



UNITED STATES  
NUCLEAR REGULATORY COMMISSION

REGION II  
SAM NUNN ATLANTA FEDERAL CENTER  
61 FORSYTH STREET, SW, SUITE 23T85  
ATLANTA, GEORGIA 30303-8931

March 22, 2007

Tennessee Valley Authority  
ATTN: Mr. K. W. Singer  
Chief Nuclear Officer and  
Executive Vice President  
6A Lookout Place  
1101 Market Street  
Chattanooga, TN 37402-2801

SUBJECT: SEQUOYAH NUCLEAR PLANT - NRC SPECIAL INSPECTION REPORT  
05000327/2007007 AND 05000328/2007007

Dear Mr. Singer:

On February 9, 2007, the U.S. Nuclear Regulatory Commission (NRC) completed a Special Inspection at your Sequoyah Nuclear Plant, Units 1 and 2. The enclosed report documents the inspection results, which were discussed on February 9, 2007, with Mr. R. Douet and other members of your staff.

On November 27, 2006, manual centrifugal charging pump discharge valve to the CCP injection tank, 2-62-527, was found to require approximately 30 minutes for two operators to shut. This was significantly greater than the 13 minutes required for operation by Abnormal Operating Procedure AOP-N.08, Appendix R Fire Safe Shutdown. The 13-minute requirement was based on the maximum time that Reactor Coolant Pump (RCP) seal flow could be interrupted during fires which result in a spurious safety injection actuation. This spurious actuation would require operators to secure all charging pump flow, change manual valve configurations, and restore a charging pump to service in order to establish RCP seal cooling.

These events were evaluated by the NRC in accordance with Management Directive (MD) 8.3, "NRC Incident Investigation Program," and accordingly, the Special Inspection was initiated. This Special Inspection was chartered to inspect and assess the circumstances associated with the inability to operate time-critical manual valves and the possible impact of maintenance activities. The inspection was also chartered to examine processes for preserving the ability to operate these valves and the generic applicability of observations industry-wide. The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records, conducted field walkdowns, observed activities, and interviewed personnel. The Special Inspection charter is an Attachment to the enclosed inspection report.

On the basis of the results of this inspection, no findings of significance were identified. The results of this inspection indicate there may be potential generic safety concerns relative to maintenance activities being performed on time-critical manual valves without appropriate post-maintenance testing (valve stroking), re-evaluate plant conditions appropriate to support accurate stroke time-testing of manual valve operations, and whether Generic Issue (GI) 127,

"Maintenance and Testing of Manual Valves in Safety-Related Systems" should be revisited. Therefore, the inspectors have communicated this issue to the Nuclear Reactor Regulation (NRR) office for further review.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the Publically Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Website at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Sincerely,

**/RA/**

Charles Casto, Director  
Division of Reactor Projects

Docket Nos.: 50-327, 50-328  
License Nos.: DPR-77, DPR-79

Enclosure: Inspection Report 05000327, 328/2007007  
w/Attachments

Attachments: 1. Supplemental Information  
2. Time Line of Events  
3. Sequoyah Special Inspection Charter

cc w/encl: (See page 3)



## cc w/encls:

Ashok S. Bhatnagar  
Senior Vice President  
Nuclear Operations  
Tennessee Valley Authority  
Electronic Mail Distribution

Preston D. Swafford  
Senior Vice President  
Nuclear Support  
Tennessee Valley Authority  
Electronic Mail Distribution

Larry S. Bryant, Vice President  
Nuclear Engineering &  
Technical Services  
Tennessee Valley Authority  
Electronic Mail Distribution

Randy Douet  
Site Vice President  
Sequoyah Nuclear Plant  
Electronic Mail Distribution

General Counsel  
Tennessee Valley Authority  
Electronic Mail Distribution

John C. Fornicola, General Manager  
Nuclear Assurance  
Tennessee Valley Authority  
Electronic Mail Distribution

Glenn W. Morris, Manager  
Licensing and Industry Affairs  
Sequoyah Nuclear Plant  
Tennessee Valley Authority  
Electronic Mail Distribution

Beth A. Wetzel, Manager  
Corporate Nuclear Licensing and  
Industry Affairs  
Tennessee Valley Authority  
4X Blue Ridge  
1101 Market Street  
Chattanooga, TN 37402-2801

Robert H. Bryan, Jr., General Manager  
Licensing and Industry Affairs  
Sequoyah Nuclear Plant  
Tennessee Valley Authority  
4X Blue Ridge  
1101 Market Street  
Chattanooga, TN 37402-2801

David A. Kulisek, Plant Manager  
Sequoyah Nuclear Plant  
Tennessee Valley Authority  
Electronic Mail Distribution

Lawrence E. Nanney, Director  
TN Dept. of Environment & Conservation  
Division of Radiological Health  
Electronic Mail Distribution

County Mayor  
Hamilton County Courthouse  
Chattanooga, TN 37402-2801

Distribution w/encls: (See page 4)

TVA

4

Letter to K. W. Singer from Charles Casto dated March 22, 2007

SUBJECT: SEQUOYAH NUCLEAR PLANT - NRC SPECIAL INSPECTION REPORT  
05000327/2007007 AND 05000328/2007007

Distribution w/encls:

B. Moroney, NRR  
S. Freeman, RII  
C. Evans, RII EICS  
L. Slack, RII EICS  
OE Mail  
RIDSNRRDIRS  
PUBLIC

**U. S. NUCLEAR REGULATORY COMMISSION**

**REGION II**

Docket Nos: 50-327, 50-328

License Nos: DPR-77, DPR-79

Report No: 05000327/2007007 and 05000328/2007007

Licensee: Tennessee Valley Authority (TVA)

Facility: Sequoyah Nuclear Plant

Location: Sequoyah Access Road  
Soddy-Daisy, TN 37379

Dates: February 5 - 9, 2007

Inspectors: M. Speck, Resident Inspector (Lead Inspector)  
R. Aiello, Senior Operations Engineer  
D. Merzke, Reactor Inspector (In-Training)

Approved by: M. Widmann, Chief  
Reactor Projects Branch 6  
Division of Reactor Projects

Enclosure

## SUMMARY OF FINDINGS

IR 05000327/2007-07, 05000328/2007-07; 2/5-9/2007; Sequoyah Nuclear Plant, Units 1 & 2; Tennessee Valley Authority; Special Inspection.

This Special Inspection was conducted by a Resident Inspector and a Senior Operations Engineer from the Region II office using Inspection Procedure 93812 to investigate the potential generic issues associated with the inability to operate time-critical manual valves within required times and not maintaining operability due to preventive or corrective maintenance or similar impairments.

A. NRC-Identified and Self-Revealing Findings

None

B. Licensee-Identified Violations

None

C. Other Special Inspection Conclusions

The inspectors observations indicate potential generic safety concerns in three areas:

- The inspectors identified the lack of specific Agency guidance on how to determine timing for emergency and abnormal operating procedure actions for manual valves under appropriate plant conditions. Using vendor guidance or field experience under cold plant conditions in a table-top review of procedure stroke time-testing is not necessarily valid for conditions expected to exist if the procedure were implemented under system pressure, valve differential pressure and local environmental conditions (Section 4OA3.2).
- Maintenance activities, including minor maintenance (i.e., valve packing adjustments), may be conducted on time-critical manual valves without adequately recognizing that the resulting as-left valve stroke time may be greater than that assumed in emergency or abnormal operating procedures. Time-critical operations with little margin may no longer be achievable within the necessary times (Section 4OA3.3).
- Generic Issue (GI)-127, "Maintenance and Testing of Manual Valves in Safety-Related Systems," requires another review for potentially expanding the scope of guidance documents associated with manual valve operability. The issue was identified as a result of the NRC's investigation following the 1985 Rancho Seco overcooling event. As a result of Information Notice (IN) 86-61, which addressed aspects of this event, valves such as locked-open manual auxiliary feedwater isolation valves were included in maintenance programs. Other manual valves required to be operated during emergency or abnormal operating procedures (e.g., Appendix R fires) within short time constraints (i.e., less than 30 minutes) need to be similarly evaluated (Section 4OA.3.5).

Enclosure

## REPORT DETAILS

### Event Description

On October 28, 2005, a change to Abnormal Operating Procedure (AOP)-N.08, Appendix R Fire Safe Shutdown, was implemented. This change incorporated updated guidance provided by a Westinghouse Technical Bulletin (TB -04-022) concerning reactor coolant pump (RCP) seal performance during Appendix R fires, and a loss of all pump seal cooling. This change reduced the time available to perform manual actions and restore RCP seal flow from 24 minutes to 13 minutes. In the event of an Appendix R fire resulting in a spurious safety injection (SI) signal, plant procedures required that all RCS injection sources be stopped to prevent filling the pressurizer solid. The vendor guidance stated that actions taken to prevent this condition and restore RCP seal flow should be completed within 13 minutes to prevent seal damage. The actions outlined by AOP-N.08 required an auxiliary unit operator (AUO) to manipulate several valves in the appropriate centrifugal charging pump (CCP) room and then restart a CCP to restore seal flow. Specifically, the AUO was to open a dedicated flow path to the RCP seals using manual valve 1/2-62-526 (A-train), or 1/2-62-534 (B-train) and close the associated CCP manual discharge valve, 1/2-62-527 (A-train) or 1/2-62-533 (B-train) to the CCP injection tank (CCPIT). To support the procedure change, these manipulations were subjected to a manual action validation that consisted of a table-top review of the necessary steps. The licensee determined that the CCP manual discharge valves to the CCPIT could be closed by an individual AUO in 5 minutes and 20 seconds.

Prior to the procedure being approved, Problem Evaluation Report (PER) 91383 was written on October 24, 2005. The PER addressed concerns by at least one plant AUO that the manual actions required by the change to AOP-N.08 may not be able to be completed within the time required. PER 91383 documented the need to further evaluate the time required to perform the manual actions by actual valve manipulations, or determine if additional procedure changes were needed to provide more margin to the required time. The corrective action planned was to perform a timed valve stroke of CCP discharge valve 2-62-527 to validate procedural change assumptions. Work Order (WO) 06-771729-000 was written to implement and track this action during an appropriate CCP maintenance period. PER 91383 was closed as completed on February 24, 2006 based on the WO being written. On November 9, 2006, during a self-assessment, the licensee determined that the WO had not been completed and was not scheduled for performance until January 22, 2007. PER 114455 was written to document the incomplete corrective action. Upon review of PER 114455, the inspectors questioned the licensee on the valve's history, the status of corrective actions, and whether a valid safety concern existed if the valve could not be operated within the prescribed time. Prior to resolution by the licensee, on November 27, 2006, during Unit 2 refueling outage activities, operators closed valve 2-62-527 to support maintenance. The operators reported that the valve was very difficult to operate and required approximately 30 minutes for two AUOs to stroke it closed. This observation was documented in PER 115490 and supported the initial concern expressed in PER 91383.

This information prompted the licensee to evaluate the consequences of the additional time needed to operate valve 2-62-527 with plant Appendix R procedures. Functional Evaluation (FE) 41722 was drafted and the licensee determined that RCP seal degradation would not occur if RCP seal flow was restored with a CCP prior to completion of the Appendix R fire safe

Enclosure

shutdown manual actions. The licensee also evaluated whether the same problems were likely for other Appendix R manual valves and determined that all other valves in both units could be operated within the required time in the event of an Appendix R fire.

### Special Inspection Team Charter

Based on the criteria specified in MD 8.3, "NRC Incident Investigation Program," a special inspection was initiated in accordance with Inspection Procedure 93812, "Special Inspection." The objectives of the inspection, described in the charter, are listed below and are addressed in the identified sections:

- (1) Develop a sequence of events including applicable management decision points from the time the concern for the inability to operate Appendix R manual valves was raised through troubleshooting and repair activities. (Section 4OA3.1 and Attachment 2)
- (2) Review the extent of condition for this event for generic safety implications involving time constrained manual operator actions in emergency, abnormal and Appendix R fire/safe shutdown procedures, i.e., determine if processes or procedures assure manual action operability during post-maintenance testing. (Section 4OA3.2)
- (3) Assess operating and maintenance procedures and operations and maintenance personnel training concerning Appendix R and emergency operating procedure actions concerning manual valves and determine if operations and maintenance personnel are aware of time constraints placed on operating these valves. (Section 4OA3.3)
- (4) Assess the process for maintaining, recognizing and protecting time-critical manual actions and if such processes are defeated (i.e., through tag-outs, impairment, etc.) if compensatory measures are implemented for the manual actions. (Section 4OA3.4)
- (5) Determine if there are regulatory or licensee requirements to assure either fire or emergency operating manual actions are verified through post-maintenance testing procedures. (Section 4OA3.5)
- (6) Collect data necessary to support completing the significance determination process for the associated Sequoyah Unresolved Item (URI) and close the URI, if possible. (Section 4OA3.6)

#### 4. OTHER ACTIVITIES

##### 4OA3 Event Followup

##### .1 Sequence of Events

##### a. Inspection Scope

Inspectors reviewed licensee documents and interviewed personnel. Inspectors derived an independent timeline of events associated with manual valve 2-62-527. A timeline

Enclosure

was prepared by the licensee and provided to the inspectors. Inspectors compared the two timelines for correctness and consistency.

b. Observations

Inspectors determined that the licensee timeline was consistent with the independently derived timeline. A complete timeline is provided in Attachment 2. Inspectors determined that failing to implement the intended corrective actions for PER 91383 (perform a timed stroke of manual valve 2-62-527) was a missed opportunity to identify the problem earlier.

.2 Review the Extent of Condition for this Event for Generic Safety Implications

a. Inspection Scope

The inspectors reviewed licensee documents to assess if the licensee had previous instances where Appendix R manual valves could not be operated within procedurally-driven time constraints. The inspectors also reviewed non-Appendix R procedures that contained time-critical local actions that had to be completed in less than 30 minutes. This review included Appendix R Compliance Verifications, Self Assessment Reports, and PER Summary of Corrective Action Plans for various procedures. Additional documents were also reviewed and are listed in the supplemental information section of this report under List of Documents Reviewed. This review was performed to verify that the licensee correctly identified the time-critical manual valves listed in AOP-N.08, Emergency Operating Procedures (EOPs), and other AOPs, which were within the scope of this inspection

b. Observations

After review of licensee documentation for time-critical manual valves identified in AOPs, EOPs, and AOP-N.08, the inspectors found that the licensee adequately identified all time-critical manual valves required to be operated within 30 minutes.

The facility has relied heavily on vendor specifications for many of the valves in order to estimate operating times using table-top exercises. In those cases where actual valve operations were conducted to determine actual operating times, the operations appeared to have been done under cold plant and/or low pressure conditions and not under expected operating conditions (e.g., system pressure, valve differential pressure and local environmental conditions). The licensee did demonstrate that there was margin between actual timed stroking of CCP discharge valves while isolated for maintenance (e.g., 2 minutes 34 seconds) and the AOP assumed time of 5 minutes 20 seconds, however the licensee was unable to show any standard means of translating these operating times to times expected under different plant conditions. The inspectors recognize that there is a potential for equipment damage from cycling EOP and Appendix R valves under expected plant conditions in order to determine realistic action times. The inability of the licensee to show any standard means of obtaining exact operating times and the differences between licensee assumptions and realistic action times are unknown. Therefore, the Agency and licensees need to consider a review to

Enclosure

explore under what conditions stroke time determinations are established including if plant conditions are warranted or appropriate. This situation may be a generic concern.

.3 Assess Operating and Maintenance Procedures and Operations and Maintenance Personnel Training Concerning Appendix R and Emergency Operating Procedure Actions Concerning Manual Valves

a. Inspection Scope

The inspectors reviewed the functional evaluation for this event and conducted walkdowns of all of the procedures that contained time-critical manual valve manipulations of 30 minutes or less to determine if local valve manipulations could be completed within the procedural time constraints. Appendix R and EOP time-critical job performance measures (JPMs) were reviewed, as well as, classroom lesson plans, in particular, lesson plan OPL273C0701, AOP-C.04, Control Room Inaccessibility, Rev 0. The inspectors assessed training materials concerning Appendix R and emergency operating procedure actions with manual valves to determine if operations personnel were aware of time constraints placed on operating these valves. Nine AUOs were interviewed and the following areas were assessed:

- Knowledge of time-critical manual valve operations
- Appendix R requirements and Emergency Operating Instruction (EOI) tags
- Appendix R training
- Individual experience with Work Orders and Post Maintenance Testing (PMT)

For time critical valves, the inspectors reviewed three samples of manual valve packing work orders and three samples of packing adjustment work orders. Inspectors interviewed craft supervisors, maintenance planners, and maintenance training personnel on several topics associated with time-critical manual valves. Inspectors reviewed training materials associated with installing new packing and making packing adjustments on manual valves along with mechanical maintenance qualification standard requirements for performing these JPMs. Nine mechanical maintenance technicians were interviewed to assess their knowledge in the following areas:

- Knowledge of manual valve maintenance practices and Work Orders
- Valve maintenance PMT
- Appendix R training and EOI/Appendix R valve tagging

Inspectors reviewed industry and valve vendor guidance on valve packing and packing adjustment and compared it to licensee training, procedures, and practices.

b. Observations

Inspectors determined that the time-critical valves identified could be operated within the procedurally-driven time constraints assuming that the provided valve stroke times and/or vendor manual information were correct for the expected plant conditions. The plant conditions that existed during the inspection prevented actual valve operations for determining exact valve operating times.

Enclosure

Very few operators have had the opportunity to actively participate in drills that require operation of time-critical valves. Most AUOs are familiar with the term "Appendix R" and the meaning of EOI tags. Many AUOs stated that if a cheater bar was required to operate a valve and if excessive force was applied, the valve may need maintenance's attention.

The work orders for packing replacement all appeared to adequately describe the work to be performed and adequately documented work completed. Post-maintenance testing for all three valves consisted of the maintenance technician stroking the valve and verifying smooth stroke with no binding. Packing leakage checks were done later after the system was pressurized. The work orders for packing adjustment were all classified as "minor maintenance." The extent of the work instructions was to "clean valve and adjust packing." One of the WOs very specifically stated what maintenance was performed, another indicated the valve was "cleaned and adjusted packing," and the third did not describe whether packing was adjusted or not. All WOs required that actual work performed be documented in the WO. No post-maintenance testing was specified in any of the WOs to ensure that the manual valves could be operated within their critical times after the maintenance.

The training and qualification standard reviewed required instructor signatures verifying satisfactory performance of valve stroking following packing replacement. The JPM for packing leakage checks following adjustment could be performed, simulated, or discussed in order to complete qualification requirements but did not have specific requirements regarding proper torquing or checks for valve operability following packing adjustments. Materials for maintenance personnel continuing-training on valve packing addressed the need to periodically retorque loosened packing fasteners as a result of vibration, however, this was not effectively implemented in field practice as discussed in the following paragraph.

All the maintenance technicians interviewed were qualified and experienced in performing packing maintenance on manual valves, including the time-critical valves of concern. Experience levels varied from hundreds of such maintenance activities down to several dozen times. All stated that they were required to demonstrate proper packing replacement and packing adjustments under observation in a classroom laboratory setting. Their description of the valve repacking process was consistent with valve vendor guidance and training information provided. All had experience cycling manual valves following packing replacement as part of post-maintenance testing and their descriptions of their actions were consistent with their training. All indicated they used their "skill of the craft" to evaluate that the valve fully stroked smoothly several times, but added that these manipulations were performed while the maintenance area was isolated and not subject to system pressure. When asked to describe the packing adjustment process, there were some differences, specifically in the use of torque values on packing fasteners to prevent overtightening. Only one technician stated he used torque values as a matter of practice. One other technician stated he would use a torque wrench if he felt overtightening was a concern based on a subjective feel. The other seven stated they would not use a torque wrench. They relied on "skill of the craft" to avoid overtightening. Technicians indicated that they did not demonstrate packing adjustments on pressurized systems with actual leakage present as part of their training.

Enclosure

Both the valve vendor maintenance manual and Electric Power Research Institute (EPRI) packing performance improvement guidance state that torque wrenches should be used when adjusting valve packing. Some of the technicians stated they had only received initial training on manual valve maintenance. Most indicated they had received follow-up training and all were aware that they would be receiving follow-up training on a periodic basis. Two of three technicians were familiar with the term "Appendix R" and what it meant. Two others had heard the term and five had not. Three of the interviewees were familiar with Appendix R tags and eight of the nine were familiar with EOI tags on valves. All stated they understood that their maintenance practices could affect the ease with which a valve could be operated.

.4 Assess the Process for Maintaining, Recognizing and Protecting Time Critical Manual Actions and if Such Processes are Defeated (i.e., through Tag-outs, Impairments, etc.) if Compensatory Measures are Implemented for the Manual Actions

a. Inspection Scope

The inspectors assessed the process for maintaining, recognizing, and protecting time-critical manual actions. The inspectors also looked for opportunities when manual valve operations credited in time-critical operator actions were defeated or impaired through various means such as tag-outs and maintenance, and the processes established to assure that there was proper compensation.

b. Observations

The licensee had identified 36 time-critical manual valves within four procedures requiring operation within 30 minutes or less. Inspectors did not identify any other procedures or valves within these procedures which required operation within 30 minutes or less.

All procedures appeared to accomplish the intended actions within the time constraints. However, in one case, the procedure had very little margin in some of the actions. Specifically, in AOP-N.08, Sections 2.31 and 2.44 (Fire in a 6.9 kV Shutdown Board Room A and B respectively), the appropriate train of motor-driven auxiliary feedwater (MDAFW) header isolation valves must be throttled or closed within 20 minutes in certain instances. The turbine-driven auxiliary feedwater (TDAFW) pump is credited for maintaining AFW flow but the fire may prevent stopping one MDAFW pump. In this case, three valves must be closed within 20 minutes to prevent steam generator overfill. During time validation testing, it took an estimated 19 minutes to simulate closing these valves. This time is based on it taking 9 minutes (3 minutes per valve) to close three valves plus 10 minutes of travel time. These are fairly large valves and two of them are located in a hot environment. Therefore, there is little margin to the 20 minute time limit. However, the licensee identified some additional actions in two of the procedures (AOP-N.08 and ECA-0.0, Station Blackout) which may provide additional success paths if operators were unable to perform required actions for the specific manual valves. These were viewed by the inspectors as possible procedure enhancements.

Inspectors reviewed maintenance history and clearance tagout records on these 36 time-critical manual valves to determine if the valves were impaired during plant conditions which would require valve operation for safe shutdown in situations addressed above. During the prior three-year period, no instances outside of refueling outages were found where the valves were impaired by maintenance or were tagged in a position that prevented them from being operated. Although there were no occasions requiring compensatory measures, inspectors were not made aware of any specific licensee process to establish compensatory measures should the valves be impaired. The pre-maintenance "Work Order Walkdown Checklist" used by maintenance shop supervisors to help ensure proper preparations have been made prior to start of work did not address potential impairments to time-critical components. Subsequent to the event, but prior to this inspection, the licensee performed a self-assessment which determined there was a lack of licensee programmatic requirements for testing to assure the ability to operate components within the required times, and further determined that formal programmatic controls on time-critical operator actions were needed. Inspectors observations support this determination. Inspectors also noted that in most cases, such impairments would invoke Limiting Condition for Operation (LCO) time constraints (e.g., Emergency Core Cooling System (ECCS)).

.5 Determine if there are Regulatory or Licensee Requirements to Assure Either Fire or Emergency Operating Manual Actions are Verified through Post-maintenance Testing Procedures

a. Inspection Scope

The inspectors reviewed operating experience, generic communications, 10CFR50.65 Maintenance Rule requirements, American Society of Mechanical Engineers (ASME) in-service-testing requirements and consulted with regional and headquarters staff to determine if there are any regulatory requirements to assure either fire or emergency operating manual actions are verified through post-maintenance testing procedures. The inspectors also reviewed the licensee's maintenance planning and testing procedures to determine if their requirements ensure that credited time-critical operator manual actions are preserved following maintenance.

b. Observations

Depending upon the manual valve's function, applicable regulations to ensure that the manual valve can perform its safety function include 10 CFR 50 Appendix B Criteria III, Design Control, and Criterion XI, Testing: 10 CFR 50.65, Maintenance Rule; License Conditions, Final Safety Analysis Report commitments; the approved inservice testing program; the Fire Protection Plan and fire protection quality assurance program.

Based on a review of generic communications, the Maintenance Rule and In-Service Testing regulatory requirements, the inspectors could not find specific regulatory requirements which assure time-critical manual actions are verified through post-maintenance testing procedures. ASME Code for Operation and Maintenance of Nuclear Power Plants, Subsection ISTC 3310 [3.4] requires that, upon performing

maintenance in a manner that could affect its performance, the licensee shall, before returning the valve to service, test it to demonstrate that the performance parameters are within acceptable limits. Adjusting stem packing is an example of maintenance that could affect performance. However, the Appendix R valves identified by the licensee which require time-critical operator manual action are not required to be placed in the IST program because these valves are not required to shut down the reactor, maintain the reactor in a safe shutdown condition, nor mitigate the consequences of an accident. The valves are scoped within the licensee's Maintenance Rule procedures at a system level. However, the inability to operate these valves within the time-constraints did not prevent the system from performing its intended safety function (i.e., provide emergency core cooling flow and RCP seal water flow).

The inspectors reviewed GI-127, "Maintenance and Testing of Manual Valves in Safety-Related Systems." At the time GI-127 was issued, it was the NRC staff's recommendation that "due to the low costs associated with maintaining the manual isolation valves, it would appear to be cost effective for plant operators to maintain them as a good practice and not require a regulatory requirement." Additionally, in order to close out Generic Issue B-17, "Criteria for Safety-Related Operator Actions," and Generic Issue 27, "Manual Versus Automatic Actions," it was the staff's position that regulatory actions implemented since 1979 provided adequate grounds to close out these generic issues. These regulatory actions included: enhanced operator training and licensing requirements, improved training based on the Systems Approach to Training, establishment of minimum plant staffing levels, and use of symptom-based emergency operating procedures. In response to Information Notice 86-61, which addressed maintenance programs for manual valves, the licensee added auxiliary feedwater manual isolations to their maintenance program, similar to those which were found to be inoperable in the Rancho Seco overcooling event which generated GI-127. The licensee did not make any additions to scheduled maintenance for other EOP or fire safe-shutdown time-critical manual valves. This limited scoping may also exist at other licensed facilities.

Inspectors reviewed licensee procedures for work order processing, screening for minor work, and post-maintenance testing. Licensee Procedure SPP-6.1, Work Order Process Initiation, defined minor maintenance and used a checklist with criteria that must be satisfied for work to be classified as such. The checklist included a determination that a detailed post-maintenance testing sequence was not necessary and also used valve packing adjustment as a specific example of minor maintenance. It appeared that packing adjustments were routinely screened as minor maintenance without recognizing that packing adjustments may change the time required for manual valve manipulations, thereby invalidating AOP/EOP procedure assumptions. Procedure SPP-6.3, Pre-/Post-Maintenance Testing, stated as one of its purposes, to assure that "a new or related deficiency has not been created by the maintenance activity," but also excluded its applicability to minor maintenance work orders. A review of a companion Procedure, 0-TI-PMT-000-000.0, Pre-Post Maintenance Testing Matrices, did have post-maintenance testing guidance (valve stroking) following packing adjustment on manual valves within the ASME Section XI program, however Appendix R manual valves did not fall under this requirement. Inspectors noted that the valve vendor maintenance manual

included a recommendation to cycle the valve for approximately the length of the packing chamber following packing adjustment. It appeared that the licensee did not incorporate this guidance into their valve maintenance.

- .6 Collect data necessary to support completing the significance determination process for the associated Sequoyah URI (05000328/2006005-02, Appendix R Manual Isolation Valve Failure to Close Within the Required Time) and close the URI, if possible

Based on regional management direction provided during the course of the inspection, inspectors will use the information gathered and will disposition the referenced URI in a resident inspector integrated inspection report.

4OA6 Meetings, Including Exit

On February 9, 2007, the lead inspector presented the inspection results to Mr. R. Douet, and other members of the licensee staff who acknowledged the findings. The inspectors did not review proprietary information during the inspection.

## SUPPLEMENTAL INFORMATION

### KEY POINTS OF CONTACT

#### Licensee

D. Baughman, Lead Mechanical Instructor  
P. Bookout, Mechanical Maintenance  
G. Buchanan, Engineering Program Manager  
K. Clayton, Maintenance Manager  
N. Cooper, Auxiliary Unit Operator  
R. Douet, Site Vice President  
D. Fine, Mechanical Maintenance  
D. Freeman, Mechanical Maintenance  
S. Fulghum, Maintenance Shop A Foreman  
R. Gladney, Systems Engineering Manager  
D. Headrick, Mechanical Maintenance  
E. Hixson, Mechanical Maintenance  
R. Johnson, Mechanical Maintenance  
C. Kier, Auxiliary Unit Operator  
D. Kulisek, Plant Manager  
A. Martin, Mechanical Maintenance  
A. McPherson, Mechanical Maintenance  
R. Mellon, Auxiliary Unit Operator  
R. Miller, Auxiliary Unit Operator  
G. Morris, Site Licensing Manager  
T. Niessan, Site Quality Manager  
K. Parker, Maintenance and Modifications Manager  
K. Perkins, Assistant Operations Manager  
D. Porter, Operations Department  
R. Proffitt, Licensing Supervisor  
W. Roberts, Mechanical Maintenance Planning Technical Engineer  
S. Russell, Auxiliary Unit Operator  
J. Seibel, Auxiliary Unit Operator  
D. Smith, Auxiliary Unit Operator  
R. Taylor, Auxiliary Unit Operator  
N. Thomas, Site Licensing  
R. Walker, Auxiliary Unit Operator  
T. Wallace, Training Manager  
W. Young, Mechanical Maintenance

#### NRC

S. Alexander, NRR, Reactor Engineer  
M. Freeman, DRP  
L. Lake, RII, DRS  
L. Mellen, RII, DRP  
M. Scott, RII, DRS  
M. Thomas, RII, DRS  
S. Unikewicz, NRR, Sr. Mechanical Engineer

## LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

### Opened

None

### Opened and Closed

None

### Discussed

URI 05000328/2006005-02, Appendix R Manual Isolation Valve Failure to Close Within the Required Time (Section 4OA3.5)

## LIST OF DOCUMENTS REVIEWED

### Drawings

1,2-47W803-2, Flow Diagram - Auxiliary Feedwater, Revision 61  
2-47W809-1, Flow Diagram - Chemical and Volume Control System, Revision 69  
2-47W811-1, Flow Diagram - Safety Injection System, Revision 57

### Procedures

0-PI-OPS-000-708.0, 10CFR50 Appendix R Compliance Verification, Revision 8  
0-SI-DXI-000-114.3, ASME Section XI ISI/NDE Program Unit 1 and Unit 2, Revision 1  
0-TI-PMT-000-000.0, Pre-Post Maintenance Testing Matrices, Revision 19  
10CFR50.65, Revision 19  
AOP-C.04, Shutdown From Auxiliary Control Room, Revision 13  
AOP-N.08, Appendix R Fire Safe Shutdown, Revision 7  
EA-32-3, Isolating Non-Essential Air to Containment, Revision 3  
ECA-0.0, Loss of All AC Power, Revision 21  
EPM-7-1, EOI Administrative Controls, Revision 8  
GOI-6, Apparatus Operations, Sections A and I, Revision 118  
MMDP-1, Maintenance Management System, Revision 10  
NADP-3, Managing the Operating Experience Program, Revision 7  
SPP-3.1, Corrective Action Program, Revision 11  
SPP-6.1, Work Order Process Initiation, Revision 4  
SPP-6.3, Pre-/Post-Maintenance Testing, Revision 2  
SPP-8.1, Conduct of Testing, Revision 4  
SPP-9.3, Plant Modifications and Engineering Change Control, Revision 13  
TI-4, Maintenance Rule Performance Indicator Monitoring, Trending, and Reporting, Revision 19

Design Changes

DCN P-21942, Changes to Fire Hazards Analysis Calculation and Fire Safe Shutdown Analysis Calculation, Revision A

Work Orders (WOs)

WO 03-013784-000, Repack Valve 2-62-537  
WO 03-013787-000, Repack Valve 2-62-539  
WO 03-014819-000, Clean Valve 2-62-527 and Adjust Packing as Necessary  
WO 04-778629-000, Clean Valve 2-62-527 and Adjust Packing as Necessary  
WO 05-780612-000, Clean Valve 2-62-539 and Adjust Packing as Necessary  
WO 06-77129-000, Perform Timed Valve Stroke of Valve 2-62-527  
WO 06-780458-000, Repack Valve 2-62-527

Problem Evaluation Reports (PER)

PER 91383, AUO Performing Valve Operating Time Validation Questioned Ability to Complete Actions in Time  
PER 114455, PER 91383 closed to WO 06-77129-000 still unresolved

Vendor Manual

SQN-VTD-085-0050, Maintenance Manual VEL-FBBM for 2-1/2" to 24" Forged Bolted Bonnet Gate and Globe Valves and Bolted Cover Check Valves, Revision 7

Other Documents

Clearance Tagout 2-TO-2006-0015  
Clearance Tagout 1-TO-2006-0014  
Functional Evaluation 41722, Effect of the Inability to Shut 2-62-527 Within Time Constraints on RCP Seal Flow  
GI 27, Criteria for Safety-Related Operator Actions  
GI 127, Maintenance and Testing of Manual Valves in Safety-Related Systems  
GI B-17, Manual vs. Automated Actions  
IN 86-61, Failure of Auxiliary Feedwater Manual Isolation Valve  
IN 97-78, Crediting of Operator Actions in Place of Automatic Actions and Modifications of Operator Actions, Including Response Times  
Licensee Snapshot Self-Assessment Report 07-SQN-27-OPS-FP, Time Critical Local Operator Actions, approved February 2, 2007  
MME010L002, Maintenance Initial Training - Valve Maintenance Lab, Revision 3  
MMQ018.006, Mechanical Maintenance OJT Qualification Standard, Revision 1  
MTM255.060, Maintenance Continuing Training - Valve Packing Retraining, Revision 0  
NUREG 1482, Guidelines for Inservice Testing at Nuclear Power Plants  
RIS 2006-10, Regulatory Expectations with Appendix R Paragraph III.G.2 Operator Manual Actions  
TVA Memorandum dated December 21, 1987, Nuclear Experience Review - IE Notice 86-61,

Failure of Auxiliary Feedwater Manual Isolation Valve  
 Westinghouse Technical Bulletin TB-04-22, Reactor Coolant Pump Seal Performance -  
 Appendix R Compliance and Loss of All Seal Cooling, Revision 1

### LIST OF ACRONYMS

ADAMS	Agencywide Documents Access and Management System
AOP	Abnormal Operating Procedure
ASME	American Society of Mechanical Engineers
AUO	Auxiliary Unit Operator
CCP	Centrifugal Charging Pump
CCPIT	Centrifugal Charging Pump Injection Tank
CFR	Code of Federal Regulations
ECCS	Emergency Core Cooling System
EOI	Emergency Operating Instruction
EOP	Emergency Operating Procedure
EPRI	Electric Power Research Institute
FE	Functional Evaluation
GI	Generic Issue
IN	Information Notice
IST	In-Service Testing
JPM	Job Performance Measure
LOCA	Loss of Coolant Accident
MCR	Main Control Room
MD	Management Directive
MDAFW	Motor-driven Auxiliary Feedwater
MR	Maintenance Rule
NRC	Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation
PARS	Publically Available Records
PER	Problem Evaluation Report
PMT	Post Maintenance Testing
PORV	Power Operated Relief Valve
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
SI	Safety Injection
TDAFW	Turbine-driven Auxiliary Feedwater
TS	Technical Specification
TVA	Tennessee Valley Authority
URI	unresolved item
WO	Work Order

## TIME LINE OF EVENTS

Early 2002	<p>Original validation performed on Procedure AOP-N.08 Rev. 0 as a part of an Appendix R upgrade project. At that time, the time limit specified in Fire Hazards Analysis for CCPIT isolation was 24 minutes. Manual actions for isolation of CCPIT were contained in Procedure AOP-N.08 App. Y.</p> <p>Walkthrough validation on closing CCP discharge valves assumed a time of 5 minutes 20 seconds to operate valves based upon vendor data and discussion with operators.</p>
2003	Valve 2-62-527 cleaned and packing adjusted due to borated water leak.
2004	Valve 2-62-527 cleaned and packing adjusted due to borated water leak.
July 2005	Engineering determined that the time limit for CCPIT isolation needed to be reduced from 24 minutes to 13 minutes as a result of seal cooling considerations. This change was incorporated in a proposed change to the Fire Hazards Analysis. Operations incorporated this change into a draft revision to AOP-N.08 (Rev. 7). This revision split Appendix Y into separate appendices (D.1 and D.2) which are assigned to separate operators.
07/26/2005	Operations performed a walkthrough validation on Appendix D.2 (Local Isolation of CCPIT). Documented event time for closure of CCP discharge valve was 12 minutes using the same 5 minutes 20 second valve operating assumption as before.
08/17/2005	Licensee received Westinghouse Technical Bulletin TB-04-22, Revision 1, "Reactor Coolant Pump Seal Performance - Appendix R Compliance and Loss of All Seal Cooling," which required reducing seal cooling restoration within 13 minutes.
10/24/2005	DCN E21314 (P21942) was issued which revised the required time in Fire Hazards Analysis from 24 minutes to 13 minutes.
10/24/2005	<p>PER 91383 was written documenting an AUO concern. Description of condition:</p> <p>"AOP-N.08, Appendix R Fire Safe Shutdown, requires locally isolating the CCPIT flowpath by realigning manual valves in the CCP Rooms for certain fire areas where a spurious SI signal may occur. Revision 7 to this procedure reduces the allowable time for this action to 13 minutes (from 24 minutes) based upon changes to the Fire Hazards Analysis. In-plant walkthrough validations were performed which indicated that this action could be performed within 13 minutes;</p>

	<p>however, these validation walkthroughs showed very little margin from the required time AND were dependent on assumed times for manipulating manual valves on the CCP discharge (rather than actual valve manipulations in the CCP room). At least one AUO performing the validation questioned the ability to complete the action within 13 minutes. Need to evaluate whether additional validation is needed (involving actual manipulation of CCP discharge valves) or whether additional procedure changes are needed to provide more margin to the allowed time (such as immediately dispatching an AUO in an SCBA to the CCP rooms if a fire is reported in one of the affected areas).”</p>
10/28/2005	AOP-N.08 Revision 7 issued which revised the required time for closing CCPIT valves from 24 minutes to 13 minutes.
11/17/2005	Corrective action plan written for PER 91383 by Ops Procedures personnel. Action was to request a timed stroke of Centrifugal Charging Pump Valve 2-62-527 during a suitable equipment maintenance window.
02/24/2006	<p>WO 06-771729-000 written to stroke Valve 2-62-527 and to track completion of this activity. Associated PER action was closed to the work order.</p> <p>Original scheduled date of work order performance was 6/25/2006.</p>
Date uncertain	WO 06-771729-000 (to stroke 2-62-527) rescheduled to 1/22/2007.
11/9/2006	Snapshot self-assessment was performed on Appendix R manual actions which included review of related PERs. The failure to resolve the concern raised in previous PER 91383 was identified.
11/9/2006	<p>New PER 114455 was written regarding failure to resolve concern regarding closure of CCP discharge valve. Description of condition:</p> <p>“PER 91383 documented a concern raised by an AUO on 10/24/2005 regarding the ability to locally isolate the CCPIT flowpath within 13 minutes as required by the Appendix R safe shutdown analysis. The local action to isolate the CCPIT requires manipulating valves on the CCP discharge. Previous walkthrough validations have assumed a conservative time for manipulating a manual valve without any objective evidence on how long it takes to reposition the subject valves. The corrective action for this PER requires performing an actual timed validation of this manual action (including manipulation of the CCP discharge valve) in conjunction with a CCP outage. The intent was to write a one-time-only procedure change to support this activity. WO 06-771729-000 was written to facilitate scheduling this action, and the PER was closed to this WO. However, this WO has been rescheduled to 1/22/2007. This is an unacceptably long time period to resolve this concern.”</p>

11/13/2006	Inspectors, upon reviewing PER 114455, began engaging the licensee on the valve's history, status of corrective action, and whether a valid safety concern existed if the valve could not be operated within the required time.
11/27/2006	Unit 2 enters Refueling Outage Cycle 14
11/27/2006	<p>2-62-527 (CCP 2A-A discharge valve) was tagged closed for outage clearance 2-62-2499-RFO. The AUOs who closed the valve noted that it was extremely difficult to turn and initiated new WO 06-780458-000 was written.</p> <p>When the AUO initiated the new electronic Work Order, he noted the earlier WO (06-771729-000) and sent an e-mail to the WO initiator (Ops Procedure Writer).</p>
11/28/2006	<p>PER 115490 written by Ops Procedure Writer. Description of condition:</p> <p>"SQN's Appendix R safe shutdown analysis requires ONE operator to manually close one CCP discharge valve within 13 minutes following a severe fire (from when AOP-N.08 is entered). However, on 11/27/2006, 2-62-527 (CCP 2A-A discharge valve) was tagged closed for clearance 2-62-2499-RFO. The AUOs who placed the clearance reported that it took TWO operators approximately 30 MINUTES to close this valve, which included use of two cheater wrenches. The valve was extremely difficult to turn. New WO 06-780458 was written".</p>
12/5/2006	Valve 2-62-527 was repacked per WO 06-780458-000. Post-maintenance testing consisted of "stroke valve and verify smooth stroke and no binding". Stroking is performed while the valve is isolated for maintenance.
12/6/2006	Licensee implemented a roving fire watch as a "prudent licensee action" on Unit 1 (operating unit) in predetermined areas where a fire could start which may initiate a spurious safety injection actuation.
12/8/2006	Post-maintenance stroke timing of valve 2-62-527 performed. Required time to shut the valve was 2 minutes, 34 seconds. Valve operation performed under cold plant conditions.
12/9/2006	Licensee performed visual inspections of similar time-critical charging pump manual valves on Unit 1 and reviewed valve maintenance history and verified valves have been cycled subsequent to maintenance. Based on inspection, engineering review and operator interviews, licensee concluded that no compelling evidence had been identified to suggest that the valves on Unit 1 could not be closed within the required time limit. Roving fire watch on Unit 1 is ended. Additionally, the licensee verified that time-critical Appendix R manual valves on Unit 2 can all be operated within required times.

12/18/2006	Functional Evaluation 41722 completed and reviewed. Evaluation concluded that the inability to shut 2-62-527 for greater than 30 minutes would not have resulted in a condition which would have prevented the plant from being maintained in a hot-shutdown or from transitioning to cold-shutdown (i.e., restarting a charging pump within 13 minutes with valve 2-62-527 still open would still result in adequate seal flow to preclude seal failure)..
12/22/2006	Caution order placed on 8 time-critical valves. "This valve is required to operate for time-critical manual actions in AOP-N.08. Do not adjust packing or perform other maintenance without evaluating/verifying ability to meet applicable time limit".
12/24/2006	Post-maintenance testing completed on valve 2-62-527 "with system in service, ensure no leakage at packing area". Unit 2 restarted and achieved criticality.

## **SPECIAL INSPECTION CHARTER TO EVALUATE OPERATIONS AND MAINTENANCE ON TIME CRITICAL MANUAL VALVES AT SEQUOYAH**

### **A. Basis**

On November 27, 2006, the licensee shut Valve 2-62-527 as part of a clearance activity to support Unit 2 outage maintenance and found the valve very difficult to operate (i.e. required two operators approximately 30 minutes to close). Closing this valve is one of several manual operator actions required by Procedure AOP-N.08 to be completed in less than 13 minutes in order to restore Reactor Coolant Pump (RCP) seal flow and prevent RCP seal failure. Review of corrective action documents indicate that operators raised questions as to the ability to perform these actions as early as October 24, 2005.

In accordance with Management Directive 8.3, "NRC Incident Investigation Program," deterministic and conditional risk criteria were used to evaluate the level of NRC response for this operational event. Based on the deterministic criteria that involved possible adverse generic implications combined with the event characteristics that are beyond the scope and capability of the risk assessment for this degraded condition, Region II determined that the appropriate level of NRC response was the conduct of a Special Inspection.

This Special Inspection is chartered to identify the circumstances surrounding this event and review the licensee's actions following discovery of the conditions. In addition, the inspectors will review this event for generic aspects regarding time-critical operator actions being impacted by maintenance activities.

### **B. Scope**

The inspection is expected to perform data gathering and fact-finding in order to address the following:

1. Develop a sequence of events including applicable management decision points from the time the concern for the inability to operate Appendix R manual valves was raised through troubleshooting and repair activities.
2. Review the extent of condition for this event for generic safety implications involving time constrained manual operator actions in emergency, abnormal and Appendix R fire/safe shutdown procedures, i.e., determine if processes or procedures assure manual action operability during post-maintenance testing.
3. Assess operating and maintenance procedures and operations and maintenance personnel training concerning Appendix R or emergency operating procedures manual actions manual valves and determine if operations and maintenance personnel are made aware of time constraints placed on operating these valves.
4. Assess the process for maintaining, recognizing and protecting time-critical manual actions and if such processes are defeated (i.e., through tag-outs, impairment, etc.) if compensatory measures are implemented for the manual actions.

5. Determine if there are regulatory or licensee requirements to assure either fire or emergency operating manual actions are verified through post-maintenance testing procedures.
6. Collect data necessary to support completing the significance determination process for the associated Sequoyah URI and close the URI, if possible.

C. Guidance

Inspection Procedure 93812, "Special Inspection," provides additional guidance to be used during the conduct of the Special Inspection. Your duties will be as described in Inspection Procedure 93812. The inspection should emphasize fact-finding in its review of the circumstances surrounding the event. Safety or security concerns identified that are not directly related to the event should be reported to the Region II office for appropriate action.

You will report to the site, conduct an entrance, and begin inspection no later than February 5, 2007. It is anticipated that the on-site portion of the inspection will be completed during the week of February 5, 2007. A status briefing of Region II management will be provided the first day on-site at 4:00 p.m. A report documenting the results of the inspection should be issued within 45 days of the completion of the inspection.