ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-445/95-19
50-446/95-19

Licenses: NPF-87
NPF-89

Licensee: TU Electric
Energy Plaza
1601 Bryan Street, 12th Floor
Dallas, Texas

Facility Name: Comanche Peak Steam Electric Station, Units 1 and 2

Inspection At: Glen Rose, Texas

Inspection Conducted: August 21-25 and September 5-8, 1995

Inspectors: M. F. Runyan, Reactor Inspector, Engineering Branch
Division of Reactor Safety

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Division of Reactor Safety

Approved: _____ 10-4-95
C. A. VanDenburgh, Chief, Engineering Branch Date
Division of Reactor Safety

Inspection Summary

Areas Inspected (Units 1 and 2): Special, announced inspection of activities related to completion of the licensee's commitments to Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance."

Results (Units 1 and 2):

Engineering

- The inspectors determined that the licensee had satisfactorily demonstrated the design basis capability of each of its Generic Letter 89-10 valves (Section 1.1).

- The licensee's motor-operated valve program was recognized for being exceptional in scope and precision. The program had identified and accounted for several effects that were not previously recognized in the industry. The technical expertise of the licensee's motor-operated valve staff was well above average (Section 1).

- The licensee's motor-operated valve program did not include an explicit margin to account for valve degradation. The licensee had decided not to establish degradation margins because of the conservative manner in which valve factors were determined. However, the inspectors recognized that valve factors used for some valves were very close to the individual test values. In response to the inspectors' concern, the licensee calculated operating margins for each valve in the Generic Letter 89-10 program. The operating margins of 21 Generic Letter 89-10 valves were shown by this effort to be less than 5 percent. However, the licensee was able to demonstrate margins in excess of 5 percent for these valves by removing conservatisms in the calculations (Section 1.1).

- The licensee had acceptably addressed technical issues related to hot shorting of motor-operated valve circuits in the control room cabinets (Section 1.2).

- The licensee program to address pressure locking was deficient, in that calculations performed in 1990 to demonstrate the motor-operated valve's capability did not reflect current Generic Letter 89-10 methodologies and were potentially non-conservative. Revised calculations performed at the inspectors' request resolved the immediate operability concerns for the valves which were most sensitive to pressure locking. Additional matters will be folded into the licensee's response to Generic Letter 95-07 (Section 1.3).

- The licensee's self-assessment of the motor-operated valve program was acceptable for program closure (Section 1.8).

Summary of Inspection Findings:

- Inspection Followup Item 445/9310-01; 446/9310-01 was closed (Section 1.8.1).

- Violation 445/9310-02; 446/9310-02 was closed (Section 1.8.2).

- Inspection Followup Item 445/9310-03; 446/9310-03 was closed (Section 1.8.3).

- Violation 445/9310-04; 446/9310-04 was closed (Section 1.8.4).

- Inspection Followup Item 445/9310-05; 446/9310-05 was closed (Section 1.8.5).

- Inspection Followup Item 445/9310-06; 446/9310-06 was closed (Section 1.8.6).

- Inspection Followup Item 445/9310-07; 446/9310-07 was closed (Section 1.8.7).

- Inspection Followup Item 445/9310-08; 446/9310-08 was closed (Section 1.8.8).

- Inspection Followup Item 445/9310-09; 446/9310-09 was closed (Section 1.8.9).

Attachment:

- Attachment - Persons Contacted and Exit Meeting

DETAILS

1 GENERIC LETTER 89-10, "SAFETY-RELATED MOTOR-OPERATED VALVE TESTING AND SURVEILLANCE" (2515/109)

On June 28, 1989, the NRC issued Generic Letter 89-10, which requested licensees and construction permit holders to establish a program to ensure that switch settings for safety-related motor-operated valves were selected, set, and maintained properly. Subsequently, six supplements to the generic letter have been issued and one additional supplement has been issued for public comment. NRC inspections of licensee actions implementing commitments to Generic Letter 89-10 and its supplements have been conducted based on guidance provided in Temporary Instruction 2515/109, "Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance," Revision 1. Temporary Instruction 2515/109 was divided into two parts: Part 1, "Program Review"; and, Part 2, "Verification of Program Implementation." The Temporary Instruction 2515/109, Part 1, program review inspection at Comanche Peak Steam Electric Station, Units 1 and 2 (Comanche Peak) was documented in NRC Inspection Report 50-445/91-51; 50-446/91-51. The Temporary Instruction 2515/109, Part 2, implementation review inspection at Comanche Peak was documented in NRC Inspection Report 50-445/93-10; 50-446/93-10.

The purpose of this inspection was to verify completion of the licensee's commitments to Generic Letter 89-10. The NRC has established a closure process for inspections under Generic Letter 89-10. This was documented in a memorandum dated July 12, 1994, entitled, "Guidance on Closure of Staff Review of Generic Letter 89-10 Programs," and was addressed to the NRC regional Division of Reactor Safety Directors from Mr. B. Sheron of the Office of Nuclear Reactor Regulation staff in NRC headquarters. The guidance contained in this document was used during this inspection. The process of "closing" a licensee's Generic Letter 89-10 program can be best defined as verification that the licensee has satisfactorily applied the principles contained in Generic Letter 89-10 (or suitable alternate methods) to demonstrate the design basis capability of each motor-operated valve in the program. The closure process does not preclude additional inspections in this area. Additionally, there remains an expectation that the assumptions and methodologies used to develop the Generic Letter 89-10 program will be maintained for the life of the plant, a concept commonly described as a "living program." The closure process does not convey final NRC acceptance of a licensee's approach to the areas of periodic verification or pressure locking and thermal binding. These areas, to be reviewed under new generic letters, were reviewed on only an interim basis for closure under Generic Letter 89-10.

All issues necessary for NRC closure of the Comanche Peak Generic Letter 89-10 motor-operated valve program were resolved during this inspection. No additional information was needed to complete the review process.

The inspectors identified the Comanche Peak Generic Letter 89-10 program as being exceptional. The engineers assigned to the program demonstrated a very high level of expertise. The program was extremely precise in defining, measuring, and accounting for motor-operated valve performance characteristics. Several previously unknown valve performance characteristics were discovered by the licensee and applied to the program. Two of these, the stem thrust effect and pressure dependency of pullout thrust requirements, are discussed in Section 1.1 of this report. By applying a proactive, objective, and comprehensive approach to resolving motor-operated valve concerns, the licensee earned a position as an industry leader in this area.

1.1 Summary Status of Generic Letter 89-10 Motor-Operated Valves

The inspectors reviewed diagnostic test results and data analyses used by the licensee to demonstrate the design basis capability of the motor-operated valves in their Generic Letter 89-10 program. There were a total of 242 motor-operated valves in the licensee's Generic Letter 89-10 program, including 136 gate, 46 globe, 52 butterfly, 4 diaphragm, and 4 plug valves. The licensee had tested 175 valves under differential pressure conditions using diagnostic equipment. The high percentage of valves tested under differential pressure conditions was partly attributable to Unit 2 being under construction during the initial phases of the program. Comanche Peak used this opportunity to test many valves which otherwise could not have been tested.

The inspectors noted that the licensee's motor-operated valve program did not include an explicit margin to account for valve degradation. Over time, mechanical interactions occurring among the valve disc, guides, and seating surfaces would potentially increase the thrust required to operate the valve in a dynamic environment. Analytically, this would be modeled as an increase in the valve factor. Although little industry test data presently exists to quantify this effect, some licensees have applied an interim margin in their motor-operated valve acceptance criteria until such time that test data becomes available to establish actual degradation rates. Comanche Peak decided to not take this approach primarily because of the conservative manner in which their valve factors were determined.

For the purposes of determining an appropriate valve factor for each valve in the program, the licensee defined 16 groups containing 136 gate valves, 4 groups containing 46 globe valves, 1 group containing 4 diaphragm valves, 6 groups containing 52 butterfly valves, and 1 group containing 4 plug valves. Test data from each group was statistically analyzed and a group valve factor was determined using either the mean valve factor increased by two standard deviations or the highest measured valve factor in the group, whichever was higher. This valve factor was then applied to the design calculations for every valve in the group, no matter how small the measured valve factor may have been for any individual valve. The licensee maintained that this "bounding" valve factor was sufficiently conservative to account for expected changes over time. The inspectors stated that, though most valves had considerable margins, certain "outlier" valves, such as those that had valve

factors in excess of the mean plus two standard deviations, could be set up in such a manner that would give them no allowance for any increase in valve factor. In response to the inspectors' concern, the licensee evaluated the existing margin for each valve in the program in both the opening and closing directions. Prior to this effort, the licensee and the inspectors agreed as to how these margins should be calculated. The result of the margin calculations revealed that 21 Generic Letter 89-10 valves had operating margins less than 5 percent. The inspectors' selection of 5 percent margin in this analysis was based on an engineering judgement that this amount of margin should be sufficient to accommodate short-term degradation that may occur before industry and site-specific testing better quantifies this effect. Of the 21 marginal valves, 18 were torque-closed valves where the thrust at torque switch trip was less that 5 percent greater than the calculated thrust required to overcome maximum differential pressure conditions. The remaining 3 valves were marginal in the opening direction, having calculated torque capability less than 5 percent greater than the estimated torque required to pull the valve disc out of the seat under design conditions.

The licensee revisited the design margin of the 21 marginal valves in an attempt to demonstrate larger margins by removing available conservatisms in the calculations. Within this process, the licensee was able to establish a minimum margin of 5 percent for each of the marginal valves.
For the valves marginal in the closing direction, individually measured valve factors were used in lieu of the group valve factors. For the valves marginal in the opening direction, the licensee deleted a conservatism that is generating by using actuator pullout efficiency in conjunction with a correction made for what was termed the "stem thrust effect," which is discussed later in this section. The inspectors reviewed the licensee's margin recalculation effort and determined that a margin of at least 5 percent existed for each motor-operated valve in the Generic Letter 89-10 program. The inspectors considered this level of margin to be sufficient in the short-term to ensure continued valve operability until test results become available to more precisely define rates of performance degradation.

As mentioned above, the licensee had defined and accounted for a "stem thrust effect." The stem thrust effect was defined as the observed phenomenon where torque delivered to the valve stem is less than the torque delivered to the drivesleeve worm gear. This torque loss was observed only when a thrust load was applied to the valve stem (test results from a torque test stand without thrust loadings did not show this effect). The torque loss was thought to be caused by frictional losses in the drivesleeve thrust bearings or in other locations. The licensee had determined the thrust output capability of its actuators by combining the stem thrust effect with motor dynamometer and torque stand testing results. The result of this process was a very precisely defined overall motor-operated valve capability assessment. This was identified as a strength in the program. The licensee informed the inspectors that, in retrospect, it had determined that accounting for the stem thrust effect in conjunction with using the standard Limitorque motor-actuator capability equation, with typical pullout efficiencies and 0.9 application

factor, was, effectively, double compensating for a single effect. The licensee had shown that for most motor-actuator combinations, their performance assessment process bounded the Limitorque method using the pullout efficiency. The licensee intended to remove this redundant source of conservatism.

The licensee had determined by testing valves both before and after stem lubrication that there did not appear to be any biased trend toward an increasing stem friction coefficient with time. This test result was somewhat unexpected. The general engineering assumption was that aging lubricant would result in greater frictional forces between the stem and stem nut. In light of the test results, the licensee established an unbiased uncertainty margin of 14 percent to account for stem friction changes. This margin was applied in a square root sum of the squares calculation along with other sources of unbiased uncertainty. The licensee's maintenance program provided for relubrication of valve stems every other refueling outage, or about once every 3 years. In those cases where relubrication was deferred beyond this schedule, the uncertainty for stem friction was adjusted using a prescribed formula. The inspectors determined that the licensee had appropriately addressed stem friction issues.

The licensee discovered during their testing program that the pullout loads for large gate valves were significantly higher under differential pressure than under static conditions. No such tendency was noted for valves less than 8 inches in diameter. This observation was contrary to the general engineering assumption that pressure loads applied across a valve disc will tend to redistribute frictional loads from the high pressure (upstream) to the low pressure (downstream) seat, but result in no net increase in the overall pullout frictional forces. The fact that Comanche Peak had found and accounted for this effect was considered a strength in the program.

The licensee used a statistical approach to define a margin to account for rate-of-loading (load sensitive behavior). As in other aspects of the program, a statistical evaluation was performed for each group of valves. A bounding rate-of-loading value and accompanying uncertainty was applied to all valves in the group, irrespective of individual test results. The licensee applied torque switch repeatability values as recommended by Limitorque in its 92-02 maintenance update. Additionally, the licensee identified a 3 percent limit switch repeatability that accounted for statistical variations in the stem thrust at the time the limit switch trips to stop valve motion.

The inspectors determined that the licensee had satisfactorily demonstrated the design basis capability of each of its Generic Letter 89-10 valves.

1.2 Mispositioning and Hot Shorts

The inspectors found that the licensee included consideration of inadvertent mispositioning of valves by operators within their Generic Letter 89-10 program.

The inspectors reviewed the licensee's evaluation of the capability to reposition motor-operated valves which may stroke without demand if their control circuitry thermally shorts during a fire in the control room.

NRC Information Notice 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire," dated February 28, 1992, identified a potential design weakness in the control wiring of motor-operated valves required for safe shutdown following a fire in the control room. Spurious motor-operated valve actuation due to a hot shorts resulting from the fire could cause uncontrolled closure of the valve, bypassing the torque and position switches which normally control closure, resulting in a motor-stall event. This could damage the motor-operated valve or render it incapable of being reopened either electrically or manually. This loss of functional capability for valves required to open or remain open may affect the alternate safe shutdown capability.

NRC Inspection Report 50-445/92-49; 50-446/92-49 identified the susceptibility of the licensee's valve control wiring design to the concern identified in Information Notice 92-18. Approximately 55 motor-operated valves were initially identified by the licensee as being vulnerable to failure with 41 motor-operated valve circuits potentially requiring modification.

The licensee had committed to eliminate the vulnerability of the affected valves by implementing design changes, as required, in the motor-operated valve control circuits to assure that the torque and limits switches were electrically connected downstream of the contacts located in the motor-control center.

Section 9.5.1.5.c of NUREG-0797, Supplement 26, "Safety Evaluation Report related to the operation of Comanche Peak Steam Electric Station, Unit 2," reviewed this issue and found the committed licensee actions to be adequate.

In a letter dated December 23, 1995, the licensee stated their commitment to implement design changes in the control circuits of the affected motor-operated valves (as required) to assure that the torque and limit switches in the valve operators were electrically connected downstream of the contacts in the motor-control center.

In a letter dated February 27, 1995, the licensee identified that the committed design enhancements had been completed to provide additional assurance that a fire will not cause a spurious operation which will have impact on alternative shutdown capability.

The inspectors reviewed the modifications that the licensee had completed to satisfy their commitments in the safety evaluation report. The inspectors considered the basic licensee commitment to be to assure, by existing design or modification, that the actuator control switches remained functional under hot-short conditions in the motor-control center to preclude uncontrolled closure of the valve.

The inspectors reviewed Engineering Report ER-ME-89, Revision 0, dated December 29, 1993, which the licensee had prepared to resolve the concern identified in Information Notice 92-18. For the 86 (total Units 1 and 2) valves (58 Westinghouse gates, 4 Borg Warner flex wedge gates, 2 globes, 22 butterflies) that were determined to be vulnerable, the licensee applied the following seven methods to resolve the concern:

1. Control Circuit Modification. The actuator control wiring of 30 valves, including Valve 2-8000A which had been previously modified, was rewired to relocate the connection of the motor-control center wiring and eliminate the potential for inadvertent stall closure.

2. Actuator Qualification. Twelve butterfly valves with HBC-type actuators were analyzed to be capable of surviving inadvertent stall closure. No control wiring modifications were performed.

3. Valve Qualification. Eighteen gate valves, including Westinghouse gate valves and 1/2-FCV-610 globe valves, were analyzed to be capable of surviving inadvertent stall closure. No control wiring modifications were performed.

4. Power Lockout. Eight valves were determined to be adequately protected against stall closure by administratively maintaining the motor-control center breaker open to remove power. No control wiring modifications were performed.

5. Gear Ratio Modification. The actuators of 8 valves, 1/2-8351A/B/C/D, were modified to reduce the final thrust during closure. Once modified, the actuators and valves were analyzed and found capable of surviving closure under stall conditions. No control wiring modifications were performed.

6. Fire Safe Shutdown Analysis Revision. Two valves, 2-8110, and -8111, were eliminated from the fire safe shutdown analysis. No control wiring modifications were performed.

7. Manual Operation. Eight valves, 1/2-8808A/B/C/D, were credited for manual operation.

The inspectors found that the licensee had modified the control circuits of 30 motor-operated valves to rewire the control switches downstream to preclude uncontrolled closure. The licensee had determined that these motor-operated valves would be overloaded by a motor-stall condition and could not be justified by any other means.

The remainder of the vulnerable valves (48 total) had been analyzed to be capable of surviving the uncontrolled closure and remaining adequately functional. The inspectors found that the licensee determined motor-operated valves capability using their Generic Letter 89-10 methodology.

The inspectors questioned the basis for the licensee's determination of the capability of manual operation following hot-short closure. The inspectors were concerned that manual handwheel operation may be incapable of exerting pullout thrust required to unseat the valve following closure under stall conditions. The licensee had not analyzed this capability. The licensee provided additional analysis to show that manual operation was justified for the valves that would be required to open using the handwheel. The inspector found the additional analysis to be adequate to resolve the concern.

The inspectors noted that the licensee had not intentionally demonstrated the opening capability following stall closure during their Generic Letter 89-10 program. The ability to declutch the operator had also not been demonstrated. However, according to the licensee, following past inadvertent stall events, they had not experienced any problems manually unseating and operating the valve.

Although the licensee had not implemented modifications to all affected valves to preclude uncontrolled closure from a hot short, the inspectors concluded that the licensee had established an adequate design basis for the capability of each of the vulnerable valves. The inspectors considered that the adequacy of the alternate design measures (other than control circuit modification) to assure alternate safe shutdown capability required additional clarification. The licensee acknowledged the inspectors' concerns and stated that it intends to revise their previous letter to the NRC to clarify the extent of the actual modifications performed. The inspectors considered the technical issues associated with hot shorts to be adequately resolved.

1.3 Pressure Locking and Thermal Binding

Supplement 6 to Generic Letter 89-10 identified that pressure locking was considered to be within the exiting design basis of susceptible motor-operated valves. The design basis reviews required for Generic Letter 89-10 should include pressure locking when determining worst-case design basis conditions. Most licensees had not initially considered pressure locking within their design basis reviews but had initiated separate reviews of pressure locking in response to industry notifications. For closure of Generic Letter 89-10, licensees were expected to have initiated comprehensive engineering reviews to identify susceptible motor-operated valves and take timely corrective actions. These corrective actions may include modifications or operating procedure changes to preclude pressure locking, or analyses to justify the existing capability of the motor-operated valve to overcome pressure locked conditions.

The inspectors reviewed the licensee's progress in conducting their review of the issue of pressure locking and thermal binding.

Pressure locking can occur in two distinct ways. Thermally-driven pressure locking occurs when water trapped in the valve bonnet heats up and increases in pressure. Depressurization-driven pressure locking occurs when water from a high pressure source migrates into the bonnet cavity, upon which a rapid depressurization occurs, trapping the pressurized fluid in the bonnet.

The licensee initially reviewed the potential for pressure locking in response to early generic communications on this topic and concluded that the redundancy in the existing system design was an adequate design provision to address the problem. Following additional notifications of industry events in 1988 involving pressure locking and thermal binding, the licensee reopened their review of the issue.

In Report SWTU-11993 dated December 22, 1988, a contractor (Stone and Webster) reviewed Unit 1 and identified 23 susceptible valves on the basis that the valves were normally-closed gate valves which had a safety-related opening function. Their letter to the licensee stated that depressurization-driven pressure locking was part of the scope of the problem to be reviewed; however, their screening criteria, which eliminated valves exposed to less than 150 pounds per square inch (psi) or 200 degrees F, appeared to address only temperature-driven susceptibility. Stone and Webster recommended modification of the following 23 valves to preclude pressure locking:

1-HV-4776,-4777	Containment Spray HX outlet valve
1-HV-4782,4783	Containment Sump to Spray Pump Suction
1-LCV-112D/E	RWST to CCP Suction
1-8701A/B,8702A/B	RCS to RHR Pump Suction (series valves)
1-8801A/B	CCP Discharge to RCS via SI Header
1-8802A/B	SI Pump Discharge to RCS hot legs
1-8804A/B	RHR Pump Discharge to SI/CCP Suction (LHSI to HHSI crossover Isolation)
1-8807A/B	CCP and SI Pump Suction Cross-Connect
1-8811A/B	Containment Sump to RHR Pump Suction
1-8840	RHR Pump Discharge to RCS hot legs
1-8000A/B	PORV Block valves

Most (19) of the 23 susceptible valves were Westinghouse valves. Stone and Webster contacted Westinghouse and referred further evaluation of the susceptibility of these valves to Westinghouse. In Report WPT-11463 dated June 5, 1989, Westinghouse reviewed the susceptible valves identified by Stone and Webster and recommended that 8 valves be modified (1-8804A/B, -8811A/B, 2-8804A/B, 2-8811A/B). The remainder of the susceptible valves were determined to not require modification on the basis that the potential for heat input to the valve was minimal.

In a subsequent licensee review, Report CPSES-9027237 dated December 3, 1990, the licensee addressed 34 valves, including the 23 normally-closed valves from previous reviews and 11 additional normally-open valves from Generic Letter 89-10. The review identified 12 valves susceptible to pressure locking. Eight of the 12 were the same valves as those recommended for modification in the previous reviews. An additional 4 valves (feedwater isolation valves) were recommended for modification due to suspected previous pressure locking events with these valves.

The inspectors reviewed Calculation ME-CA-0000-1093, Revision 2. This was the licensee's documentation of their analysis of the design basis requirements, capability analyses, and test results for each motor-operated valve in their program. Attachment Z summarized the previous reviews of pressure locking and actions taken.

The inspectors found that depressurization-driven pressure locking did not appear to be adequately addressed. For example, the hot-leg injection valves (8840) were screened out on the basis that they would only be subject to minimal bonnet heating. The potential for pressure locking under design basis depressurization did not appear to have been reviewed. The inspectors noted that NUREG 1275 identified industry experience with pressure locking of the hot-leg injection valves. The inspectors noted that the hot-leg injection valves were separated from the reactor coolant system by two in-series check valves inside containment; however, since check valves leak over time, the hot-leg injection valves could be subjected to bonnet pressurization to reactor coolant system pressure.

The inspectors found that the licensee had assumed actuator capability up to the pressure rating of the valve. The licensee did not employ a specific analysis method to predict the operating forces required under pressure-locked conditions. The licensee had analyzed thrust requirements assuming bonnet pressurization could be treated as a classical differential pressure.

In order to assess the validity of the licensees' calculation methods, the inspectors performed independent calculations using one recently-standardized methodology and determined that the licensee's approach was potentially nonconservative. The licensee performed calculations using the same method used by the inspectors and determined that all of the NUREG 1275 valves were capable of operating when subjected to worst-anticipated pressure locked conditions.

The inspectors reviewed additional informal calculations conducted by the licensee which did address depressurization-driven pressure locking. The inspectors determined that the methodology previously used by the licensee in the 1990 calculation did not reflect current Generic Letter 89-10 methodologies and was apparently less conservative.

The inspectors concluded that the licensee had initiated reviews of the susceptibility of their safety-related motor-operated valves to pressure locking and thermal binding and taken action to modify valves as required. The inspectors found several weaknesses in the licensee's reviews and evaluation methods. The licensee performed additional calculations at the inspector's request that resolved operability concerns related to those motor-operated valves considered most susceptible to pressure locking. The licensee stated that a more comprehensive review would be undertaken in response to Generic Letter 95-07 and that the identified weaknesses would be fully addressed during this effort. The inspectors found the licensee actions to be adequate for Generic Letter 89-10 closure.

The licensee's weak response to resolving pressure locking concerns was apparently attributable to a management decision to table this issue until the NRC generic letter on this topic was issued. The inspectors considered this deferral to be unjustified because various NRC information notices and Supplement 6 to Generic Letter 89-10 provided the foundation upon which the licensee should have acted to apply the best available information to evaluate valve capability to overcome pressure locking. This was identified as a weakness in the licensee's response to the emerging issue of pressure locking and thermal binding.

1.4 Supplement 5

The inspectors reviewed the error analyses utilized by the licensee in analyzing their test data and establishing switch setpoints. The inspectors found that the licensee had adequately incorporated diagnostic equipment measurement error.

1.5 Grouping

The licensee used valve grouping extensively throughout the motor-operated valve program to provide a basis for determining statistical bounds for various performance parameters, such as valve factor and load-sensitive behavior. The licensee defined 16 groups containing 136 gate valves, 4 groups containing 46 globe valves, 1 group containing 4 diaphragm valves, 6 groups containing 52 butterfly valves, and 1 group containing 4 plug valves. The valves within each group were nominally identical. The licensee had structured its program to conform with the valve grouping guidelines contained in Generic Letter 89-10, Supplement 6.

1.6 Periodic Verification and Post-Maintenance Testing

The inspectors reviewed licensee Procedure STA-754, Revision 1, "Motor-Operated Valve Program." Section 6.6 required testing following maintenance and modification activities in accordance with the "Post-Work Test Guide." Section 6.7 described testing for periodic verification design basis capability.

The inspectors reviewed the licensee's "Post-Work Test Guide" and found that diagnostic testing of Generic Letter 89-10 motor-operated valves was determined as appropriate on a case-by-case basis by the motor-operated valves coordinator.

The licensee was in the process of developing their final program for post-maintenance testing and periodic verification incorporating the use of both static and dynamic diagnostic testing. According to the licensee, actual valve margin would be considered in the determination of appropriate testing. Furthermore, critical clearances in the valve internals would be also evaluated in determining the need for dynamic testing.

According to the licensee, periodic static and dynamic testing of Generic Letter 89-10 motor-operated valves would be performed for the life of the plant. The licensee currently planned to conduct 11 to 13 dynamic tests. The licensee will consider the benefits and any adverse impact in determining appropriate periodic testing for each valve.

Although not completed at the time of the inspection, the inspectors found the licensee's planned actions to be adequate. Additional NRC review of the licensee's final testing program will be addressed during the planned staff actions related to a pending generic letter on periodic verification.

1.7 Trending and Failure Analysis

The inspectors reviewed the licensee's performance trending and failure analysis programs for motor-operated valves.

The inspectors found the licensee's computer-based trending program to be well-established. The inspectors noted that while individual parameters were trended, bounding values were based on the statistical variation expected for the parameter. Only when the parameter exceeded the bounding value was a trend identified. Furthermore, the inspectors noted that group values for the trended parameter were not identified as bounding values. Due to the statistic basis for the licensee derivation of group values, the inspectors considered that the lack of trending of individual parameters against the group value was a weakness. The licensee acknowledged the inspectors' concerns and committed to incorporate group values in their performance monitoring.

The inspectors reviewed the licensee's approach to analyzing motor-operated valve failures. The inspectors reviewed selected Operations Notification and Evaluation (corrective action) forms for the past 2 years. The inspectors noted that the licensee consistently utilized their Generic Letter 89-10 methodology as the basis for determining operability. The inspectors concluded that the licensee was satisfactorily evaluating motor-operated valve failures.

1.8 Self Assessment

The inspectors requested the licensee to supply for review all items documenting any internal or external reviews of its Generic Letter 89-10 program since March 1993, the date of the previous NRC motor-operated valve inspection at Comanche Peak. The purpose of this effort was to evaluate the effectiveness of licensee programs to self-assess performance in the area of motor-operated valves. This function is important because it can influence, to a large extent, the future status of the Generic Letter 89-10 program after the concentrated NRC inspection effort is completed.

The licensee had contracted a third-party review of its Generic Letter 89-10 program as documented in a July 15, 1994, report entitled, "Program to Comply With USNRC Generic Letter 89-10 Recommendations." The inspectors' review indicated that this review effort was beneficial, even though few significant issues were identified. The licensee's Independent Safety Engineering Group performed two assessments of the motor-operated valve program during the time period of interest. The first was dated December 8, 1994 and was entitled "Assessment of the Effectiveness of CPSES Corrective Actions in Response to Generic Letter 89-10 Inspections, ISEG Assessment Report (IAR) No. 94-09." The second was dated February 8, 1995 and was entitled "Assessment of Industry NRC MOV Program Inspections for Comparison with the CPSES MOV Program, ISEG Assessment Report No. IAR 95-02." Both of these review efforts were comprehensive with much value added for program enhancement.

In addition to the major assessments listed above, the Independent Safety Engineering Group performed several limited-scope reviews of activities in progress or of site responses to emerging issues. A Quality Assurance Audit QAA-94-116, "CPSES Test Control Program," August 25, 1994, also addressed some aspects of motor-operated valve testing. However, the licensee had not completed or scheduled any quality assurance audits that were focused strictly on motor-operated valves.

The licensee's self assessment of the motor-operated valve program was determined to be acceptable for program closure.

1.9 Open Items

The following open items were addressed during this inspection:

1.9.1 (Closed) Inspection Followup Item 445/9310-01; 446/9310-01: Valve Internals Degraded

Background

During review of a differential pressure diagnostic trace of Valve 1-8821B, the inspectors noted the presence of an unusual upward spike in the trace possibly indicating that the valve was experiencing difficulty transitioning from the valve guides to the seating surface while closing. This anomaly had not been identified on a Operations Notification and Evaluation form. This was apparently attributable to a weakness in the acceptance criteria. While static test sections contained acceptance criteria requiring review of anomalies in the traces, the dynamic test sections did not contain these requirements.

Followup

The internals of Valve 1-8821B were inspected and reworked under Work Order 1-93-045921-00. During this work, the stem, a disc gasket, and the valve packing were replaced. The licensee considered the probable cause of the problem to be the gate sticking at the bottom of travel or the gland

follower rubbing the stem. Valve 1-88221B was retested under differential pressure conditions following the maintenance effort. The diagnostic traces indicated that the anomalous operating problem had been alleviated.

Procedure PPT-PO-6004, "Safety-Related Rising Stem Motor-Operated Valve Testing," Revision 1, was revised to include a review of differential pressure traces for indications of erratic valve behavior.

Conclusion

The licensee had addressed the procedural deficiency within its dynamic acceptance criteria. The inspectors reviewed the post-maintenance diagnostic trace and concluded that Valve 1-8821B was functioning acceptably.

1.9.2 (Closed) Violation 50-445/9310-02; 50-446/9310-02: Torque Limits

Background

During review of a static diagnostic test package, the inspectors had noted that the maximum allowable torque value for Valve 2-8000A had not been adjusted downward to account for "rate-of-loading" as required by procedure. Also, the total torque had not been adjusted for this valve to account for inertia. Additionally, the same individual who entered the incorrect torque values later signed for review of the same package, indicating the apparent lack of an independent review.

Followup

The licensee performed an extensive review of its test data packages and found one additional instance in which input torque numbers had been mistranscribed (Valve 2-LCV-112D). The data discrepancies were corrected without any operational concerns being identified. The licensee issued Procedure Change Notice PPT-P0-6004R1-1 to Procedure PPT-PO-6004, "Safety-Related Rising Stem Motor-Operated Valve Testing," Revision 1. This procedure change notice added a quality control review verifying accuracy of the data transferred from the engineering calculation to the data packages.

Conclusion

The licensee had corrected the previous mistakes in transcribing data and had taken actions to preclude recurrence.

1.9.3 (Closed) Inspection Followup Item 50-445/9310-03; 50-446/9310-03: Retrain Motor-Operated Valves Test Personnel

Background

The inspectors noted that Motor-Operated Valve 1-8835 may not have been fully closed prior to performing the opening dynamic test for this valve. The test log had indicated that flow noise was still heard at this valve following its

prior closure. Further, there was no evidence of close light indication during the signature. The concern was that, if the valve was not fully closed, the opening test was not a valid demonstration of design-basis capability.

Followup

After the inspection, the licensee provided additional information on this item. In their review, the licensee identified two other valves (1-8802A and 2-8802A) that appeared to have not been fully closed prior to being tested in the open direction. However, the licensee determined that Valve 1-8835 had been fully closed at the time of its official open-stroke test, even though some bypass flow may have still been present.

Upon further review of the differential pressure diagnostic test results of Valves 1-8802A and 2-8802A, the licensee discovered that creditable test data was available. For each valve, two dynamic strokes were conducted. The opening stroke of one of the two tests for each valve was conducted following a full closure of the valve. Therefore, no additional testing was required.

The inspectors reviewed test data for Valves 1-8802A and 2-8802A and concurred that valid open-stroke differential pressure tests had been conducted.

The licensee conducted training of all Level 2 qualified motor-operated valves test personnel to ensure that future initial test conditions are suitable simulations of design basis conditions.

The inspectors reviewed the lesson plans used during this training and verified that the concerns related to this item were addressed. Specifically, the Level 2 test personnel were cautioned to ensure that an motor-operated valves is wedged in its seat prior to an opening test.

Conclusion

The licensee had satisfactorily resolved the validity of its open-stroke test data. The training that was conducted should preclude recurrence of this problem.

1.9.4 (Closed) Violation 50-445/9310-04; 50-446/9310-04: Failure to Follow Procedure

Background

The licensee had failed to review Limitorque Maintenance Update 92-02 for applicability to the Generic Letter 89-10 program, which was contrary to the provisions of Procedure STA-206, "Review of Vendor Documents and Vendor Technical Manuals," Revision 17. As a result, upwardly revised torque switch repeatability values were not incorporated into the licensee's motor-operated valve program.

Followup

The licensee added to Procedure STA-754, "Motor-Operated Valve Program," Revision 1, a responsibility for the component test supervisor to obtain a design engineering review for all Limitorque maintenance and technical updates in a accordance with Procedure STA-206.

The licensee revised the motor-operated valve program to include the torque switch repeatability values and other information contained in Maintenance Update 92-02. No operability concerns resulted from this effort. The licensee reviewed other Limitorque updates and determined that no other cases of inadvertent oversight had occurred.

Conclusion

The procedure revision to Procedure STA-754 clearly assigns responsibility for incorporation of future maintenance updates from Limitorque. The inspectors verified that the current motor-operated valve program incorporates torque switch repeatability values as recommended by Limitorque.

1.9.5 (Closed) Inspection Followup Item 50-445/9310-05; 50-446/9310-05; Torque Switch Bypass Range

Background

The licensee had established a criterion for setting the bypass of the open torque switch at 20 percent of the opening stroke or the point where flow effects terminated during an open dynamic diagnostic stroke, whichever is greater. The NRC questioned whether this was conservative for a partial differential pressure test because flow effects may persist for a greater percentage of the stroke under full differential pressure conditions.

Followup

The inspectors reviewed a matrix developed by the licensee that compared a linear extrapolation of the range of differential pressure effects to the actual open torque bypass position. All but 16 valves passed the initial screening. The bypass settings of each of the outlying 16 valves were evaluated as being acceptable based on reasons such as high open torque switch settings, loads exceeding torque switch settings seen only during pullout, or no discernible differential pressure effects.

Conclusion

The licensee had satisfactorily addressed this issue. The licensee's evaluation provided assurance that the open torque switch would not prematurely actuate for properly-functioning Generic Letter 89-10 motor-operated valves.

1.9.6 (Closed) Inspection Followup Item 50-445/9310-06; 50-446/9310-06; Actuator Thrust Ratings

Background

The licensee had increased the structural thrust limits for some Generic Letter 89-10 motor-operated valve actuators based on testing that had been performed by Kalsi Engineering, Inc. At the time of the previous inspection, the NRC had not reviewed the testing program performed by Kalsi Engineering, Inc.

Conclusion

Since the previous inspection, the NRC staff has stated in Supplement 6 to Generic Letter 89-10 that licensees may use studies such as the Kalsi Engineering study to upgrade the thrust rating of valve actuators, as long as motor-operated valve performance is acceptably monitored. Consequently, the concern of the previous inspection no longer exists.

1.9.7 (Open) Inspection Followup Item 50-445/9310-07; 50-446/9310-07; Run Efficiency in Evaluation of Motor Pullout

Background

During the previous NRC inspection, the inspectors reviewed evaluations of six butterfly valves wherein the licensee had used the actuator running efficiency for the purposes of predicting the opening torque capability of the motor actuator. A lower "pullout" efficiency is normally used for opening evaluations and this value is the only one endorsed by Limitorque for this application. The concern with the six butterfly valves had been mitigated by the overall conservatism in the remainder of the licensee's evaluations of these valves. However, the licensee was expected to further justify its position if running efficiency was to be used in this application for the long term.

Followup

During this inspection, the inspectors reviewed the licensee's justification for using running efficiency in the opening evaluation of the six butterfly valves. The inspectors noted that the licensee had also taken credit for running efficiency in the open evaluations of two safety-related gate valves.

The inspectors did not accept the licensee's assertion that running efficiency could be used whenever the motor and gearing were at full rated speed prior to significant loading. Limitorque has consistently declined to endorse this position. However, the licensee's treatment of the stem thrust effect, as discussed in Section 1.1 of this report, was sufficient to provide an

effective margin commensurate with the use of pullout efficiency and rated motor starting torque. Thus, using conventional Limitorque capability calculations, the licensee was able to demonstrate standard pullout capability for the affected valves.

Conclusion

This item was left open because the licensee had not acceptably justified the use of running efficiency to calculate open stroke capability. This issue remains an open question that should be resolved through continued industry testing.

1.9.8 (Closed) Inspection Followup Item 50-445/9310-08; 50-446/9310-08: Pressure Locking of Normally Open Valves

Background

The licensee's review of pressure locking had excluded normally-open motor-operated valves. However, the inspectors expressed a concern that these valves may be closed for maintenance or operational reasons for extended periods of time, during which an accident requiring them to open could occur. The licensee stated that further review would be performed in this area.

Followup

The licensee had identified those normally-open valves that will require evaluations for pressure locking. However, these evaluations had not been performed at the time of this inspection. The licensee stated that pressure locking evaluations of normally-open motor-operated valves would be completed as part of their response to the recently-issued Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves."

Conclusion

Because this issue will be assessed along with other elements of the licensee's response to Generic Letter 95-07, the inspection followup item was closed.

1.9.9 (Closed) Inspection Followup Item 50-445/9310-09: Springpack Displacement Included in Test Acceptance

Background

At the time of the previous inspection, the licensee was using stem-mounted strain gages to measure the torque applied to the valve stem. The inspectors questioned whether a check of torque measured at the actuator springpack

should be used to determine whether actuator structural limits were being exceeded. This concern was based on the inspectors' opinion that some torque losses may occur in the drive train and that stem torque measurements may underestimate the amount of torque being applied to the actuator.

Followup

The licensee performed a comprehensive review of its test data and concluded that torque losses between the actuator worm gear and valve stem were significant. The licensee revised the Generic Letter 89-10 program to account for this effect. The licensee called this the "stem thrust effect." It is discussed in more detail in Section 1.1 of this report. Torque measurements were taken both on the stem and at the springpack and were being used independently to demonstrate conformance with the appropriate acceptance criteria.

Conclusion

The licensee had fully addressed the concern.

ATTACHMENT 1

Persons Contacted and Exit Meeting

1 PERSONS CONTACTED

1.1 Licensee Personnel

J. Barker, Manager, Mechanical Engineering
O. Bhatty, Licensing/Compliance
B. Black, Senior Engineer
P. Chiu, Senior Engineer
B. Cockrel, Mechanical Consulting Engineer
D. Davis, Manager, Nuclear Overview
D. Dillinger, Senior Engineer
C. Harrington, Mechanical Equipment Design Supervisor
J. Kelly, Vice President, Nuclear Engineering and Support
J. Lee, Component Test Engineer
F. Madden, Manager, Engineering Overview
D. Manning, Nuclear Specialist, Training
J. Muffett, Station Engineering Manager
N. Paleologos, Vice President, Operations
W. Ross, Senior Engineer
M. Sunseri, Manager, Plant Modifications
L. Terry, Group Vice President, Nuclear
R. Withrow, Component Test Supervisor

1.2 NRC Personnel

H. Freeman, Resident Inspector

The personnel listed above attended the exit meeting. In addition to the personnel listed above, the inspectors contacted other personnel during this inspection period.

2 EXIT MEETING

An exit meeting was conducted on September 8, 1995. During this meeting, the inspectors reviewed the scope and findings of the report. The licensee did not express a position on the inspection findings documented in this report. The licensee did not identify as proprietary any of the information provided to the inspectors.