformance procedure be revised to ensure that NCRs are not closed prior to completion of corrective action to rectify the nonconforming condition to prevent recurrence.

D. R-84-09-BLN-04, Evaluation of "Offsite-Generated NCRs"

Conclusion

The evaluation of "offsite-generated NCRs" allowed by BNP-QCP-10.4 and QAP 15.1 violates upper-tier requirements. See section IV.D for details.

Recommendation

NSRS recommends that the site perform a review to determine if any items with "offsite-generated NCRs" have been received and that nonconformance reports be initiated for items not covered by site NCRs. In addition, the NSRS recommends that BNP-QCP-10.4 and QAP 15.1 be revised to require the site to initiate NCRs to track "offsite-generated NCRs."

IV. DETAILS

A. Inspectors Encouraged Not to Write NCRs

The INPO evaluator's basis for this concern appeared to be interviews of quality control (QC) inspectors. The following accounts of interviews were included in the supporting details for item QP-5.1:

> During an interview with two inspectors both individuals expressed a concern that not all of the nonconformance reports that they prepared were approved and issued. One individual voiced a concern that some construction supervisory personnel had been placed in QC inspection supervisory positions. The perception expressed by the individual was that construction was taking over Quality Control.

> During an interview with an individual from one of the QC inspection units the individual expressed a concern that he and some of his subordinates were being encouraged not to write nonconformances reports because of the cost involved and how it looked bad for QC if the reported deficiency turned out not to be valid.

Since this type of concern cannot be identified or substantiated by a records review, the NSRS utilized the interview process to gather information used in making a determination of the validity of the concern. A total of 36 quality control inspectors and 3 management personnel were interviewed during the NSRS review.

The Quality Manager's Organization (QMO) became effective January 23, 1983, and was implemented February 20, 1983. This organization was formed to separate the QC functions from production support units. Previously to this all engineering and QC personnel reported to the same first line supervisor (M-5). The reorganization removed the QC inspection and related quality assurance (QA) functions from the CONST engineering organization (CEO) and placed them under the QMO. The QMO is headed by a Quality Manager who reports directly to the Project Manager. The QMO was staffed similarly to the CEO and contained management positions at the appropriate levels. Two of the supervisory positions were filled by personnel from the CONST (craft). These two individuals had held supervisory positions in their respective areas before becoming supervisors in the QMO. Each individual was offered and accepted a supervisory position in the same area (electrical and instrumentation) he worked with in CONST. During the course of interviewing QC personnel, no inspector expressed the opinion or perception that the movement of these two supervisors into the QMO was an effort by CONST to take over quality control. As a result of the absence of input concerning the issue of CONST taking over quality control, NSRS did not pursue this area any further.

On November 1, 1983, a significant change was made in the QA program. This program change was the replacement of the quality control investigation report (QCIR) with the inspection rejection notice (IRN). The QCIR was an integral part of the nonconformance program. It was used to document, disposition, and control known or suspected conditions adverse to quality (CAQ). The procedure (BNP-QCP-10.4) required that upon institution of a QCIR all affected items be tagged, if practical. After the QCIR tag was attached to an item, it was "not to be relocated, reworked or repaired except as designated by the approved disposition on the QCIR form." All QCIRs were evaluated to determine if a nonconformance report should be generated. Upon completion of the recommended disposition, the QCIR was closed and kept as a QA record. An IRN as defined by BNP-QCP-10.43 is "a communication tool used by inspection personnel to inform craft and/or engineering of a failed inspection." In accordance with the procedure an IRN should not be used for identification of possible nonconforming conditions. It does not prevent work from being accomplished on an item and is closed when the failed inspection condition is corrected. The IRN is a unit record and is required only to be maintained in the unit files until closure or voiding and completion of applicable trend analysis. Interviews of the QC personnel revealed that the inspectors as a group had a good understanding of the IRN process. As required by procedure, an IRN is only written on QA activities. Normally QC personnel do not inspect non-QA related activities, but will do inspections of this type if requested by engineering. Any deviations discovered on non-QA inspections are forwarded to the engineering unit via an informal means, such as a "Reply" memo.

The "Reply" memo as described by the Quality Manager was an "in-house" communication tool to be used on nonsafety related, non-QA items. It was to be used by engineering units to request quality control units to perform inspections on those activities not normally inspected by QC. In turn QC would give engineering the results of those inspections by returning the memo. The "Reply" memo could also be used by inspection to request information from engineering on possible drawing problems. It was stressed by the Quality Manager that the use of the memo was limited to matters dealing with non-QA, nonsafety related items. However during interviews with inspection personnel (inspectors and supervisors), it appeared to the NSRS reviewer that the "Reply" memo was not being strictly limited to non-QA, nonsafety related activities. (Due to time constraints, the NSRS reviewer was unable to obtain specific examples of the "Reply" memo being used for safety-related activities.) As indicated earlier the memo was being used by engineering to solicit an inspection by QC. In addition to using them to pass information to engineering, QC personnel were using the "Reply" memo to make engineering aware of problems (i.e., questionable conditions of items in the powerhouse and drawing discrepancies). At the time of the NSRS review there was no procedure governing the use of a "Reply" memo. Therefore, as indicated by QC personnel, there was (1) no requirement for the engineering unit to answer the memo (however, inspectors indicated most were answered), (2) no formal documentation of potential deficiencies, (3) no tracking capability, (4) no required follow-up by inspectors, and (5) no requirement to escalate a memo to the NCR status if a nonconforming condition was identified. A nonconforming condition should be documented on an NCR and not a "Reply" memo.

BNP-QCP-10.4 defined nonconformance as "a deficiency in characteristic, documentation or procedure that renders the quality of an item or activity unacceptable or indeterminate." Questioning of inspectors on when to write an NCR revealed a very consistent response. The response was that QC personnel primarily wrote a nonconforming condition report on an incorrect item when it had been inspected and accepted and the records were in the vault (bought off). Questioning of inspectors on the method to handle incorrect or questionable items that had not been "bought off" revealed the following answers: (1) leave the condition as-is and wait for an inspection request to write up the condition, (2) prepare a "Reply" memo to engineering, (3) write an IRN, and (4) use any available method other than an NCR to rectify the situation. From the interviews, it appeared that inspectors had been indoctrinated to ensure that a condition was definitely nonconforming before initiating an NCR report and had been exposed to conversation concerning the cost of a nonconformance report. Although an unacceptable item is a nonconformance, by definition an indeterminate item is also a nonconformance. However, with the deletion of the QCIR procedure and the indoctrination to NCR only items positively identified as nonconforming, it appeared that inspectors had no "formal" method of addressing a questionable condition. This could have resulted in the alternative methods (cited earlier) being utilized to handle potential nonconformances. Contrary to the response given by the inspectors, when asked by the NSRS reviewer when to write an NCR, the QC supervisors essentially repeated the definition given by the procedure.

When questioned about the procedure for writing an NCR, the QC inspectors appeared to be following the same procedure. The following is a generalization of the procedure utilized by the inspectors:

1. Identification of potential nonconformance.

2. Check to ensure item had been "bought off".

3. If undecided ask opinion of fellow workers, group leader, and/or unit supervisor.

4. Write NCR.

5. Submit NCR to unit supervisor for review and approval.

6. Upon return of NCR from supervisor, obtain number from the Document Control Unit (DCU).

7. Submit to appropriate unit for disposition.

From interviews and review of NCRs, it was apparent that the NCRs were receiving another review and approval by the Assistant Quality Manager (AQM) in addition to the one performed by the unit supervisor. One unit supervisor indicated that the review was being performed and the review by the Assistant Quality Manager was for clarity of the NCR. The unit supervisor also stated that the additional review of NCRs by the AQM was performed because the Quality Manager had directed it be done. All of this review and approval are accomplished prior to the nonconformance being numbered. When the NCR was numbered by DCU then it became a recognized nonconformance.

In November and December 1983 the Office of Quality Assurance (OQA) performed an audit, COO-A-84-0001, at the Watts Bar (WBN) and BLN sites. Deviation number 10 of that audit cited BLN for conflicting requirements for initiation of NCRs. Attachment D of BNP-QCP-10.4 indicated that the report was numbered prior to review and approval by the supervisor. Paragraph 6.2.2.1 of the procedure required that the NCR be reviewed and approved before being numbered (currently the method being utilized). In the details of the report OQA recommended that the procedure as outlined in Attachment D be the site practice to control potential nonconformances since the responsible supervisor had the discretion to invalidate or void the initiated nonconformance report. The site response to this deviation was that BNP-QCP-10.4 would be revised to eliminate the conflicting requirements for initiation of NCRs by March 9, 1984. There was no statement as to the position that BLN would take on the issue (i.e., whether the NCR would be numbered before or after review and approval process). On March 9, 1984, a memo (BLN 840309 302) from L. S. Cox to R. W. Diebler stated that the revision to BNP-QCP-10.4 had not been initiated since the site was awaiting revision to higher tier documents (QAPs 15.1 and 16.1). The memo indicated that the procedure would be changed upon approval of these higher tier documents. Revision 11 to BNP-QCP-10.4, which was in the review cycle, stated explicitly that the NCR was not to be numbered until the responsible supervisor reviewed and approved it. This position is opposite to the recommendation made by OQA.

In continuance with the questioning the NSRS reviewer asked 25 of the 36 QC personnel if at any time they had been "encouraged" not to write a nonconformance report. (NOTE: This question was used to determine if an inspector had been "encouraged" not to write an NCR for any reason. This included the INPO examples of NCRs possibly not written because of high cost as well as damage to the QC unit reputation if the reported deficiency turned out not to be valid.) Twenty-four of the inspectors indicated that they had not been encouraged not to write an NCR. Most inspectors recounted that the group leader(s) and the supervisor were used as a source of advice on whether or not a condition was nonconforming but the final decision to write (or not write) the NCR had been left to the inspector. However, there were two questionable incidents revealed by this inquiry. The first incident was recalled by an inspector who stated that on one occasion he had been persuaded not to write an NCR. The inspector felt that the problem was a "gray" area and still wasn't sure that the condition was conforming but the problem had been corrected. Upon interviewing the responsible supervisor, he did not recall the problem and stated that he had never encouraged anyone not to write an NCR. Information on the other incident was obtained from a unit supervisor. He had encouraged a QC inspector not to write an NCR on one inspection. The explanation given by the supervisor was that the work had already been done and that an NCR would not accomplish anything else. However, the supervisor stated that the inspector had been instructed to write the NCR if in the inspector's opinion one was deemed necessary. No inspector from this unit bought this incident to the NSRS reviewer's attention during the interviews. It was also noted that no inspector recalled any occasion of being "encouraged" not to write an NCR because of cost or possibly damaging the unit's reputation if the NCR was not valid.

In connection with this question the inspection personnel were asked if any NCRs generated by them had not been approved and issued. With one exception the inspectors related that there had been no incidents where the NCR was not approved and issued. The majority revealed that there had been questions about the NCRs they had written from group leader(s) and supervisor(s). These questions had been clarification-type inquiries. In some cases inspectors recalled that some NCRs had not been written after being questioned, but the decision not to write the nonconformance report had been their own. The one exception occurred when an inspector accompanied an engineer to perform an activity. The results of the test were unacceptable. Instead of nonconforming the item, the engineer troubleshot the item, corrected the problem, and successfully completed the test. The inspector related that the supervisor felt that the documentation from the test activity was sufficient to cover the item. Also the supervisor said it was not an NCR because the problem did not exist anymore. The inspector believed that the documentation was barely adequate to justify the action taken. At a later date, during a discussion of what was an NCR, this situation was described to the Assistant Quality Manager and the inspector was told the condition was nonconforming. In the interview the inspector stated if the problem ever arose again, he would initiate an NCR. While interviewing the responsible supervisor, the NSRS reviewer related the details of the incident to the supervisor and asked the supervisor his account. The supervisor did not recall the problem and stated that he had never disapproved an NCR.

As a part of the review the NSRS reviewer asked the QC personnel if there had ever been any discussion in their unit(s) as to why the QCIR was deleted. The typical comments made were: (1) IRN was cheaper than QCIR, (2) too many QCIRs being written, and (3) QCIRs were not being utilized properly. Some QC personnel perceived that deletion of QCIR was a mistake and that it should be reinstituted. On the subject of cost of QCIRs, one supervisor indicated that economics had been a factor in determining the fate of the QCIR. However, he indicated that quality had not been sacrificed when the IRN replaced the QCIR.

In summary, two supervisors from the CONST (craft) were placed in supervisory positions in the QMO. The disciplines to which the supervisors were assigned were the same as the ones they were involved with in CONST. Interviews revealed that the inspectors did not view this event as CONST trying to take over Quality Control. The "Reply" memo as described by the Quality Manager (i.e., to be used on non-safety related, non-QA activities) could be used to cover all activities at the site. Inspectors had been indoctrinated to ensure that a condition was definitely nonconforming before initiating an NCR. As a result of this indoctrination inspectors indicated that "indeterminate conditions" could be handled by: (1) leaving condition as-is until item was inspected, (2) preparing a "Reply" memo, (3) writing an IRN, or (4) using any alternative other than writing an NCR. In addition, cost of QCIRs and NCRs had been discussed in the units. Although two cases were identified that could be classified as "inspector being encouraged not to write an NCR," it did not appear that either was influenced by cost or how it might make the unit look if the NCR was not valid. With the exception of one incident, no evidence was found that NCRs prepared by the inspectors were not approved and issued.

NSRS determined that the transfer of the two CONST managers into the QMO had not led to the belief by the inspectors that CONST was taking over Quality Control. In addition, there was no evidence found to substantiate that inspectors were being "encouraged" not to write NCRs because of high cost or because it would damage the unit's reputation if the NCR was not valid.

The following factors when considered in total, do support the INPO contention that some inspectors could have perceived a supervisory attitude that discouraged the reporting of deficiencies using an NCR.

1. The "Reply" memo could be used to cover all activities.

2. Inspectors had been indoctrinated to write NCRs only on conditions that were definitely nonconforming.

3. "Indeterminate conditions" could be handled by alternate methods other than writing an NCR.

4. Cost of NCRs and QCIRs had been discussed in the units.

5. NCRs had to be reviewed and approved by management before being numbered.

6. Three incidents were identified that could be labeled "inspector encouraged not to write an NCR" or "potential NCR disapproved."

However, NSRS concluded that even though these factors did exist, there was no pervasive, systematic attempt by BLN management to discourage the reporting of nonconforming conditions.

In order to strengthen the program and to address the identified factors, NSRS recommends: (1) definitive guidelines be issued to provide instructions for the usage of the "Reply" memo, (2) appropriate action be taken to emphasize to all employees the importance of proper identification and handling of NCRs, and (3) revise the nonconformance procedure to require the NCR be numbered prior to the review and approval cycle.

B. <u>Nonconforming Conditions Dispositioned by Invalidating or Voiding the NCR</u>

The INPO evaluator listed four examples in the supporting details of NCRs that were dispositioned by invalidating or voiding. These nonconformance reports were numbers 765, 913, 2300, and 2839. The following paragraphs are excerpts from the INPO report that explain the INPO evaluator's position on the four NCRs.

<u>NCR 765</u> - Temperature in a class "B" warehouse had dropped below the minimum requirements. The NCR was invalidated because it was accomplished by a QCIR. However, no specific QCIR was referenced.

<u>NCR 913</u> - A 4-inch crack in the base material of a piping elbow. The NCR was invalidated because the process specification was revised.

<u>NCR 2300</u> Some modules could not be calibrated. The NCR was determined to be significant, but was later invalidated.

<u>NCR 2839</u> - Two installed category I conduit supports had the same unique identification number on them. The NCR was invalidated because it did not meet the definition of a nonconforming condition.

Prior to the start of the NSRS review, a quality assurance engineer on the Quality Manager's staff conducted a review of NCRs that had been invalidated from October 4, 1983 to March 21, 1984. His findings and conclusions were contained in a memorandum dated March 26, 1984, sent to the Quality Manager. The memo indicated during this time period there had been 18 invalidated NCRs (this number did not include the NCRs mentioned in the INPO report). Attached to the memo was a copy of these 18 NCRs (and a copy of the 4 noted in the INPO report) with the QA engineer's opinion of whether or not the nonconformance had been properly voided noted on each NCR. Prior to and/or during the course of the review, another evaluation of invalidated NCRs was completed by this same QA engineer. This review listed all the NCRs that he found to have been invalidated at BLN. The total number was 120. In the opinion of the QA engineer, approximately 47 percent of those nonconformances had been invalidated or voided improperly. The NSRS reviewer performed a review of selected voided NCRs. The identification of the NCRs and the results of that review are detailed in Appendix 1. (Note: The NSRS review included 8 invalidated NCRs that had not been reviewed by the site.)

BNP-QCP-10.4, paragraph 6.7.2 states:

> If the supervisor responsible for approving the disposition determines that further action on the NCR is not warranted, the supervisor shall mark the NCR "INVALID" or "VOID," state the reason, and sign and date the NCR in section 3. All invalid or voided NCRs receive the same approval and distribution as the original.

As shown by Appendix I, NCRs 177 and 2807 did not state a reason for the invalidation. The reason given for voiding NCRs 2732 and 2733 was that the condition was not nonconforming in accordance with BNP-QCP-10.4 or QAP 15.1. This is a blanket statement with no specifics for invalidating the NCR. NCRs 192, 808, and 2147 were voided because another document, a Field Change Request (FCR), was generated. If problems did not exist, then FCRs would not have needed to be written. NCRs 1508 and 2845 were voided by saying that the items would be reworked. NCR 2698 was invalidated because the problem of grease (lubricant) separation was determined not to be a nonconforming condition since a significant amount of oil had not leaked into the switch compartment. However, no criteria was given as to what constituted a significant amount. It appeared to the NSRS reviewer that NCRs 177, 192, 765, 808, 913, 1508, 2147, 2374, 2539, 2553, 2698, 2732, 2733, 2735, 2807, and 2845 were all improperly voided. Although there is no procedural requirement for interface, interviews with quality control (QC) inspectors indicated that there was no interface between engineering units and QC units before invalidation of NCRs occurred. The QC inspectors related that if the reason for voiding the NCR was unsatisfactory, then the NCR could be taken to the group leader or unit supervisor for discussion. However, no inspectors related any examples of having the invalidated NCRs reinitiated.

NSRS concluded that nonconformance reports were invalidated or voided improperly. This is confirmed both by the review made at BLN and by NSRS. The high percentage of the NCRs that were invalidated or voided improperly in the samples taken by BLN and NSRS indicate that the problem may be widespread. To correct this situation BLN should review all invalidated or voided NCRs to determine if nonconforming conditions still exist. Where nonconforming conditions are identified the site should initiate NCRs and properly correct the nonconformances. The NCR procedure should be revised to provide a detailed explanation of the invalidation process and to require an independent review of all invalidated NCRs. Appropriate action (e.g., training) should be taken to ensure all personnel have a thorough understanding as to what constitutes a valid NCR.

C. Nonconformance Reports Closed Before Corrective Action Completed

In the supporting details for item QP-5.1, the INPO evaluator stated that 35 closed NCRs were randomly selected for review. Of these 35, 10 nonconformance reports had been signed off as having been completed based upon a commitment to take action in the future. For four NCRs, documentation supporting or indicating that the corrective action had been accomplished could not be located. The INPO evaluator did not list any specific nonconformance reports. Therefore, the NSRS reviewer randomly selected completed NCRs for review. Thirty-two nonconformance reports were analyzed in detail. Of the 32 NCRs reviewed, 14 appeared to have been closed in accordance with procedures. Five NCRs involved support problems and were closed by initiation of another document to correct the nonconformance (similar to items 9 and 10). The following paragraphs contain the results of the review for the remaining 13 NCRs all of which involved NCRs which were closed before corrective action was completed or where documentation was not available.

1. NCR 995

Problems: (1) Core flooding tanks A and B could not be installed due to an interference between the lower manway of the tanks and the cross bracing of the tank supports and (2) the attaching bolts between the tank and the supports could not fully engage due to insufficient thread length on the bolts. On December 4, 1978, QCIR 1139 was written to document these problems. The disposition of the QCIR was to initiate an NCR for the first problem and an FCR to correct the second problem. NCR 995 and FCR M-521 were initiated. The QCIR was closed on May 24, 1979. EN DES agreed to the rework disposition submitted by CONST on the NCR and was to revise drawing 1RN0430-X2-19 to reflect the necessary changes. NCR 995 was closed by the site on August 16, 1979. Drawing 1RN0430-X2-19R7, which included the changes made, was issued on November 23, 1979. This action occurred approximately three months after the NCR was closed.

2. NCR 2344

Problem: Embedded plates for supports OWD-MPHG-0028 and 2KC-MPHG-0808 Sheet 1 were not installed per drawings 4AW0824-X2-21 and -30. The problem was initially documented on QCIR 32,564. The QCIR was dispositioned to prepare a NCR and was closed on April 22, 1983. NCR 2344 was written on April 21, 1983, and was dispositioned to use surface-mounted plates in lieu of the embedded plates that were omitted. EN DES agreed with the recommended disposition on May 31, 1983. Drawings 4AW0824-X2-21 R4 and 4AW0824-X7-30 R4 were issued on August 4, 1983. These revised drawings changed the embedded to surface-mounted plates as requested by the NCR. The site closed NCR 2344 on August 25, 1983. However, support drawing 2KC-MPHG-0808 Sheet 1 still shows the support attached to an embedded plate.

3. NCR 2464

Problem: Indications of galling were found on the north key (B&W part number 20-4) and guide of the core support cylinder (INC-MRCT-001B) for the reactor pressure vessel. QCIR 35,164 was initiated on August 2, 1983, and was dispositioned to prepare a NCR. The QCIR was closed on September 23, 1983. NCR 2464 was written August 31, 1983, to document the problem. EN DES and Babcock and Wilcox (B&W) provided the site with repair instruction on December 13, 1983. The NCR was closed on January 24, 1984. Documentation indicating that the corrective action had been accomplished could not be located.

4. NCR 2480

Problem: Various discrepancies on B&W supplied core supports. These discrepancies were documented on QCIR 36,020 dated September 1, 1983. The recommended disposition was to issue an NCR. NCR 2480 was initiated on September 20, 1983, and the QCIR was closed on September 21, 1983. EN DES and B&W provided the site with corrective action. The site closed the NCR on April 17, 1984. Review of records indicated that sequence control chart (SCC) No. INC-W007 had been initiated on March 13, 1984. However, no records were located to indicate that the work had been accomplished.

5. NCR 2564

Problem: Wedge bolts holes for support 1CA-MPHG-0237 R3 were drilled in the wrong location. CONST initiated the NCR on November 25, 1983. The recommended disposition was to use-as-is and to write a support modification request (SMR). BNP-QCP-10.4 required that NCRs dispositioned use-as-is be approved by EN DES. However, the NCR was not reviewed by

EN DES and was closed by the site on December 8, 1983. Per the NCR, SMR 15285 was generated on December 8, 1983. At the time of this review the SMR was still open.

6. <u>NCR 2397</u>

Problem: Elevation west on drawing 1NB-MPHG-0658F R4 should be elevation east. QCIR 33305 identified this problem on May 13, 1983, and was dispositioned to initiate an NCR. The QCIR was closed on June 20, 1983. NCR 2397 was opened on June 10, 1983. The NCR disposition was to rework the drawing by initiating a field modification (FM). The NCR was closed by the site on August 1, 1983. FM 18848 was opened on June 20, 1983, but was not closed until September 13, 1983.

7. <u>NCR 2574</u>

Problem: Seismic support 1NV-MPHG-0642 damaged. NCR 2574 was written to document this problem on November 29, 1983. The recommended disposition was to rework the support by initiating a sequence control chart (SCC). The NCR was closed by the site on February 9, 1984, without EN DES review. SCC 1NV-H1853, which was generated by this NCR, was opened on November 29, 1983. The support was inspected and accepted on March 21, 1984, approximately six weeks after closure of the NCR. During examination of this NCR, the NSRS reviewer was unable to locate support drawing 1NV-MPHG-0642 R3.

8. <u>NCR 2577</u>

Problem: Hanger span violated for hangers OEA-EHNG-43-/1, OEA-EHNG-69-/1, OEA-EHNG-71-/1, OEA-EHNG-68-/1 and OEA-EHNG-70-/1. The NCR was written on November 30, 1983, and the disposition was for EN DES to resolve the problem. On January 23, 1984, EN DES dispositioned NCR 2577 by stating that drawings would be issued showing new hangers for OEA-EHNG-43-/1 and OEA-EHNG-44-/1. The other hangers were to be used-as-is. The site closed the NCR on January 27, 1984. Revision 4 of the affected drawing (5AW0206-EA-1) was issued on March 19, 1984.

9. <u>NCR 2579</u>

Problem: Support load table 3BH0462-WE-01F and support drawing OWE-MPHG-0018F R0 did not agree on elevation location of support. The NCR was opened on November 29, 1983, and dispositioned to initiate an FM. NCR 2579 was closed on February 8, 1984. FM 19760 was issued on December 6, 1983 and at the time of the NSRS review was still open.

10. <u>NCR 2580</u>

Problem: Support load table 3BH0471-RF-148 R2 and support drawing ORF-MPHG-2965 R1 did not agree on elevation location of support. The problem was documented on NCR 2580 November 28, 1983. The recommended disposition was to initiate an FM. The FM number was not recorded on the NCR. NCR 2580 was closed on January 25, 1984. The NSRS identified the FM by reviewing the revision block on the support drawing. By this method it was determined that drawing ORF-MPHG-2965 R2 had been revised as a result of FM 19735. The FM was opened on December 1, 1983, and was closed on March 14, 1984.

11. <u>NCR 2590</u>

Problem: Anchor spacing violation on seismic pipe support 1NV-MPHG-1018. The NCR was written on December 9, 1983 and was dispositioned use-as-is by initiating an anchor spacing variance (ASV). NCR 2590 was closed by the site on December 21, 1983, without EN DES review as required by the nonconformance procedure for use-as-is dispositioned NCRs. Anchor spacing variance H2412 was initiated on December 16, 1983, and was still in the review cycle at the time of the review.

12. <u>NCR 2795</u>

Problem: One of four embedded studs for support anchorage MK9-3 (unit 1) was broken off. On January 25, 1984, an NCR was initiated to document the problem. The site's recommended disposition was to use-as-is. EN DES agreed with the disposition on February 2, 1984, and was to revise drawings 1RN0430-X2-27 and 1RN0433-X2-9 per ECN 2484. The site closed NCR 2795 February 15, 1984. Drawing 1RN0430-X2-27 R7 was issued on May 26, 1983. Drawing 1RN0433-X2-9 R5 was issued on August 16, 1983. At the time of the review neither drawing had been revised per ECN 2484.

13. <u>NCR 2811</u>

Problem: Hanger OYP-MPHG-0011F was not welded per the drawing. The NCR was written on February 7, 1984, and dispositioned to issue a repair card on the hanger so that weld "C" could be completed. The NCR was closed on February 10, 1984. An operation checklist was issued on February 10, 1984; however, the weld was not inspected and accepted until February 21, 1984.

The preceding examples can be divided into three categories: (1) NCR closed on a future commitment, (2) NCR closed without documentation being located, and (3) NCR closed by initiating another document. NCRs 995, 2344, 2577 and 2795 fall into category 1. At the time of the NSRS review all necessary corrective action had been accomplished for NCRs 995 and 2577.

(NOTE: As indicated in the details of these NCRs, the corrective action was not completed prior to closure of the NCRs.) However, drawing revisions required by NCRs 2344 and 2795 had not been issued at the time of the review, although the NCRs had been closed by the site. Nonconformance reports 2464 and 2480 fall into category 2, that is documentation indicating or supporting that the corrective action had been accomplished could not be located. The remaining NCRs (2564, 2377, 2574, 2579, 2580, 2590 and 2811) can be placed in category 3. All these NCRs were dispositioned to generate another document to correct the nonconformance. The nonconforming condition had not been corrected before closure of the NCR. The documents generated by NCRs 2564, 2579, and 2590 were still in the "open" status at the time of the NSRS review. NSRS concluded that this method of closing NCRs was improper because there is no assurance that the generated documents will be processed to completion.

In addition to being identified by the INPO evaluator, the problem of closing NCRs without completing corrective action was documented by deviation 11 of OQA audit COO-A-84-0001. As a part of the reply to this deficiency, BLN CONST stated that it had "taken the position that nonconformances written against drawing discrepancies or hardware discrepancies that require drawing revision as corrective action where the hardware is dispositioned to use-as-is, only require initiation of necessary documents to correct the drawing prior to closure of the nonconformance report." This position is scheduled to be incorporated into BNP-QCP-10.4 R11.

The NSRS conclusion was that NCRs were closed without corrective action to rectify the nonconforming item being completed. The BLN site should document this condition adverse to quality on a nonconformance report and take action (e.g., a sampling program) to determine the magnitude of this problem. To prevent this condition from occurring again, BNP-QCP-10.4 should be revised to preclude closure of NCRs prior to completion of corrective action. Contrary to BLN's position, this revision should also prohibit closing NCRs requiring drawing or procedural changes.

D. Evaluation of "Offsite-Generated NCRs"

In the course of the review, NSRS observed an area in the site nonconformance procedure that had been changed by Addendum 2 to BNP-QCP-10.4 on December 15, 1983. This addendum revised the BLN procedure to conform to the requirements of QAP 15.1 R9 concerning initiation of NCRs. Paragraph 6.2.1.2 of BNP-QCP-10.4 R10 had required that the site generate an NCR to track any "offsite-generated NCR" until closure. By the addendum the requirement was revised to state that a site NCR may be initiated if an evaluation indicated a need to tag or segregate to prevent inadvertent use or installation of nonconforming items. Criterion XV of 10 CFR 50 Appendix B states:

Measures shall be established to control materials, parts, or components which do not conform to requirements in order to prevent their inadvertent use or installation. These measures shall include, as appropriate, procedures for identification, documentation, segregation, disposition, and notification to affected organizations. Nonconforming items shall be reviewed and accepted, rejected, repaired or reworked in accordance with documented procedures.

It appeared to NSRS that the procedural change made to QAP 15.1 and BNP-QCP-10.4 violates upper tier requirements, and the NSRS recommends these procedures be revised to require the site to initiate NCRs to track "offsite-generated NCRs." An example of a problem that could develop with only the requirement to perform an evaluation was given by deviation 6 of OQA audit S-A-84-0001. Details of the deviation indicated that a vendor had shipped approximately 1600 valves to SQN, WBN, HTN, and PBN. After shipment, the vendor notified TVA that the hydrostatic shell tests for the valves had been performed at a pressure lower than required. The valves were not identified or tagged as nonconforming. Subsequently, PBN transferred the valves to BLN. At BLN these valves were not received as nonconforming (because PBN had not identified the valves as nonconforming), thus allowing corrective action proposed by EN DES to be incomplete and not providing proper control over the valves.

E. Potential Problems

1. Management Action/Reaction

After concluding their review of BLN, the INPO team held an exit meeting. This meeting was held to discuss all the findings (weaknesses and good points) with site management.

During the interview process of QC personnel, the NSRS reviewer became aware of the fact that after the INPO review was concluded one of the QC units held a meeting to discuss item QP 5.1. The Assistant Quality Manager and unit supervisor were both present. It was the perception of some inspectors that the meeting was held to determine who, which inspector(s), had voiced concerns to the INPO evaluator. The unit was also told during the meeting that there would be an investigation because of the allegation. It appeared from the interviews with the QC inspectors that the two supervisors used this meeting to express their opinion that the allegations were unwarranted and that the system had been circumvented because someone may have voiced a concern to an outside organization without using onsite channels. When asked about this meeting, the unit supervisor confirmed that the meeting had been held, but he stated that it had been held to reassure the inspectors rather than to chastise.

NSRS finds it a normal and desirable practice to have an organizational unit meeting and discuss a finding regardless of the source of the finding, (i.e., NRC, INPO, NSRS). The meeting should be one to discuss the findings and obtain clarification and understanding, certainly not to identify the individual voicing a concern. This meeting would also be an appropriate time to emphasize the employee concern program and to encourage employees to discuss any concerns with their supervisor or the designated organization at the site to handle employee quality or safety concerns. It was imprudent on the part of the supervisors to hold a meeting and announce there would be an investigation into the allegations and at the same time indicate the allegations were unwarranted. In fact, subsequent investigation both by BLN staff and the findings of this investigation support this contention.

V. PERSONNEL CONTACTED

Abernathy, K. A.	EQC Unit, CONST
Bell, W. C.	EQC Unit, CONST
Black, T. R.	EQC Unit, CONST
Bowlin, T. L.	EQC Unit, CONST
Claiborne, C. M.	IQC Unit, CONST
Coffman, C. O.	IQC Unit, CONST
Cox, P. R.	EQC Unit, CONST
Curry, D. A.	EQC Unit, CONST
Davis, W. M.	EQC Unit, CONST
Dulaney, M. L.	EQC Unit, CONST
Farmer, J. W.	EQC Unit, CONST
Fletcher, M. E.	EQC Unit, CONST
Ford, L. M.	EQC Unit, CONST
Goggans, M. J.	EQC Unit, CONST
Gross, S. W.	IQC Unit, CONST
Hill, J. L.	EQC Unit, CONST
Holder, C. M.	EQC Unit, CONST
Johnson, C. A.	EQC Unit, CONST
Jones, W. A.	EQC Unit, CONST
Killingsworth, D. D.	IQC Unit, CONST
Kindred, J. F.	EQC Unit, CONST
Leeth, W. K.	IQC Unit, CONST
Lott, J. L.	EQC Unit, CONST
Lowe, L. E.	EQC Unit, CONST
Mann, P. C.	Supervisor, Nuclear Licensing Unit, CONST
Martin, R.	Supervisor, EQC Unit, CONST
McCutchen, J. H.	IQC Unit, CONST
Mitchell, J.	EQC Unit, CONST
Nix, A. J.	IQC Unit, CONST
Pankey, T. R.	IQC Unit, CONST
Parde, V. L.	IQC Unit, CONST
Price, S.	IQC Unit, CONST
Richardson, M. R.	Supervisor, IQC Unit, CONST
Sanders, D. A.	EQC Unit, CONST

Smith, J. M.	EQC Unit, CONST
Starcznski, C. E.	IQC Unit, CONST
Thomas, B. J.	Quality Manager, CONST
Thompson, M. B.	EQC Unit, CONST
Torrie, T. B.	IQC Unit, CONST
Yockel, D. E.	EQC Unit, CONST

VI. DOCUMENTS REVIEWED

QAP 15.1, "Reporting and Correcting Nonconformances," R10 (Proposed)

QAP 16.1, "Evacuation of Nonconformances Condition Reports," R4 (Proposed)

QAP 15.1, "Reporting and Correcting Nonconformances," R9 (Addendums 1, 2, and 3), 9/19/83

BNP-QCP-10.4, "Nonconforming Condition Reports," R8 (Addendums 1, 2, and 3), 6/5/80

BNP-QCP-10.4, "Nonconforming Condition Reports," R9, 11/18/82

BNP-QCP-10.4, "Nonconforming Condition Reports," R10 (Addendums 1, 2, and 3), 11/1/83

BNP-QCP-10.26, "Quality Control Investigation Reports," R4 (Superseded by R5), 3/20/81

BNP-QCP-10.29, "Quality Assurance Training Program," R5 (Addendum 1), 8/24/83

BNP-QCP-10.35, "Employee Concerns and Differing Opinions," R2, 12/23/83

BNP-QCP-10.43, "Inspection Rejection Notice," R0 (Addendum 1), 11/1/83

BNP-QCP-10.29, R5, Attachment E, "Bellefonte Nuclear Plant Unit Certification/Training Requirements" for EQC and IQC units

Personnel Certification and Training Program for EQC and IQC Personnel

Memorandum from R. W. Diebler to C. Bonine, Jr., "Office of Quality Assurance Audit Report No. COO-A-84-001, Nonconformance Control and Corrective Action," 12/30/83 (OQA 831230 601)

Memorandum from L. S. Cox to R. W. Diebler, "Bellefonte Nuclear Plant - Office of Qualtiy Assurance Audit Report No. COO-A-84-0001, Nonconformance Control and Corrective Action," 1/26/84 (BLN 840126 303)

Memorandum from L. S. Cox to R. W. Diebler, "Bellefonte Nuclear Plant - Office of Quality Assurance Audit Report No. COO-A-84-0001," 3/9/84 (BLN 840309 302)

Memorandum from R. W. Diebler to L. S. Cox, "Deviation Report Closure - Audit COO-A-84-0001, Nonconformance Control and Corrective Action," 5/9/84 (OQA 84 0509 601)

Memorandum from J. W. Davenport to B. J. Thomas, "Bellefonte Nuclear Plant - INPO Construction Project Evaluation, Finding QP-S.1, Corrective Actions," 3/26/84

Nonconformance Reports - 0117, 0177, 0192, 0438, 0471, 0505, 0548, 0593, 0639, 0738, 0759, 0765, 0808, 0833, 0838, 0913, 0919, 0955, 0991, 1003, 1021, 1132, 1177R1, 1247, 1302, 1378, 1458, 1508, 2024, 2058, 2080, 2084, 2094, 2109, 2147, 2155, 2210, 2269, 2296, 2300, 2344, 2357, 2363, 2369, 2370, 2374, 2374, 2395, 2397, 2412, 2415, 2464, 2478, 2480, 2482, 2526, 2539, 2548, 2553, 2554, 2564, 2574, 2577, 2579, 2580, 2586, 2588, 2589, 2590, 2605, 2607, 2613, 2615, 2617, 2624, 2641, 2674, 2675, 2686, 2698, 2699, 2701, 2710, 2721, 2728, 2732, 2733, 2735, 2737, 2738, 2739, 2751, 2752, 2757, 2761, 2763, 2773, 2775, 2777, 2778, 2779, 2789, 2792, 2795, 2799, 2807, 2811, 2817, 2824, 2830, 2832, 2839, 2840, 2845, 2888, 2908, 2953, 2981, 3013

Miscellaneous quality assurance records

Memorandum from D. R. Bridges to Those listed, "Bellefonte Nuclear Plant - E, I, C&M Units - Late (Tardiness) and Sick Leave Policies," 12/9/83

APPENDIX I

CHART - REVIEW OF INVALIDATED NCRs

NCR Number	Nonconforming Condition	Reason for Invalidation	NSRS Opinion	BLN Opinion
117	Material received without material test report	Not code material	Agree	Agree
177	Pneumatic tests were substituted for hydrostatic tests subassemblies O-KE-01-7 part B and O-KE-01-8 part A	None	Disagree	Disagree
192	Vertical steel dowels (rebars) have been welded	Handled by FCR, no FCR number referenced	Disagree	Agree
438	Tape received without documentation	Not required	Agree	Agree
471	Removed three bearing plates without approval of procedure	Approval of procedure obtained prior to activity being performed	Agree	Agree
505	COC not received on material	Covered on NCR 507	Agree	Agree
639	Crack in grease can for rock anchors	Covered by NCR 24	Agree	Agree
738	Damaged sections (MK 100) for traveling water screens	Duplicate of NCR 759	Agree	Agree
765	Temperature in class B warehouse dropped below minimum	Accomplished by QCIR, no QCIR number referenced	Disagree	Disagree
808	Incorrect reinforcing steel cut	Dispositioned on FCR 0-920	Disagree	Agree
913	Base material cracked	Process specification revised	Disagree	Disagree
1508	Anchor bolt on box 2ED-EJB-26 during torque test	Item was reworked to conform to design specifications	Disagree	Disagree
2147	Flex conduits cannot be installed as required per drawing	The condition can be corrected within scope and requirements of the drawing. FCR E2792	Disagree	No comment

NCR Number	Nonconforming Condition	Reason for Invalidation	NSRS Opinion	BLN Opinion
2374	Documentation not complete for welding activities	Disposition of 33571 sufficient to document problem	Disagree	No review
2539	Incorrect welds for whip restraint	Deficiency will be dispositioned by EN DES	Disagree	No review
2553	NCR to track EN DES NCR	Not needed since material does not need to be tagged and segregated	Disagree	Agree
2698	Internal grease separation in valves	The separation of lubricant does not become a nonconforming condition unless a significant amount of oil has leaked into the switch compartment.	Disagree	Disagree
2732 2733	Drawings do not address supports for installation of electrical boxes	This condition is not a nonconforming condition in accordance with BNP-QCP-10.4 or QAP 15.1	Disagree	No review
2735	Completed NCR on ASME item not signed by authorized nuclear inspector (ANI)	No further action required. NCR 2561 corrected by revision	Disagree	No review
2807	Carbon steel pipe (ASME) contains pitted indications	None	Disagree	No review
2845	Digital isolator output state does not change when the input's state is changed	Modules to be reworked onsite. Failure is isolated occurrence	Disagree	Disagree

GNS 840801 051

TENNESSEE VALLEY AUTHORITY

NUCLEAR SAFETY REVIEW STAFF

INVESTIGATION

NSRS REPORT NO. I-84-12-SQN

SUBJECT: SEQUOYAH NUCLEAR PLANT - INVESTIGATION OF UNIT 1 INCORE INSTRUMENTATION THIMBLE TUBE EJECTION ACCIDENT ON APRIL 19, 1984

DATES OF INVESTIGATION: APRIL 25 THROUGH MAY 18, 1984

INVESTIGATORS: Gerald G. Brantley — GERALD G. BRANTLEY — August 1, 1984 — DATE

Michael D. Wingo — MICHAEL D. WINGO — 8/1/84 — DATE

APPROVED BY: for MSK — MICHAEL S. KIDD — 8/1/84 — DATE

MEDS, W5B63 C-K

TABLE OF CONTENTS

Page

LIST OF ATTACHMENTS

1. Trojan Nuclear Plant Flux Thimble Tube Cleanout at Full Power

2. INPO Entry

LIST OF FIGURES

I. SCOPE

This investigation was conducted to identify the causal and event factors that precipitated the ejection of a highly radioactive thimble tube from its respective guide tube and the unit 1 reactor core into an adjacent instrument room containing eight employees. Additionally, an assessment was made of the actions taken to recover the ejected thimble tube, the Office of Nuclear Power (NUC PR) investigation and reporting of the accident, the efforts to determine the operational readiness of the unit for restart and return to service, and long-term planned corrective actions. During the investigation established accident investigation techniques were utilized in obtaining information from personnel interviews, document and record reviews, and accident scene observation.

II. MANAGEMENT SUMMARY

The thimble tube ejection accident subjected eight Sequoyah Nuclear Plant (SQN) employees to hazardous energy sources of water/steam at 545° F and high radiation levels but caused no injuries, and caused no danger to the general public or the environment. Approximately 16.5 man-rem of radiation exposure and 21 days were required to return the unit to its state prior to the accident (30 percent power).

After the accident the SQN operators took appropriate immediate and subsequent actions in accordance with established procedures to classify, mitigate the consequences of the accident, place the affected unit in a safe shutdown condition, and report the events as they occurred. The operator actions and the design of the plant systems prevented uncovering the reactor core and endangering the health and safety of the general public. The operator efforts were enhanced by prompt notification by the workers of the nature of the reactor coolant leak and conditions in the work area.

No physical injuries were reported as a result of the accident. This is attributed to coincidence, luck, and the prompt egress from the work area which was promoted by the increased awareness of some of the radiological hazards of the job. The increased awareness of the workers can be attributed to the actions by the plant health physics staff to question and slow the job down as the radiological hazards increased and the response of the workers to heed the warnings and stop and discuss the safety aspects of the job.

The causal factors that precipitated the accident were determined by NSRS to be associated with allowing the degraded conditions of the thimble tubes to progressively worsen without taking decisive and effective actions to restore the tubes to their fully operational status, an inadequate decisionmaking process to clean the tubes at power, and assignment of the work activity to a plant organization that was normally accustomed to working on the system while shut down, cooled down, and depressurized without providing sufficient information and management involvement. The assignment of a timeframe of less than 48 hours in which to plan and accomplish the job created an atmosphere of urgency as opposed to safety.

The workers were aware that if the job was not accomplished in that timeframe the reactor was going to be shut down and they were working hard to prevent that from happening.

Those factors discussed above promoted the subsequent breakdown in program controls that were established to regulate maintenance activities of this nature. These breakdowns resulted in the direct causal factors of the accident and include the following:

- Inadequate control of the maintenance activity in that planning, job safety analysis, and review phases were not adequate.

- Breakdown in the procedure process in that inappropriate work instructions were proposed, reviewed, approved, used, and violated.

- Inadequate controls over modification of tools used on the system in that tools were modified without performing adequate evaluations and testing to determine the effects on the system.

Indirect causal factors for the accident include the following:

- The ineffectiveness of the Independent Safety Engineering Group (ISEG) in executing their responsibilities for maintaining surveillance of plant maintenance activities to verify that known system deficiencies are identified and corrected.

- Failure to use all available resources for input into the decisionmaking process to do the job with the reactor at power.

There were other observed program weaknesses that were not causal factors for the accident but could have made the consequences of the accident worse or indicate possible program weaknesses. These include the following:

- Noncompliance with the requirements of a Radiation Work Permit (RWP).

- Improper issuance of hold orders.

- Lack of control of egress routes from the work area.

- Inoperative communication equipment.

On a more positive note the recovery effort was well planned and executed using available industry, TVA, and plant resources, approved instructions, and well-informed personnel. Those involved with the planning and execution of the recovery effort made themselves acutely aware of the hazards they were up against and exercised ingenuity in devising special tooling and simulated exercises to keep radiation exposures as low as reasonably achievable.

It should be emphasized that the TVA health physics organization performed well prior to and after the accident and their efforts can be credited with minimizing the possible serious consequences of this accident.

The actions taken to assure that unit 1 was safe for restart involved inspections, repair, and restoration of affected equipment along with special testing and evaluations. These actions were considered appropriate to ensure that the plant was safe for restart when the decision was made to proceed with returning the unit to operation.

TVA accident reporting and investigation requirements were not adhered to after the accident, and an accident investigation performed by NUC PR did not address important causal factors and respective corrective actions. The report submitted to the NRC describing the nature of the accident, causes, and needed corrective actions was misleading and revisions of that report have been recommended.

TVA's and SQN's policies for safety first before schedule and providing a safe work environment for our employees was not properly executed primarily because the plant staff did not take the time to carefully identify and evaluate the hazards of the job. This led to the subsequent breakdown of established program controls intended to prevent an accident of this nature from occurring. Realizing the hazards associated with the recovery, that effort was carefully evaluated, planned, and executed, and made good use of available resources and established program controls.

Management attention should be focused on evaluating and improving the execution of TVA policy and correcting direct and indirect causal factors and other identified program weaknesses of this accident. This was the second undesirable event involving radiation hazards that has occurred at SQN in less than two years, the last mo : serious than the first, that were precipitated by similar causal factors.

III. CONCLUSIONS AND RECOMMENDATIONS

A. Background

1. I-84-12-SQN-1, Inadequate Corrective Measures to Alleviate the Degraded Condition of the Thimble Tubes

Conclusion

The degraded condition of the thimble tubes had existed for a period of four years prior to the accident. Effective cleaning efforts had not been accomplished nor changes made in the methods prescribed by documented instructions to correct the problem despite the importance of the system.

Responsibilities for the different aspects affecting system operability (operation and maintenance) were dispersed among several organizations with no one central figure responsible or accountable for overall system operability allowing the degraded condition of the system to remain uncorrected (see sections IV.A.4 through IV.A.11 for details).

Recommendation

Responsibility for overall systems operability should be formally assigned to plant engineers and those engineers held accountable for periodically assessing the adequacy of the performance of the systems, the adequacy of instructions affecting the operation, maintenance or testing of the systems and for assuring that problems are promptly identified and corrected in a quality manner. The responsible engineers should be required to keep informed of industry and TVA information relating to the different aspects of the systems and to periodically formally update plant management on the status of the system.

B. The Decisionmaking Process to Clean the Thimble Tubes at Power

1. I-84-12-SQN-2, Inadequate Industry Survey and Feedback to Field Services Group (FSG) Personnel

The industry survey performed by the Engineering Section was limited in scope and appeared to attempt to determine if the thimble tubes could be cleaned at power rather than how they could be cleaned safely. The engineer performing the survey did not use available information sources (INPO), had not read the cleaning instruction, had not cleaned thimble tubes, and did not interface with FSG personnel after the survey (see section IV.B.1 for details).

Recommendation

In the future, work assignments of this nature should be given to those who are knowledgeable of and will be responsible and accountable for the success and safety of the operation to be accomplished. All available information should be identified and used.

2. I-84-12-SQN-3, Inadequate Decisionmaking Process

Conclusion

The decisionmaking process for the conduct of the cleaning of the thimble tubes while at power was less than adequate. The process used to acquire information was inadequate, readily available information sources and input resources were not used, no independent hazard analysis was performed, and the magnitude of the hazards was not realized or identified (see section IV.B.3 for details).

Recommendation

For unique activities plant management should take the time necessary to identify and thoroughly evaluate hazards associated with the activities using readily available inputs and obtaining information from knowledgeable personnel who will be responsible and accountable for the activity to be performed. Techniques such as a systematic hazard analysis methodology to identify and derive an independent assessment of the hazards involved should be used.

C. Assignment of Work Functions and Job Planning Prior to Beginning the Cleaning Operation

1. I-84-12-SQN-4, Assignment of Work Function to the FSG as an Ordinary Work Activity

Conclusion

The supervision, coordination, and execution of the cleaning operation were assigned as if the activity was an ordinary maintenance activity when in reality it was a unique activity with unique hazards identified. The coordinators and workers were unaccustomed to working on the system when the reactor was operating at rated temperature and pressure and with the dose rates that would likely be encountered and had little if any feedback from the industry survey and management discussion process. A sense of urgency was established as the supervisors, coordinators, and workers knew that the work would have to be done or the unit would be brought off the line (see sections IV.C.1 and IV.L for details).

Recommendation

Emphasize to plant management that it is a fundamental responsibility of management to assure that the knowledge and background of workers assigned to work functions is adequate and that sufficient time and information are provided to properly plan and execute the work activity.

2. I-84-12-SQN-5, Selection of an Inappropriate Instruction for the Control of the Work Activity

Conclusion

Special Maintenance Instruction SMI-0-94-1 was a poor quality instruction and inappropriate for the activity to be controlled. However, the instruction was selected during the planning process as the primary procedural control for the cleaning activity apparently because those performing the planning and coordination function were not aware of what quality elements an instruction should contain, the change process for inadequate instructions, or had a careless attitude toward procedural compliance (see section IV.C.2.b.(1) for details).

Recommendation

Conduct an awareness program to reaffirm supervisor, engineer, and worker knowledge of the importance of procedure controls, compliance with procedural requirements, and the proper change process for inadequate procedures. Emphasize the SQN policy as stated in SQA129, which states that following instructions and taking the time to correct those which are inadequate are methods to achieve nuclear safety.

3. I-84-12-SQN-6, Inadequate Job Safety Analysis and Hazards Assessment

Conclusion

The job safety analysis and hazards assessment program associated with maintenance activities at SQN is inadequate for identifying, evaluating, preventing, and mitigating accidents of this nature. Similar findings had been identified to SQN as causal factors of an inadvertent radiation exposure at SQN in December 1982, but recommendations in that report (I-82-21-SQN) had not been implemented (see sections IV.C.b.2 and IV.O for details).

Recommendation

The job safety analysis program should be upgraded. An effective hazards assessment methodology should be established as a tool to be used to analyze the identified radiological and industrial aspects of the job, the probability of an accident, and the impact on the workers, plant, and the public. Additionally, implement the recommendations of NSRS Report No. I-82-21-SQN.

4. I-84-12-SQN-7, Inadequate Field Quality Engineering (FQE) Review of Maintenance Request (MR) and Referenced Work Instruction

Conclusion

SMI-0-94-1 was referenced and attached to the MR when sent to FQE for review. The poor quality of the instruction was not identified nor was the fact that the instruction could not be used to perform the cleaning activity with the reactor at power. The FQE review process had not been effective in initiating quality improvement of the instruction since its original issuance in July 1981 (see section IV.C.2.c for details).

Recommendation

Improve the quality of the FQE review process of MRs to assure the quality of the referenced work instructions, the proper program controls are identified, and the instructions are appropriate for the activity being performed.

5. I-84-12-SQN-8, Noncompliance With Requirements of RWP No. 01-1-00102

Conclusion

RWP No. 01-1-00102 specified the following requirement: "Verify hold order is in effect on incore probes prior to entering Reactor Building lower compartments and the Annulus." On April 18 and 19 FSG evening and day shift employees and a HP technician entered the reactor building lower compartment while the hold order was not in effect (see sections IV.C.3.a-c for details).

Recommendation

Emphasize to plant employees that compliance with the requirements of RWPs is essential for their own protection.

6. I-84-12-SQN-9, Noncompliance With Requirements of Section 5.1.4 of AI-3, "Clearance Procedures"

Conclusion

Hold Order No. 1 was issued only to the Assistant Shift Engineer (ASE) and not as required by AI-3 to the persons responsible for work being performed in the instrument room between 0220 on April 17 and 0400 on May 1. This is contrary to the requirements of section 5.1.4 of AI-3 (see section IV.C.3.d for details).

Recommendation

As the hold order system is the method used at SQN for the protection of workers, the public, and equipment, strict compliance with the requirements of AI-3 should be emphasized and enforced.

D. Work Activities Related to the Thimble Tube Cleaning Prior to the Incident

1. I-84-12-SQN-10, Modification of Cleaning Tool Base Supports Without Performing a Technical Evaluation or Testing

Conclusion

The cleaning tool base support was modified and a temporary base was constructed and used without a technical evaluation of the effect on the mechanical seals. No testing was performed before use. Use of the tool and its support was determined during postaccident testing to impose forces of considerable magnitude on the mechanical seals and those forces were found to cause strain sufficient that the thimble tube separated from the mechanical seal (see section IV.D.1.a. and b for details).

Recommendation

Emphasize to the plant staff that changes to tools and equipment affecting work on critical structures, systems, and components (CSSC) can be made only after a thorough technical evaluation has been made on the effect it will have on the system and used only after the modified tool or equipment has tested satisfactorily.

2. I-84-12-SQN-11, Violation of Work Instruction

Conclusion

SMI-0-94-1 clearly stated that the Teleflex-supplied equipment and the instruction were not to be used at power. Using the equipment and instruction for that operation was a violation of work instruction and the unit 1 SQN Technical Specifications. If the responsible engineers had written an adequate procedure appropriate for the activity and that procedure had been Plant Operation Review Committee (PORC) reviewed the result of the cleaning operation may have been different (see section IV.D.2.a for details).

Recommendation

Emphasize to the plant staff that adherence to PORC-reviewed, plant manager-approved plant instructions is mandatory and a requirement of the Technical Specifications and that instructions are controls established to assure nuclear and industrial safety. Periodic assessments of compliance with instructions should be initiated and corrective actions taken to correct weaknesses observed.

3. Health Physics (HP) Technicians Expression of Concern for Radiation Safety of the Job

Conclusion

The health physics technicians providing coverage for the job expressed concern for safety when they realized the potential for high dose rates. They made recommendations that as low as reasonably achievable (ALARA) preplanning should be performed and that further discussions should be conducted with management about the hazards. These recommendations were heeded by the workers and as a result the workers had an increased awareness of the hazards for the job before entering the containment to commence work on the evening of April 19 (see sections IV.D.2.a and d and IV.D.3 for details).

4. I-84-12-SQN-12, <u>Lack of Control of Egress Capability from Containment</u>

<u>Conclusion</u>

For approximately 30 minutes during the morning of April 19, the inner door of the personnel airlock was made inoperable without the knowledge of some of the workers cleaning the thimble tubes. This would have hindered egress from the room if the mechanical seal had failed at this time. The FSG workers were unaware of the Technical Specification requirements for maintaining containment integrity and that leaving the inner door of the airlock open would enter the unit into a limiting condition for operation. Leaving the inner door open would have hampered rescue efforts if needed (see sections IV.D.2.b. and IV.D.3 for details).

<u>Recommendation</u>

Establish a policy and methodology requiring an evaluation of the effect on work in progress and notification of affected workers as necessary before granting permission to incapacitate egress routes from the reactor building containment. Emphasize to plant managers and workers that working in the reactor building containment involves some risks and controls for containment integrity are established. Identify the risks involved and established controls to the employees.

5. I-84-12-SQN-13, <u>Breakdown in the ALARA Preplanning Program</u>

<u>Conclusion</u>

The responsible supervisor is required to initiate and complete an ALARA preplanning report prior to job commencement. Even though the cleaning job was expected to involve unusually high dose rates, ALARA preplanning was not conducted until the cleaning operation was well underway on the day shift on April 19, and some recommendations made in the Trojan report to reduce the radiation dose to workers were not incorporated in the cleaning instruction or the work process. The responsible supervisor was not involved in the preplanning effort (see section IV.D.2.c for details).

<u>Recommendation</u>

Emphasize to the plant staff that compliance with ALARA preplanning requirements as specified in RCI-10 must be accomplished.

6. I-84-12-SQN-14, Need for Formal Documentation for Upper Plant Management Approval to Work in Radiation Dose Rate Fields Greater than 50 Rem/Hour

Conclusion

There are no requirements for formal documentation for authorization to work in dose rate fields greater than 50 rem/hour (see section IV.D.3 for details).

Recommendation

Establish formal requirements and a method to document authorization to work in dose rate fields greater than 50 rem/hour.

E. The Accident

1. Failure Mode of the Mechanical Seal

Conclusion

Based upon observations of the workers immediately prior to the accident, a kink in the cleaning cable entered the cleaning tool and resulted in more force being exerted by the worker turning the handle. Additional force was transmitted to the mechanical seal resulting in strain of the seal metal allowing separation of the seal and the thimble. When separation occurred, the thimble tube started out of the guide tube immediately. SMI-0-94-1 had no restrictions or warnings on the use of the cleaning tool or the cable to alert the workers to the potential for causing a failed seal (see section IV.E.3 and IV.K for details).

2. Nature of the Leak

Conclusion

The leak occurred as a sudden spray of relatively cool water in the immediate vicinity of the workers (slightly wetting two of the workers) and rapidly developed into a "gusher" type leak flashing to steam above the workers constituting a life threatening hazard (see section IV.E.3 for details).

3. Egress From the Work Area After the Accident

Conclusion

The egress was rapid and orderly with the exception that one HP technician fell over the handrail a distance of approximately seven feet, there was some crowding and pushing at the door, and one worker was late getting into the airlock. The rapid egress can be attributed to the fact that by the time the workers entered the work area on the evening of April 19 they were acutely aware and alert to some of the hazards associated with the cleaning operation (see sections IV.E.2 and 4 for details). However, had welding in the airlock been in progress, or if the HP technician had been hurt in his fall and required assistance, the potential for catastrophic consequences is evident. NSRS attributes the fact that severe personal injury was not sustained during the accident to coincidence and luck as well as to the heightened sensitivity of the group to the hazardous conditions.

4. Head Counts of Employees

The FSG day shift coordinator had the presence of mind to conduct a head count in the airlock and again immediately after exiting the airlock. Had someone been injured and left behind in the instrument room it is probable that the head count would have initiated immediate rescue efforts and improved the chances for a successful rescue (see section IV.E.4 for details).

5. I-84-12-SQN-15, Availability of Communications Following the Accident

Conclusion

When the workers entered the airlock after the accident, they discovered that the telephone in the airlock was inoperable (see section IV.E.4 for details).

Recommendations

Anytime the telephone is out of service in the airlock, alternate communications methods should be considered and employed. Additionally, availability of communications should be considered during the performance of the job safety analysis and job planning.

6. Reporting of Accident Conditions to the Control Room

Conclusion

Immediately after exiting the airlock the FSG day shift coordinator told the Public Safety Officer controlling access to reactor building containment to notify the control room of what was happening. The officer was unsuccessful in getting through to the control room (reason not determined by NSRS). The coordinator exited the contamination zone immediately and notified the control room operators of the accident and the nature of the leak. This early notification was helpful to the operations staff in properly classifying the degree of the problem (see sections IV.E.4 and IV.F.1 for details).

F. <u>Operator Actions to Mitigate the Accident</u>

1. <u>Immediate and Subsequent Operator Actions</u>

<u>Conclusion</u>

Using the information provided by the FSG coordinator and properly analyzing the system responses, the operations staff classified the nature of the leak and took proper action in accordance with established procedures to shut the unit down, report the accident, and mitigate the leak. Reactor coolant charging capacity compensated for the leak rate. The core was never uncovered even though the leak was nonisolable and no core damage was sustained. Public health and safety were not jeopardized (see section IV.F for details).

G. <u>Initial Actions Taken to Evaluate Conditions in the Instrument Room</u>

1. <u>Establishment of Upper Plant Management Direction and Control of the Recovery Effort</u>

<u>Conclusion</u>

Realizing after the accident that the radiation levels in the instrument room were unusually high, one RWP (RWP No. 02-1-0005) was established to track total radiation dose acquired by the workers during the recovery effort and to establish plant manager control of all activities relating to the recovery effort. Considering the magnitude of the hazards in the room this was an appropriate decision (see section IV.G.2 for details).

H. <u>The Recovery of the Thimble Tube and Actions Taken to Ensure Unit 1 Was Safe to Return to Power</u>

1. <u>Prior NUC PR Planning for Emergency Project Management</u>

<u>Conclusion</u>

NUC PR had issued in November 1983 a procedure to delineate a program for emergency project management that enhances the ability of normal plant forces to ensure that nuclear safety and remaining plant capactity and availability are not affected. The plant manager elected to use the established concept for the recovery effort at SQN. The prior establishment of this concept and its use proved useful and effective during the recovery effort (see sections IV.H.1 and IV.H.2.a and b for details).

2. Effective Use of TVA and Industry Resources

Conclusion

Personnel were brought in from other industry, TVA, and NUC PR organizations to assist in obtaining ideas, planning, oversight, and execution of the recovery effort to ensure that the recovery was conducted in a safe manner and that the radiation doses to the workers involved were kept ALARA. This action proved useful to a successful recovery effort (see section IV.H for details).

3. Use of Ingenuity in the Planning and Execution of the Recovery Effort

Conclusion

The recovery effort of the highly radioactive thimble tube was carefully thought out, evaluated, planned, simulated, practiced, and executed using available resources, appropriate procedures for the activities, and remote handling tools. The radiation dose to individuals involved in the effort was closely monitored, controlled, and was very close to the projected man-rem dose for the job. Personnel involved in the effort demonstrated excellent ingenuity during the recovery effort (see sections IV.H.2.c and d for details).

4. I-84-12-SQN-16, Effective Cleaning of the Thimble Tubes by Nuclear Utilities Services (NUS) Corporation

Conclusion

The method used by NUS as prescribed in SMI-0-94-2 to clean the thimble tubes after the accident was effective in eliminating the material causing the blockage in the thimble tubes. This effectiveness is primarily due to the pressure of the new backflush process (200 psi) versus that of the old method (40 psi) and the controlled application of NEOLUBE as prescribed in SMI-0-94-2 (see sections IV.H.4 and IV.I for details).

Recommendation

Advise Watts Bar Nuclear Plant (WBN) of the effectiveness of the NUS cleaning method over the Teleflex method.

5. I-84-12-SQN-17, Poor Quality Cleaning Procedures and Inadequate PORC Review

Conclusion

As noted in section III.C.2, SMI-0-94-1 was not adequate for its intended use. SMI-0-94-2 was written after the accident to clean the tubes via the NUS method. It too was a poor quality instruction and could promote accidents of a similar nature in the future. This conclusion is based upon the facts that SMI-0-94-2 had no cautions or warnings to prevent damage to the mechanical seals, no administrative barriers to prevent cleaning the tubes at pressure, no instructions for disassembly and reassembly of the detector drive system, no postmaintenance inspections after cleaning and before pressurizing the reactor, and postmaintenance testing to ensure operability was optional.

Despite the poor quality of the instructions both were recommended for approval by PORC. In these instances, PORC failed to adequately fulfill its responsibilities to the plant manager on these matters relating to nuclear safety (see sections IV.H and IV.N.2 for details).

Recommendation

Evaluate the PORC procedure review process and consider supplementing the review process with expert subcommittees to properly evaluate procedures and advise the plant manager on their adequacy before he approves or disapproves.

Additionally, cancel SMI-0-94-1 and do not use SMI-0-94-2 again until it has been revised to include at least the quality elements listed above. Perform a generic review of all maintenance and special maintenance instructions to ensure adequacy.

6. Inspection, Testing, and Repair of Affected Equipment Before Returning the Unit to Power

Conclusion

The actions taken by SQN to inspect and repair the thimble tubes high pressure seals, evaluate various combinations of SWAGELOK/GYROLOK fitting hardware, and other equipment possibly affected by the accident were appropriate to ensure the unit was safe to return to power (see sections IV.H.6 through IV.H.9 for details).

I. Accident Investigations (Other than NSRS)

1. I-84-12-SQN-18, Noncompliance with Serious Accident Reporting and Accident Scene Preservation Requirements

Conclusion

Corporate and SQN procedures require that serious accidents be reported immediately and that the accident scene be preserved until released by the chairman of an appointed Accident Investigation Team (AIT). The accident was not reported as a serious accident until approximately three weeks after the accident occurred, nor was the accident scene preserved as restoration of equipment was essentially complete before the accident was reported (see section IV.J.2 for details).

Recommendation

Determine the cause of the noncompliance and take corrective actions as necessary to ensure future compliance with established requirements.

2. I-84-12-SQN-19, Limited NUC PR Accident Investigation

Conclusion

The appointment of the SQN FSG supervisor to the NUC PR investigation team was inappropriate for this investigation as it created a potential conflict of interest. The NUC PR investigation did not address any breakdown of program controls such as job planning, job safety analysis, inadequate procedures, or the nuclear safety and radiological aspects of the accident. Overall the accident investigation performed by NUC PR is considered limited in scope, somewhat misleading, and did not address what NSRS determined to be the nature of the causes of the accident (see section IV.J.2.a for details).

Recommendation

During future accident investigations appropriate personnel should be appointed to eliminate any potential conflict of interest; the investigation should be initiated as soon as possible after the accident as prescribed by established procedures; sufficient time should be allowed for conduct of the investigation; and it should encompass all aspects of the accident including programmatic weaknesses or breakdowns, and nuclear and radiological safety.

Recommendation No. 5 of the NUC PR report should be revised to delete the recommendation that consideration should be given to leaving the inner door open during such activities.

J. Employee Expression of Concerns for Safety

1. I-84-12-SQN-20, Needed Reemphasis on the TVA and SQN Employee Expression of Concerns for Safety and Safety-First Policies

Conclusion

The employees should have but did not relate their increasing concerns for the safety of the job to upper plant management, and an expression of concern for the adequacy of the design of the new tool support base was not followed up. The workers felt that they had to accomplish the job to prevent shutdown of the unit. It is probable that the workers are not acutely aware of TVA's and SQN's policies and their related responsibilities for expression of concerns for safety and safety first before schedule (see section IV.M for details).

Recommendation

Emphasize to all SQN employees that they are actually responsible for voicing their views concerning safety, that these views are valuable management tools to prevent accidents of this nature from happening, and that management is responsible for addressing the views in a satisfactory manner. Emphasize to all supervisors, engineers, and foremen that responsible concerns expressed to them by their employees must be evaluated regardless of how insignificant they may seem. The TVA and SQN safety-first policy should be emphasized to all SQN employees that nuclear safety is the number one SQN objective and that safety first means before schedule and before production.

K. Program Controls Established by SQN Unit 1 Technical Specifications

1. I-84-12-SQN-21, Ineffective SQN ISEG Activities

Conclusion

The SQN ISEG organization had been ineffective in performing the function that was originally intended for the organization. This is due in part to the dual responsibilities for compliance/ISEG activities and lack of true independence from line responsibilities and pressures (see sections IV.N.1 and IV.Q for details).

Recommendation

Reorganize or reassign functions as necessary to provide ISEG personnel adequate independence from line responsibilities and pressures. Additionally, functions should be limited to ISEG-type duties as required by Technical Specifications.

2. I-84-12-SQN-22, Significant Breakdown in the SQN Procedure Process for Maintenance Activities

Conclusion

There is an apparent breakdown in the procedure process at SQN for maintenance activities as PORC reviewed and recommended approval of two poor quality instructions used for cleaning thimble tubes (one after the accident); the biennial review did not correct poor quality in one instruction; instructions being used were inappropriate for the activities being performed; an instruction was violated; and some engineers and managers interviewed did not seem to understand what quality elements should be in a maintenance instruction, were not aware of the procedure change process, or expressed a careless attitude toward procedure compliance (see section IV.N.2 and 3 for details.)

Recommendation

The procedural process for maintenance activities at SQN should be thoroughly evaluated. Corrective actions including procedure verification should be initiated as necessary to improve the (1) knowledge of those personnel preparing and using procedures of what constitutes an appropriate procedure, the quality elements that should be incorporated into a procedure, and the change process for existing procedures; (2) quality of the PORC and biennial reviews; and (3) compliance with procedures.

L. SQN Licensee Event Report (LER) No. SQRO-50-327/84030

1. I-84-12-SQN-23, Inadequate Reporting of the Event to NRC

Conclusion

The subject LER was misleading in that the true nature of the leak was not described, there was no mention of an inadequate procedure or violation of procedures as causal factors, and the long-term corrective actions are not adequate to correct the true causal factors of the event (see section IV.P for details).

Recommendation

Revise the LER to reflect the true nature of the leak, the adequacy and violation of SMI-0-94-1, and effective long-term corrective action.

IV. DETAILS

A. Background

This accident occurred during the performance of maintenance activities on the unit 1 incore instrumentation system. The following is a description of that system along with a discussion of background information considered pertinent to the accident itself.

1. Incore Instrumentation System Description

This system was designed to measure temperatures and neutron densities at 58 different locations in the reactor core. The process of measuring the neutron density at different locations in the core is referred to as flux mapping. The flux mapping data is used to confirm nuclear design parameters and ascertain that the nuclear fuel is properly loaded and oriented.

a. Neutron Detectors and Drive System (Refer to figure 1 for the basic system schematic)

The neutron instrumentation portion of the system consists of six movable miniature fission chamber detectors (0.188 inches in diameter and 2.1 inches long). Each detector is welded to the end of a 0.188-inch-diameter helical (spiral wound) drive cable. Each detector and cable is inserted into the reactor core by an electric drive unit through interconnecting tubing via path transfer units which direct the detectors to the desired core location through an isolation valve and one of 58 stainless steel tubes known as "thimble tubes." The thimble tubes are terminated at a common header-type device known as the "seal table" (see figure 2) and are physically held stationary against reactor pressure by mechanical seals (SWAGELOK/GYROLOK fittings).

b. Thimble Tubes (Refer to figures 1, 3, and 4)

There are 58 stainless steel thimble tubes each having an outside diameter (od) of 0.300 inch and an inside diameter (id) of 0.201 inch. The last 1.5 inches of each thimble tube at the seal table is expanded from 0.300 inch od to 0.314 inch od to facilitate installation of the mechanical seal. The thimble tubes vary in length between 103 and 117 feet depending upon the distance between their respective position at the seal table and the route to their respective position in the reactor core. The clearances between the detectors and the inside of the thimble tubes is 0.013 inch. The ends of the thimble tubes in the reactor are sealed, the tubes are dry on the inside, and they serve as a reactor coolant system pressure boundary and thus are a "critical system, structure, or component" (CSSC). The tubes are designed for service at 2500 psig. Each thimble tube is individually routed from the seal table to the reactor vessel through its respective guide tube. The configuration of the thimble tubes as designed and installed creates a loop at the lowest portion of the system which is a natural collection or concentration point for any loose substances in the tube.

Approximately 12 to 14 feet of each thimble tube is in place in the reactor core region during normal plant operation. This portion of the tube is normally exposed to an intense neutron flux causing activation of the stainless steel tubing into long-lived radioactive nuclides.

The radiation from these long-lived nuclides caused high dose rates in the instrument room after the thimble tube was ejected during the accident, complicating recovery of the tube.

c. Guide Tubes

The guide tubes are 1 inch od stainless steel and are essentially extensions of the reactor vessel with no isolation valves. The thimble tubes are routed through the guide tubes which extend from the bottom of the reactor vessel through the concrete shielded area to the seal table (see figure 1). The space between the thimble tube and the guide tube contains approximately four gallons of reactor water at reactor pressure. The water in this space is relatively cool rather than at reactor water temperature (~545° F) as it is normally stagnant and there is approximately 100 feet of thimble and guide tube between the seal table and the reactor pressure vessel.

d. Mechanical Seals (Refer to figures 5 and 6)

The thimble tube is held in place at the seal table against reactor pressure (~2250 psig normal operating pressure) by two mechanical seals connected to the guide tube and thimble tube by a SWAGELOK union, ferrules, and nuts. The guide tube is reduced in size from 1 inch od to 0.625 inch od at the seal table and is welded in place at the seal table surface. The end of the thimble tube passes through the end of the guide tube at the seal table.

The high pressure fitting on the thimble tube involved in this accident contained a two-piece GYROLOK ferrule assembly in a SWAGELOK fitting. Figure 6 shows a photograph of a piece of thimble tube and a typical SWAGELOK fitting. Once tightened, the unit compresses the two-piece ferrule assembly against the thimble tube forming a reactor pressure boundary seal and holding the thimble tube in place against reactor pressure within the guide tube. The lower and larger portion of the fitting forms a reactor pressure boundary seal between the guide tube and the SWAGELOK union in a similar fashion.

2. <u>Physical Arrangement of the Incore Instrument System Equipment</u>

This accident occurred inside the lower compartment of the unit 1 reactor containment building in a room called the instrument room. Figure 7A is a top view of the lower compartment of reactor containment showing the instrument room, the relative position of the seal table, personnel airlock, a submarine hatch allowing access into the containment raceway, and a door allowing access to inside the polar crane wall (a wall supporting the polar crane and providing a radiation shield from the radiation produced by the reactor during operation). Figure 7B is a view of the WBN personnel airlock door as viewed from inside the reactor building containment. Figure 8 is an elevation drawing of the reactor building and illustrates the relative position of the seal table to the top of the reactor core. The drawing depicts the location of the raceway below the instrument room.

Figure 9 is an elevation drawing that illustrates the location of the incore instrumentation system equipment in the instrument room. The portion of the system directly over the seal table is on rollers and can be disconnected and rolled back out of the way allowing overhead access to the seal table.

Figure 10 is a top view of the location of the incore instrumentation equipment in the instrumentation room. The neutron detectors can be stored in cavities in the polar crane wall for radiation shielding while personnel are working in the area.

3. <u>Access to the Instrument Room in the Reactor Building Through the Personnel Airlock at Elevation 690</u> (See figures 7A and 7B)

The personnel airlock is the primary means of entrance and egress to and from the instrument room where the seal table is located. This airlock is normally locked to prevent uncontrolled entry into the containment. Access is administratively controlled by Administrative Instruction AI-8, "Access to Containment." AI-8 establishes requirements that entry into containment will be controlled by the shift engineer with lock and key and strict personnel accountability by a public safety officer who formally tracks personnel entering and leaving containment on a "Containment Entry Checklist."

The personnel airlock is equipped with two doors that close to form a gastight seal. These two doors are interlocked with one another so that during unit operation both doors cannot be opened at the same time thus breeching containment integrity. Although infrequent, problems have been encountered with these interlocks and personnel have been prevented from exiting containment through that route because one or both doors would not open. On at least one occasion personnel have been caught in the airlock and could not get out without assistance. A telephone is provided in the airlock for communication.

4. <u>Lubrication of the Incore Detectors, Cables, and Thimble Tubes</u>

The lubricant selected for use in the portions of the system involved in this accident was a colloidal graphite alcohol mixture with a product name of "NEOLUBE." This lubricant was approved for use for this application and was selected because of its compatibility with the component constituents, its lubrication properties (described by those interviewed as not being the very best), its resistance to damage from radiation and temperature, and its low neutron activation properties. The lubricant works properly for this application only when used sparingly and properly applied. If used in excess in this environment (high radiation and temperatures), corrosion products from the system (thimble tubes and detector drive cables) mix with the lubricant and cause it to harden and lump resulting in thimble tube blockage.

5. <u>Initial Installation, Cleaning, and Lubrication of Unit 1 Thimble Tubes</u>

The thimble tubes for unit 1 were installed by TVA construction forces using Westinghouse specifications. After the thimble tubes were installed it was observed that they were significantly blocked. The reason for the blockage was not determined by the plant staff but was thought possibly to be caused by improper storage of the thimbles prior to installation causing the buildup of corrosion products or dirt on the inside of the tubes. Teleflex Corporation was contracted to clean the tubes prior to operation. Resistance was met during initial attempts to insert a cleaning cable into the thimble tubes. Copious amounts of NEOLUBE were added to the tubes by Teleflex personnel to facilitate insertion of the cleaning cable. The tubes were then brushed, backflushed, and dried using methods similar to those prescribed in Special Maintenance Instruction SMI-0-94-1 discussed in section IV.A.8 of this report.

During the performance of the "Incore Movable Detectors Preoperational Test W-11.4, Unit 1," in April 1980, blockage was encountered while attempting to insert test cables. Further cleaning efforts by the FSG was conducted along with attempts to "polish" the tubes by driving the test cables in and out of the tubes at a fast speed. When the unit 2 thimble tubes were installed they, were not blocked and no NEOLUBE was added to the tubes. Problems with thimble tube blockage on that unit have been minimal.

6. <u>Maintenance History of the Incore Instrumentation System Thimble Tubes Prior to the Accident</u>

The detailed history of prior cleaning activities was not determined by NSRS other than it was related to NSRS by plant management that they were not very successful since blockage problems continued to worsen. Prior to the shutdown for the cycle 2 outage, a maintenance request was written in December 1983 to clean all 58 thimble tubes during the outage. However, due to manpower limitations, time restrictions, and low priority only nine thimble tubes were cleaned. The personnel performing the cleaning reported that they had difficulties getting the brush and the backflush tubing to the ends of the thimble tubes due to the severe blockage and restrictions on the use of NEOLUBE in the thimble tubes.

7. <u>NUC PR Requirements Applicable for the Control of Plant Maintenance</u>

NUC PR requirements applicable for providing control over maintenance activities on CSSC equipment were delineated in Part II, Section 2.1, "Plant Maintenance," of the NUC PR Operational Quality Assurance Manual (N-OQAM). This section of the N-OQAM contained the following requirements:

- Paragraph 1.3 - Specified that maintenance on CSSC shall be properly preplanned and performed in accordance with written procedures or documented instructions appropriate to the circumstances.

- Paragraph 3.3.1.3 - Specified that the instructions shall contain requirements for verifying the quality of maintenance or repair and shall include appropriate quantitative or qualitative acceptance criteria.

- Paragraph 3.3.1.4 - Specified that upon completion of maintenance on any item of the CSSC list and before release for service, appropriate testing shall be performed to verify operational acceptability.

- Paragraph 4.4.2 - Specified that if generic problems are suspected, equipment maintenance history files should be consulted to determine the frequency, cause, and mode of previous failures. If evidence indicates that equipment of the same type has performed unsatisfactorily, corrective measures shall be planned and carried out.

8. Special Maintenance Instruction SMI-0-94-1, "RPV Bottom Mounted Instrument Thimble Tubes Cleaning," Issued July 10, 1981

The thimble tube cleaning process consisted of five steps, only three of which were discussed in SMI-0-94-1. SMI-0-94-1 established the primary administrative controls that had been used on past thimble tube cleaning operations at SQN. These steps and controls are discussed below.

a. Thimble Tube Cleaning Steps.

(1) Disconnecting the Overhead Drive Assembly (Not Discussed in SMI-0-94-1). The thimble tubes and interconnecting tubing were disconnected at the SWAGELOK union flare fittings between the high pressure fittings and the isolation valves (see figures 1 and 5). The overhead assembly was then rolled out of the way allowing access to the top of the seal table and the thimble tubes.

(2) Dry Brushing (Refer to figures 11A, 11B, 12A, and 12B). The dry brushing step involved the use of a brush assembly which consisted of a 0.200 inch od brass wire brush welded to a 0.187 inch od carbon steel helical (spiral wound) cable driven by a handcranked drivebox. The brush assembly was provided by the same vendor (Teleflex) that provided the detector drive system. The upper and lower supports for the handcrank device were fabricated by TVA. The lower support was equipped with a 90° base support that fit over a boss on a seal table providing additional stability to the support assembly as the handcrank was turned. The fit of the base support over the bosses for all the thimble tubes was not always secure. The brush assembly was used to "dry" brush each of the thimble tubes to dislodge particles and dried lubricant attached to the thimble tube wall by the scrubbing action of the brush. The brush was driven into the thimble 10 inches for each revolution of the handcrank. The brushing motion was strictly linear without any rotation of the brush.

(3) Demineralized Water Backflush. After the thimble tubes were dry brushed, pressurized water from the plant demineralized water supply system at approximately 40 psi was injected into each of the thimble tubes via a nylon fluid injection tubing (0.156 inch od) inserted into each thimble tube. It was intended that the turbulent waterflow backflushing out through the void between the inside of the thimble tube (0.201 inch id) and the

outside of the injection tubing would carry the particles dislodged by the scrubbing action of the dry brushing step out of the thimble tubes to waste. Backflushing was to continue until water leaving the tube was visually clear. The clearance between the backflush tube and the inside of the thimble tube is 0.045 inch. Note: The NUS system used to backflush the thimbles after the accident used demineralized water at approximately 200 psi.

(4) Drying of the Thimble Tubes. After the demineralized water backflush, the remaining water in each thimble tube was removed by injecting nitrogen or control air through the nylon injection tubing until there was no evidence of moisture in the nitrogen or air backflushing from the tubing.

(5) Reconnecting the Overhead Drive Assembly (Not Discussed in SMI-0-94-1). After the cleaning operation was complete, the interconnecting tubing and the thimble tubes were reconnected at the SWAGELOK union flare fitting.

b. Administrative Controls. The administrative controls for the thimble tube cleaning process as prescribed by SMI-0-94-1 are discussed below.

(1) Precautions and Warnings. SMI-0-94-1 contained cautions and warnings indicating that the cleaning equipment and the instructions were not to be used at power (reactor operating). These limitations were placed in the instruction because of contamination hazards created from the neutron activation of foreign matter in the thimble tubes. The materials removed from the thimble tubes would be extremely radioactive thus subjecting the workers to additional radioactive contamination.

With the reactor shutdown the normal radiation dose rate level in the work area (seal table) was approximately 10 millirem/hour. Since the special maintenance instruction was not to be used during power operations, no warning or cautions were included in the instruction addressing any unique radiation dose rate hazards that would be encountered due to activation of the cleaning equipment (cable and brush). The instruction did not address any special precautions or unique actions that should be taken if the thimble tubes were being cleaned at elevated reactor pressure regardless of the operating status of the reactor. The instruction did not address any special precautions that should be taken to prevent damage to the mechanical seals when disconnecting the drive system from the thimble tubes at the seal table, during the cleaning operation, or when connecting the drive system back up to the thimble tubes.

(2) Disconnection/Connection Instructions. There were no instructions provided for the disassembly and reassembly of the drive system from and to the thimble tubes at the seal table.

(3) Acceptance Criteria. The instruction contained no acceptance criteria other than section 5.2.E which stated "when all 20 thimbles are clean, as evidenced by continued clear fluid passing through the discharge base assembly, clean the remainder of the thimbles in the same manner." Note: If the backflush was ineffective in removing the loose materials in the tube the water backflushing would appear clean while the loose materials remained in the tubes.

(4) Postmaintenance Inspections. The instruction contained no postmaintenance inspections to verify that the mechanical seals had not been degraded during the cleaning activity.

(5) Postmaintenance Testing. The instruction contained no postmaintenance testing requirements of the thimble tubes to ensure operability after cleaning was performed.

In summary, the methods employed in the past cleaning operations including those during the outage had been ineffective in removing solid matter from the thimbles. This is due in part to the design of the system (minimal clearances between thimble tubes and guide tubes and low point collection of solid matter) and to the backflush method using demineralized water at 40 psig rather than at 200 psig as with the NUS method that was eventually used to adequately clean the system after the accident. The primary controlling document for the activity (S.I-0-94-1) did not promote thoroughness or prevent damage to the system as it contained only a marginally effective acceptance criteria to establish when the thimble tubes were clean, no postmaintenance testing requirements to ensure the thimble tubes were functional before reassembly and use, and no postmaintenance inspections to assure that the mechanical seals could perform their functions against full reactor pressure. The instruction contained no restrictions on the use of cleaning tools or cleaning cable other than those prohibiting the use of the tools and methods established in the instruction during power operations. Despite the historical ineffectiveness of the cleaning methods no changes had been made to the instruction (and thus the cleaning methods) since its original issuance in July 1981.

9. Plant Restart Testing Program

After a refueling outage the plant restart testing program as defined in Restart Test Instruction RTI-1, "Restart Sequence," revised April 13, 1984, required that a reactor core neutron flux map be performed prior to exceeding 30 percent reactor power. Section 3.3.3.2 of the SQN Technical Specifications required that 75 percent (44 of 58) of the detector thimble tubes must be operable (i.e., capable of passing the detector into the core) in order to perform the flux mapping.

10. Plant Responsibilities for Different Aspects Relating to the Operability of the Incore Instrumentation System

At SQN the incore detector system was operated by operators, nuclear engineers, and shift technical advisors (STAs). The system drive units were maintained by the Electrical Maintenance Section and thimble tube cleaning was performed by the FSG.

The operators of the system were aware that it would be required for the startup testing program but were not involved with the cleaning activities. Those involved with the cleaning activities were not involved with the startup program and were possibly not aware of the importance of the system to that program. There was no apparent central figure who seemed to be cognizant of the system as a whole to recognize and coordinate resolution of problems affecting the system. Efforts to clean the thimble tubes were not effectively accomplished until after the accident when it was recognized that the tubes must be cleaned and cleaned properly to continue the restart of the unit.

11. Unit 1 Operational History After the Startup From the Cycle 2 Refueling Outage

After the 56-day Cycle 2 refueling outage, initial criticality occurred on April 15, 1984. Low power physics testing commenced on April 15 in accordance with RTI-1. With the first attempts to insert the incore detectors into the reactor core for testing purposes, it was noted that the detectors could not be inserted through the required minimum number of thimbles (less than 75 percent of the thimble tubes were operable). Five of the nine thimbles cleaned during the refueling outage were still inoperable. Engineers and craft personnel from the FSG, the Reactor Engineering Unit (REU), and the Electrical Maintenance Section (EMS) performed testing and maintenance to try to determine if the blockages were unique to certain detector cables and drive units thus indicating problems with the cables and drive units, or if indeed the thimble tubes were blocked. From these testing and maintenance activities it was determined that 23 out of the 58 thimble tubes were blocked, leaving only 60 percent of the tubes operable. By 1700 April 18, the unit had reached 30 percent power and could proceed no further because of the blocked thimbles and the requirements of the restart testing program. Also, problems were being encountered with secondary water chemistry and a leaking power-operated pressurizer relief valve (PORV).

In summary, the unit 1 incore instrumentation system had been in a degraded condition since initial installation, preoperational testing, and subsequent power operations (approximately four years). The cleaning methods employed by the plant personnel as described by SMI-0-94-1 were ineffective in removing the material causing the blockage from the tubes. The cleaning instruction was of poor quality and did not meet the requirements as specified by the N-OQAM. The inadequate instruction was PORC reviewed and plant manager approved but had not been revised since the original issuance in 1981. Despite the importance of the system for the restart testing program to confirm nuclear design parameters and ascertain that the nuclear fuel was propeily loaded and oriented and periodic verification of calculated parameters, cleaning of the tubes was given a low priority during the outage. Attempts were made to clean only 9 out of 58, and only 4 of these 9 were successfully cleaned. It is apparent that assigned cognizance responsibility for the overall system operability is less than adequate or improperly executed in that no decisive action was taken to correct the program inadequacies until the degraded condition of the thimble tubes prevented the plant restart process after the refueling outage and the occurrence of the accident. The less than adequate cognizance of system operability was determined by NSRS to be due in part to the dispersion of the assigned responsibilities for operation and maintenance of the system.

For conclusions and recommendations relating to this section, refer to section III.A.1.

B. The Decisionmaking Process to Clean Thimble Tubes at Power

During the restart from the refueling outage, plant management had recognized that if a neutron flux map could not be successfully obtained, the normal restart testing and power escalation of the unit could not proceed. The Engineering Section Supervisor had discussed cleaning thimble tubes at power with a representative from the Trojan Nuclear Plant during a reactor engineers conference he had attended in the past. Thimble tubes had been cleaned (dry brushed only) at the Trojan Nuclear Plant while operating at 100 percent power. The SQN plant management had a copy of a report of that particular cleaning activity (see attachment 1). This report was a brief outline of the Trojan cleaning operation, contained some recommendations, and related the problem encountered with the high dose rates at the seal table (170 rem/hour maximum and 60 rem/hour average) when the cleaning cable and brush were withdrawn. As a cleaning operation of this nature had been performed at Trojan, SQN upper management directed the Engineering Section Supervisor to perform an industry survey to obtain further knowledge of industry experience in cleaning thimble tubes at power. Additionally, they directed him to inquire about the possibility of acquiring the services of a contractor experienced in thimble tube cleaning to come to the plant and perform the cleaning operation at power. The Engineering Section Supervisor assigned these jobs to the Reactor Engineering Unit (REU) Supervisor who in turn assigned them to two nuclear engineers in his unit. The following are the results of the surveys and inquiries:

1. <u>Industry Survey of Operating Nuclear Plants to Determine Their Experience in Cleaning Thimble Tubes at Power</u>

   During the course of the survey the following nuclear plants were contacted by a SQN nuclear engineer:

   a. <u>Trojan Nuclear Plant</u>. Thimble tubes had been cleaned (dry brushed) at 100 percent power at Trojan in 1979. The major problem encountered during the cleaning operation was the high radiation dose rates (170 rem/hour maximum; 60 rem/hour average) at the seal table when the brush and cable were being withdrawn after they had been inserted into the reactor core. Teleflex, the vendor of the incore instrumentation drive system, assisted Trojan in the brushing operation.

   b. <u>Beaver Valley Nuclear Plant</u>. Beaver Valley had cleaned (dry brushed) thimble tubes at power and did not have any problems. However the cleaning operation was not effective since only one out of six tubes that were blocked was made operable by the dry brushing operation.

   c. <u>Kewaunee Nuclear Plant</u>. Kewaunee did not clean thimbles at power because their technical specifications were not as restrictive as the SQN technical specifications on the use of the incore instrumentation system. They had never had the need arise to clean the thimble tubes at power.

d. North Anna Nuclear Plant. North Anna did not clean thimbles at power because they have a subatmospheric containment of 10 psia which restricted access to containment during power operations.

e. Ginna Nuclear Plant. Ginna had contracted Nuclear Utilities Services (NUS) to clean their thimble tubes in 1978 using a water backflush method while they were shutdown. They hadn't experienced any problems with their thimble tubes since that time.

None of the people contacted at these plants indicated any problems with thimble tube ejections.

The nuclear engineer performing this survey was told which plants to call, had not read the special maintenance instruction (SMI-0-94-1) prior to making the survey, had no experience cleaning thimble tubes, and did not interface with the FSG personnel doing the cleaning after the survey. The information received from this survey was passed on to the Engineering Section Supervisor.

NSRS consulted the INPO "Nuclear Network" for industry experience with thimble tubes. The Network contained an entry made May 3, 1983 concerning incore thimble tube blockage (see attachment 2). The entry indicated that Salem Nuclear Plant had experienced problems with thimble tube blockage over the years at the point where the thimble tubes enter the reactor vessel. To discover the source of the blockage two tubes were removed and a contract awarded to Battelle Columbus Laboratories. The entry stated that the blockages had been successfully removed at Salem with the unit at full power by probing the thimble tubes with a test cable. Salem removed the input tube from a 10-path transfer device and attached a Teleflex hand drive with a cable loaded into it. They then drove the cable to the area of the blockage and pushed it out of the way. They had found it unnecessary to drive the cable into the core region. In fact they took precautions to prevent that from happening so as not to activate the cable to ~ 100 rem/hour. They counted the revolutions of the handcrank and drove the cable to within 6 feet of the core. They then retracted the cable, rotated the 10-path to the next path and repeated the process. The method used by Salem did not subject their workers to high dose rates and did not subject the mechanical seals to any forces greater than those encountered during normal operation. The name and number for a contact at Salem for further information was given. SQN did not consult the INPO Network or talk to Salem during the survey.

The industry survey performed by the Engineering Section was limited in scope in that it did not identify any significant hazards or better methods to perform the cleaning operation and did not result in any changes to the cleaning instruction to improve the safety and efficiency of the operation. The engineer was told exactly who to call and did not use readily available information sources, had no experience in cleaning the thimble tubes, had not read the cleaning instruction prior to performing the survey, and was not responsible for performing the cleaning operation. The survey appeared to attempt to determine if the thimble tubes could be cleaned at power rather than how they could be cleaned safely.

For conclusions and recommendations relating to this section, refer to section III.B.1.

2. Inquiries of Contractors for Acquiring Services to Clean the Thimble Tubes at Power

During the course of the inquiries the following contractors were contacted by another SQN nuclear engineer:

a. Nuclear Utilities Services (NUS). NUS indicated that their method of cleaning thimble tubes (water flush) was not acceptable for cleaning at power because of temperature considerations (water would flash to steam and injection tubing would melt at 545° F). The NUS procedure did not include dry brushing thimble tubes.

b. Teleflex Corporation. Teleflex indicated that they would not dry brush the thimble tubes at power. They did indicate that they would send a representative from their company to SQN to advise and assist the plant staff during the cleaning operation if they did elect to clean at power. Plant management decided that they had people with sufficient experience in cleaning thimble tubes and thus elected not to acquire the services of the Teleflex adviser. NSRS was informed on May 7 by a representative of Teleflex that they had assisted Trojan with a dry brushing cleaning operation of thimble tubes at power and had decided after that operation not to do it at power again because of the radiation exposure received by their personnel during that operation.

3. Assessment of the Results of the Survey and Inquiries and Risks of the Job

The survey and inquiry information was relayed to the Assistant Plant Manager and on April 18 meetings were conducted to evaluate the results of the survey and to decide whether to clean the tubes or not. Those in attendance and providing input included the following:

- Assistant Plant Manager
- Engineering Section Supervisor
- Electrical Maintenance Supervisor
- Field Services Group Supervisor
- Field Services Group Maintenance Specialist

There were no health physics, safety section, or Independent Safety Engineering Group (ISEG) members present during these meetings. The ISEG organization was aware that the decisionmaking was in progress but that group was not involved.

The following is a summary listing of the pertinent information available to management at that time to support the decision to clean thimble tubes at power:

- The objective of a nuclear power plant is to produce maximum electrical power at the lowest practical cost consistent with maintaining a high degree of nuclear safety.

- The plant could not proceed past 30 percent power because 23 thimble tubes were blocked (9 out of 23 had to be cleared to meet 75 percent required by Technical Specifications).

- Trojan Nuclear Plant had cleaned thimble tubes at 100 percent power reportedly with no problems other than high radiation dose rates (170 rem/hour maximum; 60 rem/hour average).

- SQN had qualified and experienced health physics personnel along with approved radiation control procedures to assist during the cleaning operation and control radiation exposures to ALARA and below any plant limits.

- Plant management had a report from Trojan giving a brief outline of the cleaning method, the results, and containing some recommendations.

- Beaver Valley Nuclear Plant had cleaned thimble tubes at power. Even though 5 out of the 6 tubes cleaned were still blocked after the operation, they reported no problems during the cleaning itself.

- SQN had an established system of procedures hat had been reviewed by PORC.

- SQN had an established method (Standard Practice SQM2) for the control of the planning, work instruction preparation, FQE review for quality assurance criteria, performance of job safety analyses, and work authorization to ensure no Technical Specification criteria were violated (MR process).

- SQN had an established plant operational review committee (PORC) to review any required work instruction to ensure it would not endanger the health and safety of plant personnel, the general public, and safe operation of the plant. PORC would recommend approval or disapproval of the instruction to the plant manager.

- SQN had an ISEG group that routinely reviewed maintenance activities to ensure that unsafe conditions were minimized.

- The plant had a trained and experienced operations crew with approved instructions to handle off-normal situations with plant operations.

- The nature of operating reactor and associated power conversion systems creates the necessity to perform maintenance on systems and components at elevated pressures and temperatures. Maintenance on pressurized systems at temperature can be and had been performed safely with proper planning, good procedures, and trained personnel.

- The probability that a thimble tube would rupture was minimal because of the material and metal thickness.

- SQN had previously performed cleaning operations on the tubes without creating leaks or problems.

- While cleaning the tubes the steam generator water chemistry problems could be stabilized and minimized.

- They had people on the staff who had experience cleaning thimble tubes while the plant was shutdown.

The following is a summary listing of the pertinent information available to management at that time to counter the decision to clean thimble tubes at power:

- SQN cleaning operations including both dry brushing and water backflushing had been only temporarily successful in the past in alleviating the blocked tube problem. Dry brushing was not a permanent fix to the problem.

- Five out of nine tubes cleaned (dry brushed and backflushed) during the outage were still blocked.

- Beaver Valley Nuclear Plant had cleaned (dry brushed) 6 thimble tubes at power and were unsuccessful as 5 out of 6 tubes were still blocked after the operation. Details of their operation were not known.

- Dose rates during the Trojan cleaning operation were 170 rem/hour maximum and 60 rem/hour average. They could expect the same at SQN. These dose rate levels are not encountered during normal plant maintenance activities and could result in higher than normal exposures.

- The Trojan report was brief and did not provide the details of how the cleaning operation at that plant was conducted. There was no real basis to compare the SQN and Trojan operation from a safety review standpoint.

- SQN had no appropriate procedure for performing the work at power.

- Ginna Nuclear Plant had contracted NUS to clean their thimble tubes in 1978 using a water backflush method while they were shutdown and they had not experienced any problems since. This represented a permanent fix.

- NUS indicated that they would not clean thimble tubes at power as their method involved a water backflush method (would flash to steam at reactor operating temperatures of 545° F and the injection pressure of their system 200 psig).

- Teleflex Corporation indicated they would not perform the dry brushing operation at power for TVA but would send an engineer in to advise TVA personnel. Teleflex had assisted Trojan with their cleaning operation at power.

- If a leak occurred in the thimble tube during the dry brushing operation, the leak could not be isolated.

- A thimble tube had been ejected at SQN during the initial cold hydro or hot functional testing probably due to a missing ferrule in a mechanical seal.

- They did not have anyone onsite who had experience cleaning thimble tubes at power operations.

- The job involved some risks to personnel both from the radiological aspects (high dose rates from brush and cable) and from the industrial hazards (working in containment during operation on systems pressurized and at temperature in contamination zone clothing including full face mask for respiratory protection).

- The commitment to maintain the safest work environment practical for employees is inherent in all TVA plant operating philosophy.

- The job involved some risk to the safety of the plant in the event a thimble tube leak occurred.

- Unit 1 had a PORV leaking and it would eventually have to be repaired.

- Unit 1 had problems with steam generator chemistry and they could clean up the water while shutdown.

During the meetings, the results of the industry survey and contractor inquiries and the potential hazards were discussed. The discussion included the increased radiation hazards, the inability to isolate the system should a leak develop through a ruptured thimble tube, and the fact that the work would involve working on a pressurized system (2250 psig) at temperature (545° F). The probability associated with rupturing a thimble tube was considered minimal because of the material of construction (304 stainless steel) and the wall thickness of the tube. The probability that the mechanical seal would leak was not considered because the tubes had been dry brushed before without creating leaks. No one in attendance recognized or discussed the probability that a thimble tube could be ejected in the event something happened to the mechanical seal. Note: A thimble tube had been ejected at SQN during initial hydro testing or hot functional testing of unit 1. Most of the managers interviewed were aware of this event but were unsure of the causes (some thought it was due to a missing ferrule in one of the fittings of the seal table.)

The dry brushing cleaning method was recognized by plant management as only a temporary fix but the goal at this point was not to provide a permanent fix to the problem but only to clear a sufficient number of tubes to facilitate continuing the restart program.

It was considered acceptable to work on a pressurized system at temperature because there are frequent maintenance requirements to do so and it had been done safely before. The primary hazard was considered to be due to the high radiation dose rates that would be encountered at the seal table during the cleaning activity, but it was felt that the dose rates and worker doses could be controlled by assigning constant health physics coverage during the cleaning activity. Management at this point did not recognize that the procedure was inadequate to perform the work and any potential hazard associated with use of the cleaning tool in promoting failure of the mechanical seal. Management did not recognize that a failed seal could cause a thimble tube to eject. The opinion of those in the meetings was that dry brushing the thimble tubes at power was an accepted industry practice as it had been performed at power at Trojan and Beaver Valley and there were no unusual risks involved in the process other than the high radiation dose rates. With this in mind the decision to clean the thimble tubes was made by the Assistant Plant Manager and the decision was approved by the Plant Manager in the afternoon of April 18. The Plant Manager established that if the thimble tubes were not cleaned by noon on Friday, April 20 that he was going to shut the unit down over the weekend to clean the tubes and resolve the other problems they were encountering (steam generator chemistry and a leaking PORV) during the restart. The weekend was considered a desirable time for the shutdown because of the lighter system load.

In summary, plant management made the decision to clean the tubes with a false sense of security and without the realization or knowledge of the magnitude of the hazards involved. Even though the radiation dose rates were unusually high, the operation involved working on a system pressurized at 2250 psig at 545° F, and the operation was to be conducted inside the reactor containment, the health physics supervision and the plant safety section were not consulted to provide an independent hazard analysis and to get a head start on job planning.

For conclusions and recommendations relating to this section, refer to section III.B.2.

C. Assignment of Work Functions and Job Planning Prior to Beginning the Cleaning Operation

The cleaning operation was assigned and planned as follows:

1. Assignment of Work Functions

The task of dry brushing the thimble tubes was assigned to the FSG as this group had cleaned or coordinated the cleaning of the thimble tubes in the past while the units were shutdown. The assignment was made in the afternoon of April 18 after normal working hours. The FSG mechanical supervisor was notified to make assignments for the cleaning operation. This supervisor had not been involved in the decisionmaking process nor had he interfaced directly with the REU for feedback from the utility survey and contractors inquiries. He in turn assigned a mechanical engineer on the evening shift the task of planning the preparation for the cleaning operation. (For purposes of this report this individual will be referred to as the "evening shift coordinator.") The evening shift coordinator had never cleaned thimble tubes prior to this assignment. He had been involved in the maintenance and testing activities associated with the incore instrumentation system since the startup on April 15 and had interfaced with the Shift Technical Advisors (STAs) and the nuclear engineers during these activities.

The FSG mechanical supervisor notified a mechanical engineer (for purposes of this report this individual will be referred to as the "day shift coordinator") assigned to the day shift to come in to work at 0315 on April 19 to relieve the evening shift and continue the work of dry brushing the tubes. The day shift coordinator was experienced in thimble tube cleaning as he had been involved in cleaning activities during prior outages. However, his experience was limited to cleaning while the units were shutdown, cooled down, and depressurized.

Management recognized that this was a unique activity as they had identified that the operation involved working on a system at pressure and temperature in the reactor building containment with the reactor operating, if a leak developed it could not be isolated, and the job would involve unusually high dose rates. Management had taken the trouble to have an industry survey performed and had tried to get the activity performed by a contractor. Neither contractor would do the job at power. Discussions concerning the activity had been held involving engineers and plant managers. However, the job assignment was made to the FSG as if the activity was an ordinary maintenance activity in that the supervision and coordination were assigned to a supervisor and engineers who had not participated in the surveys, inquiries, and management discussions, were not aware of the unique hazards, and were normally accustomed to working on systems while the unit was shutdown, cooled down, and depressurized. The routine process to plan and execute the activity was to be used when in reality this was not a routine job. Upper plant management involvement from that time on was minimal. Additionally, a sense of urgency was established as the work was to be planned and performed in less than 48 hours. Planning and work commenced almost immediately on the evening shift, one crew was called in at 0315 for around-the-clock efforts and coordination, and workers knew that the job had to be accomplished or the unit would be shut down.

For conclusions and recommendations relating to this section, refer to section III.C.1.

2. The Maintenace Request Form (MR) for Initiating, Planning, and Controlling the Work Activity

The methodology for managing the initiation, planning, scheduling, and execution of maintenance activities at SQN is depicted in Standard Practice SQM2, "Maintenance Management System," revised April 18, 1984. The primary mechanism for control of these functions is form TVA 6436, "Maintenance Request Form," commonly referred to as the MR.

a. MR Origination. MR A-238084 was initiated by a STA on April 18 and described the work requested as "dry brush blocked thimbles listed below: See attached.** Use no water or NEOLUBE.**" The attachment had 23 thimble tubes listed. The MR was assigned to FSG for planning, scheduling, and execution of the activity. The MR was initialed by the STA's supervisor signifying that the request was needed and that sufficient information had been given to allow FSG to plan the work to be done. The STA supervisor had been involved with the recent maintenance and testing activities of the incore instrumentation system and the industry survey and contractor inquiries.

The priority of the MR was classified as requiring immediate attention indicating that the maintenance activity was to be started expediently. The "Equipment Category" was classified as CSSC by the evening shift coordinator which ensured that the MR would be directed to the plant FQE for a quality assurance (QA) review to ascertain that required QA controls were in place. (QA controls are necessary when working on CSSC to assure that the quality of the system is not degraded by the operation being performed. QA controls include proper work instructions appropriate to the work being performed, qualification of workers, acceptance criteria, postmaintenance inspections, and postmaintenance testing to ensure the system is suitable to return to service.) The MR was forwarded to the FSG evening shift coordinator.

b. MR Planning

(1) Work Instruction. The evening shift coordinator referenced SMI-0-94-1 as the work instruction to be used in the performance of this work activity because that procedure had been used in the past for cleaning activities. He recognized that the instruction stated that the cleaning equipment and the instruction was not to be used at power but thought that the restriction was placed in the instruction to prevent the use of water for backflushing because of the high temperature water

flashing problem. For this reason he added the additional instructions to the MR "dry brush only following applicable sections of SMI-0-94-1." The applicable sections of SMI-0-94-1 were not specified on the MR. A copy of SMI-0-94-1 was attached to the MR. The selection of this instruction was inappropriate as it was a poor quality instruction for the activity to be performed and contained administrative barriers stating that the instruction and the equipment (including dry brushing equipment) were not to be used during power operations (see section IV.A.8 of this report).

The QA or postmaintenance test requirements were specified as "per SMI-0-94-1." SMI-0-94-1 did not contain any postmaintenance test requirements.

When asked how SMI-0-94-1 should have been changed to make it appropriate for the dry brushing cleaning operation at power, managers and engineers interviewed responded that a temporary change to the instruction should have been issued to delete the words concerning not using the instruction or equipment at power. NSRS determined that a temporary change would not be in order as a change of that nature would be an "intent" change and would thus be disallowed by section 6.8.3 of the SQN Technical Specifications. It was apparent that those managers and engineers interviewed were not aware of what quality elements procedures should contain and the procedural change process, or were expressing a careless attitude about procedure compliance. This lack of awareness or careless attitude toward procedural compliance allowed the unique activity to be initiated with inadequate procedural controls.

For conclusions and recommendations relating to this section, refer to section III.C.2.

(2) Job Safety Analysis. The MR was routed to an FSG second shift steamfitter foreman for performance of a job safety analysis. Section B.4 of SQM2 indicated that the responsible first line foreman (or engineer) will review each job for the safety aspects. The review was to include the need for transient fire load considerations, special work permits (replaced by the radiation work permit at SQN), and the need for a hold order. Section B.4 states "The MR supplement form should be used when one or more of the MR supplement (Form 6436D, Figure 2) safety/work control considerations are

required. If any 6436D item is required, Form 6436D should be filled out, signed by the planner, and attached to the MR."

Safety/work safety control considerations on the supplement that were applicable for this work activity included the following:

- Operations Authorization
- Hold Order Clearance
- Special Work Permit (SWP)
- Health Physics Assistance
- Respiratory Protection
- Special Processes

The supplement was not filled out and attached to the MR. Supervisors, engineers, and foremen in the FSG interviewed indicated that these forms were seldom used and attached to MRs. On the MR the foreman wrote the words "perform work safely." This was the statement normally used by the foremen unless there was sowe special precaution that should be observed.

Guidance provided in Standard Practice SQM2 for performing a job safety analysis addresses only transient fire load considerations, RWPs, hold orders, and special processes. There was little or no guidance for identifying and evaluating the safety hazards (radiological, industrial, and potential impact on safe plant operation) and prescribing unique accident preventive and mitigation measures for the following:

- Working on a system at primary or secondary temperatures and pressures that cannot be isolated, cooled down, and depressurized.

- Identifying unique safety hazards (such as use of improper tools and instructions) that might promote system failures.

- Performing an evaluation of how the job may promote failures of the system or components that might endanger the safety of workers, plant, and the public.

- Work performed in a harsh environment.

- Work in containment while the reactor is at power.

- Designation and control of primary and alternate egress routes during hazardous activities.

- Communications for emergencies.

- Evaluation of work instructions versus system/component hardware to ensure that they are compatible and the instructions contain adequate precautions to prevent degrading the system or component to the point of failure.

- Prejob meetings and briefings with supervisors, engineers, foremen, and crafts to seek out ideas for unique hazard identification, expressing safety concerns, and if concerns are identified, ideas for performing the work safely.

- Involvement of the plant safety engineering group for workplace hazard identification and assessment.

- Involvement of a plant cognizant authority for related industry and plant experience pertaining to the job and the system.

- Guidance on how to openly express any responsible concerns relating to the safety aspects of the job.

- Methodology for a hazards assessment of the identified industrial and radiological aspects of the job for their impact on the workers, the plant, and the public.

In summary, the unique hazards associated with this job were not recognized or adequately addressed in the preplanning phase for the job at the plant management, engineer, first line supervisor, FQE, operator, or craft level. The thought process that went into the safety analysis was not documented on the attachment to the MR as suggested. Interviews with managers and engineers indicated that the attachments were seldom used. The foreman that performed the safety analysis had never cleaned the thimble tubes, had not read the work instruction, and his experience was primarily construction and outage working on systems when the reactor is shutdown and systems are cooled down and depressurized.

In general the job safety analysis and hazards assessment program at SQN is inadequate for identifying and evaluating an operation of this nature. Similar findings had been previously identified to SQN as causal factors of an inadvertent 10-rem extremity exposure in December 1982 (see section IV.O of this report).

Note: SQN Hazard Control Instruction (HCI) G29, "Workplace Hazard Assessment," establishes a methodology that can be used to evaluate and establish priorities to correct identified hazards. The methodology evaluates such items as proximity to hazardous condition/operation, number of employees exposed to the hazardous conditions, and the length of exposure and uses a point system (1-10) to establish a basis for determining the accident probability (highly likely, predictable, remote) and the hazard severity (catastrophic, serious, minor, negligible).

For conclusions and recommendations relating to this section, refer to section III.C.3.

c. MR Review. The MR was routed to the FQE unit for a QA review to assure the format and controls were in compliance with quality assurance requirements and that the preparation and initial planning guidelines for MRs had been consulted. Guidelines for review of MRs were specified in Appendix C of Standard Practice SQM2 and Quality Engineering Section Instruction Letter No. 5.3, "Maintenance Requests - FQE Section Review," revised January 20, 1984. SQM2, Appendix C guidelines included the following:

- Include appropriate clearance and permits [e.g., hold orders, temporary alterations, SWP (RWP), drilling and chipping permit, etc.]. Note: Hold Order 1 was normally required for any work on the detector drive system of thimble tubes to prevent exposing workers to the highly radioactive incore detectors. RWP No. 92-1-00102 was posted at the entrance to the personnel airlock. Therefore an RWP Timesheet was required to enter the lower compartment of the reactor building.

- Include appropriate controls for special processes (e.g., welding, NDE, hydro, cleaning, protective coating, etc.). Note: Appropriate controls include work instructions appropriate to the special process.

- Determine whether the work is within the skills of qualified maintenance personnel or if detailed instructions need to be included or referenced.

The MR and the attached work instruction had none of the following:

- No indication that a hold order was needed.
- No indication that a SWP (RWP) was required.
- No applicable acceptance criteria.
- No postmaintenance inspections.
- No postmaintenance testing.

Although not followed, the attached work instruction did contain cautions and warnings not to use the Teleflex supplied equipment and SMI-0-94-1 at power.

The MR was reviewed by an FQE engineering associate assigned to the evening shift, signed, and routed to the Operations Section for work authorization. The FQE review failed to identify that the MR and referenced work instruction SMI-0-94-1 (which was attached to the MR) had no indication that a hold order was required, no indication that an RWP was required, no acceptance criteria, no postmaintenance inspection and testing requirements were specified, and the equipment was not to be used at power. During an NSRS interview the FQE unit supervisor indicated that the MR and attached work instruction would probably have been approved even if reviewed by an engineer on day shift.

For conclusions and recommendations relating to this section, refer to section III.C.4.

d. Work Authorization. An assistant shift engineer on the second shift authorized the work in the evening of April 18. This authorization signified that the work would not violate technical specifications.

3. Radiation Work Permit (RWP) and Clearances (Hold Orders)

a. RWP and RWP Timesheets. The RWP is an administrative control used for radiation protection of workers and establishes requirements for entry or work in an area of known or potential radiological hazards. The RWP Timesheet is a subset to the RWP and is used to set protective clothing requirements, list specific instructions, and document personnel entry and exit date, time, and radiation exposure received for specific jobs. The work supervisor initiates the RWP Timesheet after discussion of the work to be performed with the HP representative.

b. Clearance Procedures. The clearance procedure process is the method used at SQN for the protection of workers, the public, and equipment. The shift engineer or designated assistant shift engineer (ASE) are the only persons authorized to issue a clearance. A clearance is established by the use of protective tags placed so as to indicate the main point of control and the boundary of isolation.

The hold order is a subset of the clearance procedure and is a red tag normally used as a master tag for the clearance. It is usually installed on the main control point to isolate equipment from all sources of energy and to permit work to be safely performed.

Hold Order No. 1, "Unit 1 Incore Probes," is the clearance used to assure that the highly radioactive incore detectors are stored in their storage cavities for radiation protection of personnel working in the reactor building lower compartments and the annulus (which includes the instrument room).

RWP No. 01-1-00102 was issued on January 1, 1984, for the seal table location for the job of "Inspection and Maintenance." The requirements established for entry were included in the RWP. One of the requirements stated "Verify hold order is in effect on incore probes prior to entering reactor building lower compartments and the annulus."

The FSG evening shift coordinator initiated an RWP Timesheet at 2000 on April 18 to "break loose thimble connections @ seal table, remove selector path from seal table, and dry brush blocked thimbles." The protective clothing requirements were specified on the RWP Timesheet.

The RWP Timesheets specified the following "Special Instructions:"

- Obey all instructions on the RWP

- Do not exceed 700 mrem per day

- Sign in and dress out to enter containment

- Do not enter high RAD areas (A high RAD area is an area where the radiation dose rate exceeds 100 mrem/hour.) Note: This special instruction was deleted on April 19 after high dose rates were encountered.

- HP to be present during job

- Protective requirements subject to change at the discretion of HP covering the job

- HP to instruct workers on proper placement of dosimeter, multibadging, and extremities.

c. Hold Order No. 1 Issue and Release Versus Entry and Exit to and From the Instrument Room Before the Accident. A comparison of the issue and release of Hold Order No. 1 versus entry and exit to and from the instrument room is depicted below. All times are Eastern Standard Time (EST).

- At 1910 on April 18 Hold Order No. 1 was released.
- At 2300 on April 18 five FSG evening shift personnel and an HP technician entered the instrument room.
- At 2330 on April 18 Hold Order 1 was issued to the ASE.
- At 0006 on April 19 Hold Order 1 was released.
- At 0020 on April 19 Hold Order 1 was issued to the ASE.
- At 0030 on April 19 Hold Order 1 was released.
- At 0330 on April 19 two FSG day shift employees entered the instrument room.
- At 0430 on April 19 two FSG day shift employees entered the instrument room.
- Between 0435 and 0525 on April 19 all employees exited the instrument room.
- At 0530 on April 19 Hold Order 1 was issued to the ASE.

The hold order was released while workers were in the instrument room to accomodate work being performed by FSG to free two detectors that were stuck in thimble tubes and could not be retracted using the drive units. At 2300 on April 18 and 0330 and 0430 on April 19, FSG and HP personnel entered the instrument room while Hold Order No. 1 was released and not in effect. This represents noncompliance with requirements of RWP 01-1-00102 and the respective RWP Timesheet.

For conclusions and recommendations relating to this section, refer to section III.C.5.