ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Docket Nos.:	50-361 50-362
Licensc Nos.:	NPF-10 NPF-15
Report No.:	50-361/96-10 50-362/96-10
Licensee:	Southern California Edison Co.
Facility:	San Onofre Nuclear Generating Station, Units 2 and 3
Location:	5000 S. Pacific Coast Hwy. San Clemente, California
Dates:	October 21-25, November 4-8, and November 18-21, 1996
Inspectors:	C. Myers, Reactor Inspector M. Runyan, Reactor Inspector M. Holbrook, Contractor, Idaho National Engineering Laboratory
Approved By:	C. VanE nburgh, Chief, Engineering Branch
Attachment:	Supplemental Information

TABLE OF CONTENTS

EXECUTIVE SUMMARY

San Onofre Nuclear Generating Station, Units 2 and 3
NRC Inspection Report 50-361/96-10;50-362/96-10

This inspection evaluated the licensee's motor-operated valve program for closure under Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," and actions taken in response to previous inspection findings.

Engineering

- The licensee had adequately demonstrated the existing design basis capability of all motor-operated valves consistent with its commitments in response to Generic Letter 89-10 (Section E1.1).

- The licensee properly developed valve groups and adequately justified valve factors to each group (Section E1.1).

- In response to the inspectors' concerns, the licensee incorporated required margin for rate-of-loading as an operability criteria for untested valves (Section E1.1).

- Two valves will be retested in November 1996 to resolve concerns with anomalous behavior observed during earlier design basis testing (Section E1.1).

- The licensee had adequately addressed the potential for hot short mispositioning of motor-operated valves (Section E1.2).

- The inspectors considered that the licensee had made adequate progress in its efforts to address pressure locking and thermal binding to close the staff's review under Generic Letter 89-10 (Section E1.3).

- The inspectors found the licensee plans for periodic verification testing to be adequate for closure of the staff's review of Generic Letter 89-10. Further NRC review of this subject area will be conducted under Generic Letter 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves" (Section E1.4).

- The inspectors concluded that the licensee had established adequate controls for post-maintenance/modification testing to maintain design basis capability consistent with its Generic Letter 89-10 program (Section E1.5).

- In response to the inspectors' concern for the effects of lubrication of valve internals prior to testing, the licensee conducted preliminary testing and determined that measured valve performance parameters were unaffected. The licensee planned to retest valve 2HV-9348 during the upcoming outage in December 1996 to confirm its conclusions regarding the effect of lubrication of valve internals (Section E1.5.b).

- The inspectors concluded that the licensee's trending activities were adequate for closure of the NRC review of Generic Letter 89-10 (Section E1.6).

- Although oversight of the program was weak, the licensee's quality assurance involvement of the motor-operated valve program was adequate for closure of Generic Letter 89-10 (Section E7).

Report Details

Summary of Plant Status

Units 2 and 3 operated at 100 power during the inspection.

III. Engineering

E1 Conduct of Engineering

E1.1 Motor-Operated Valve Design Capability (TI 2515/109)

a. Inspection Scope

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, seven supplements to the generic letter were issued.

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 2. Temporary Instruction 2515/109 was originally divided into two parts: Part 1, "Program Review"; and, Part 2, "Verification of Program Implementation." The Part 1 program review inspection at San Onofre Units 2 and 3 was documented in NRC Inspection Report 50-361/92-02; 50-362/92-02. The Part 2 implementation review inspections at San Onofre Nuclear One were documented in NRC Inspection Reports 50-361/93-17; 50-362/93-17 and 50-361/93-36; 50-362/93-36. In addition, other inspections addressing elements of the licensee's motor-operated valve program were conducted during this period.

The purpose of this inspection was to verify that the licensee had completed its commitments to develop and implement a safety-related motor-operated valve program as described in Generic Letter 89-10. In Revision 2 to Temporary Instruction 2515/109, Part 3, "Program Closure," was added. The guidance contained in Part 3 of Temporary Instruction 2515/109 was used during this inspection.

The process of "closing" a Generic Letter 89-10 program includes 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. This concept is commonly referred to 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 will be reviewed by the NRC under separate generic letters and were assessed during this inspection on an interim basis for closure under Generic Letter 89-10.

The inspectors reviewed various plant documents and held discussions with the motor-operated valve engineers to determine whether the licensee had acceptably demonstrated the design basis capability of each Generic Letter 89-10 valve. The expectation was that at this stage of the licensee's Generic Letter 89-10 program (following the licensee's notification to the NRC that activities pursuant to Generic Letter 89-10 had been completed), each motor-operated valve in the program would be qualified on the basis of in-situ design basis testing or by comparison to well-justified, test-based design information.

The inspectors focused on several design parameters used to predict the operating capability of motor-operated valves, specifically: (1) valve factor, which correlates differential pressure to stem-thrust requirement; (2) stem-friction coefficient, which affects the conversion of actuator output torque to valve-stem thrust; and (3) rate-of-loading (a.k.a., load sensitive behavior), which reflects the change (usually a loss) in deliverable stem thrust under dynamic closing conditions as compared to the available closing static thrust.

b. Observations and Findings

Scope of Program

The licensee's Generic Letter 89-10 program encompassed 178 motor-operated valves (89 per unit) including 82 gates valves (6 Westinghouse, 10 Walworth, 14 Target Rock, 52 WKM), 28 butterfly valves (Fisher), 20 rotating-rising stem globe valves (Target Rock), and 48 standard globe valves (8 Borg Warner, 30 WKM, 2 Gimpel, 8 Target Rock). All valves were tested under static conditions.

The licensee demonstrated motor-operated valve design-basis capability using (1) valve-specific dynamic testing at, or near, design-basis conditions, (2) valve-specific dynamic testing at less than design-basis conditions with linear extrapolation to design-basis conditions, and (3) dynamic tests on similar motor-operated valves. The licensee tested 142 of the valves under differential pressure conditions including 23 butterfly valves, 43 standard globe valves, 20 rotating-rising stem globe valves, and 56 gate valves. The licensee did not perform differential pressure testing for 52 valves, considering 8 valves to be

impractical to test, 26 valves to have no safety-related differential pressure design basis condition, and 18 valves to be exempted in accordance with Supplement 6 response letter dated September 2, 1994. The licensee demonstrated the design basis capability of 18 untested valves by grouping and establishing torque switch setpoints for all valves based on group valve factors.

Valve Grouping

For the purposes of determining valve factors and stem friction coefficients, the licensee developed the 12 valve groups:

Group 1:	(8)	Borg Warner globe valves (10-inch)
Group 2:	(28)	Fisher butterfly valves (8-,10-,24-,30-,42-inch)
Group 3:	(2)	Gimple globe valves (4-inch)
Group 4:	(14)	Target Rock gate valves (3-,8-inch)
Group 5:	(20)	Target Rock globe valves (2-,3- inch, rising rotating)
Group 6:	(8)	Target Rock globe valves (8-inch)
Group 7:	(10)	Wallworth/Alloyco gate valves (12-,14-,24-inch)
Group 8:	(36)	WKM gate valves (8-,16-inch)
Group 9:	(16)	WKM gate valves (3-inch)
Group 10:	(18)	WKM globe valves (3/4-,2-inch)
Group 11:	(12)	WKM globe valves (4-,6-inch)
Group 12:	(6)	Westinghouse gate valves (3-inch)

The licensee further subdivided some of the above groups into "subgroups" based on same or comparable size and, in some cases, had assigned valve factors and stem friction coefficients independently to the subgroups. After reviewing the groups and subgroups, the inspectors concluded that the licensee had incorporated the guidance of Generic Letter 89-10, Supplement 6, in its motor-operated valve grouping plan.

Valve Factor - Gate Valves

The inspectors considered that the licensee had satisfactorily supported the valve factors that had been assigned the gate valve groups (4, 7, 8, 9, 12) with one exception. In Group 12, two valves that were credited for closure under blowdown conditions (Valves 2/3-TV-9267, "Regenerative Heat Exchanger Outlet Valve"), had been assigned a valve factor of 0.4. This valve factor had been supported by the licensee test data, but it did not account for the adverse hydrodynamic conditions associated with blowdown conditions. In response to the inspectors' concern, the licensee contacted another facility that had performed blowdown tests of the same type and size of valve. Based on this testing, the licensee changed the valve factor for this group to be 0.7. The inspectors concluded that the revised valve factor was adequately supported.

Valve Factor - Globe Valves

The licensee used an "effective area" term in lieu of assigning valve factors to globe valves. In comparison to the standard sizing equation, the effective area was used for the standard geometric seat or guide area along with the assumption of a 1.0 valve factor. Therefore, any actual valve factors greater than 1.0 were reflected by the use of an effective area greater than the geometric seat or guide area. The area terms generally reflected the licensee's test data but, in some cases, for conservatism, the licensee used manufacturer-specified dimensions as the effective area. The manufacturer dimensions were used only when test data would have suggested a smaller area term. The assigned area terms generally reflected a seat-area-based or guide-area-based behavior as reflected by the test data and type of valve (y-pattern globe valves are considered to be controlled by the guide area). The inspectors concluded that the effective area terms established for Groups 1, 3, 5, 6, 10, and 11 (all globe valve groups) were adequately supported.

Stem Friction Coefficient

For each group, and, in some cases, subgroups within the groups, the licensee compiled measured stem friction values and assigned bounding values. These values ranged from 0.15 to 0.20 for gate valves and 0.20 to 0.27 for globe valves. The inspectors concluded that the licensee's assigned stem friction coefficient values were valid.

Rate-of-loading

Rate-of-loading is a performance characteristic of motor-operated valves which accounts for a difference in available operating thrust under static and dynamic conditions. By convention, a positive rate-of-loading indicates that the thrust at torque switch trip is greater under static conditions than under dynamic conditions.

The inspectors identified the following four concerns associated with the licensee's treatment of rate-of-loading:

(1) The licensee had not assigned any rate-of-loading to the gate valves in the program because the licensee's test data had not conclusively indicated a statistically significant bias attributable to rate-of-loading. The licensee had assumed that any amount of load sensitive behavior below 10 percent was due to diagnostic equipment uncertainty.

The inspectors independently reviewed the licensee's test data to evaluate the basis for the licensee's conclusion. The inspectors found that 15 motor-operated gate valves had been tested under differential pressure conditions with sufficient diagnostic instrumentation to compute a rate-of-loading. The inspectors determined that the mean of the 15 data points was +0.7 percent with a standard deviation of 4.49 percent. To

determine a bounding rate-of-loading value, the inspectors calculated that the mean plus two standard deviations for the test data was 9.63 percent. The inspectors concluded that, although the mean of the licensee's test data did not indicate a significant rate of loading, the variance in the licensee's test data indicated the need for a conservative bounding value of approximately +10 percent. In response to the inspectors' concerns, the licensee applied a 10 percent rate-of-loading value to each gate valve in the program with the possible exception of those valves having a direct measure of rate of loading (in which the actual measured value may have been used). The licensee conservatively applied the 10 percent margin directly to the required thrust value for each valve as a biased effect.

As a result of applying this additional margin, the following five motor-operated valves were calculated to have less thrust than necessary to perform its design closing function:

2HV9306	ECCS Pumps Combined Miniflow to RWST, Train A (-3 percent)
2HV9307	ECCS Pumps Combined Miniflow to RWST, Train A (-5 percent)
2HV9348	ECCS Pumps Combined Miniflow to RWST, Train B (-1 percent)
3HV9306	ECCS Pumps Combined Miniflow to RWST, Train A (-1 percent)
3HV9347	ECCS Pumps Combined Miniflow to RWST, Train B (-1 percent)

The licensee initiated Action Request 961100104 to evaluate the operability of the five valves. All of the valves had been tested under differential pressure conditions and by applying actual test results (in lieu of the bounding valve factor assumption), each of the five valves were calculated to possess positive margin. The licensee considered the five valves to be operable, but marginal, and planned to change the torque switch settings or bypass the torque switches of these valves during the next refueling outages for each unit. This action would enable these valves to accommodate the group valve factor assumption. The inspectors considered the licensee's handling of this matter to be acceptable.

(2) The licensee had applied no rate-of-loading to Group 6 (Target Rock globe valves), but had no test data to support this position. In response to the inspectors' concern, the licensee agreed to apply a 25 percent margin for rate of loading to this group. This value bounded the mean plus two

standard deviations of all of the licensee test data for globe valves. According to the licensee, no inadequacies in design basis capability resulted from the addition of this required margin.

(3) The licensee had applied no rate of loading to Group 10 (WKM globe valves) based on no clear indication of rate of loading from the test data in this group. However, two of the five rate-of-loading measurements in the group indicated positive rate of loading (4.0 and 2.5 percent). The mean plus two standard deviations of the five data points was 8.9 percent. In response to the inspectors' concern, the licensee agreed to apply a 10 percent rate of loading to Group 10. According to the licensee, no inadequacies in design basis capability resulted from the addition of this required margin.

(4) The licensee had not applied any additional margin in its opening analysis for gate valves to account for rate-of-loading effects. Although the open torque switch is bypassed and does not control the opening torque output, rate-of-loading effects (or load-sensitive behavior) can reduce the available open thrust under dynamic conditions by causing an increase in the stem friction coefficient. This margin is typically applied to the calculated torque or thrust capability under degraded voltage conditions. In response to the inspectors' concern, the licensee incorporated a 10 percent margin for rate of loading in the opening direction for gate valves in the Generic Letter 89-10 program. In lieu of applying this margin to the available thrust, the licensee applied the margin to the estimated required thrust. The application of this margin did not result in any capability concerns.

The inspectors concluded that the licensee's program, as revised to address the above concerns, adequately addressed the rate-of-loading behavior of its Generic Letter 89-10 valves.

Other Margins

The licensee applied the standard Limitorque specifications for torque switch repeatability. For stem lubrication, the licensee applied a margin that ranged from 5 to 25 percent. The inspectors considered these two margins to be adequate.

No margin existed to account for springpack relaxation. The licensee considered that any relaxation of the actuator springpacks had already occurred, but indicated that a margin would be applied in the event that a new springpack were installed.

No margins existed to account for valve factor degradation. The inspectors considered this to be a concern because the licensee did not have any test data or other information to suggest that such degradation would not occur. The

inspectors found that the licensee planned to trend valve factors as part of their periodic verification to promptly detect any trends of increasing valve factors and to obtain test data to support their assumptions regarding valve factor degradation.

WKM Motor-Operated Gate Valves

Because of the large number of WKM gate valves, which were unique to the licensee's facility, the inspectors reviewed the licensee's methods for motor-operated valve sizing and setting the control switches for WKM gate valves. A total of 52 WKM gate valves were in the licensee's Generic Letter 89-10 program. This amounted to 63 percent of the total number of gate valves in the licensee's program. The inspectors reviewed the licensee's program summary documents including Attachments 1 through 6 of "GL 89-10 Valve Margin Assessments." Using these documents, valves were selected that included examples of methods used by the licensee's Generic Letter 89-10 program to demonstrate design-basis capability.

Two styles of WKM gate valves were utilized. The WKM Model M for sizes up to 4 inch and the WKM Model D-2 for sizes 8 inch through to 20 inch. Both styles consisted of a two-piece, parallel disk with a wedging backside surface to expand the disk into the valve seat at the end of disk travel. During disk travel, the disk halves travel together in a collapsed condition. This allows a larger clearance for disk movement between the valve seats. At the end of travel after flow has been cutoff, one disk half stops and the other continues to travel, causing the wedging backside surface to expand the disk halves to seal against both valve seats. The WKM Model M utilized two springs to collapse the disk halves at the start of travel and during disk travel. The WKM D-2 utilized a "Lev-R-Loc" mechanism to connect the disk halves during disk travel and assist in unwedging at the start of travel.

The inspectors reviewed special test packages and engineering evaluations for the following selected motor-operated valves:

2HV6368	CCW to Emergency Cooling Unit 2E400 Containment Isolation Valve
2HV9306	ECCS Pumps Combined Miniflow to RWST, Train A Valve
2HV9307	ECCS Pumps Combined Miniflow to RWST, Train A Valve
2HV9348	ECCS Pumps Combined Miniflow to RWST, Train B Valve
2HV9377	Shutdown Cooling Suction Containment Isolation Valve
3HV9306	ECCS Pumps Combined Miniflow to RWST, Train A Valve
3HV9347	ECCS Pumps Combined Miniflow to RWST, Train B Valve

The inspectors reviewed valve documentation that established the thrust requirements for WKM gate valves in their Generic Letter 89-10 program. The licensee's methods for determining minimum thrust requirements were summarized in the MS-123-125, "SG 89-10 Setpoint Design Guide," Revision 2 . The purpose of this review was to assess the licensee's justifications for assumptions used in WKM thrust calculations, which form the basis for determining the design-basis requirements.

The licensee's thrust calculations utilized the standard industry equations. The licensee used mean-seat diameter measurements to calculate valve seat area. Valve factors were based on in-plant test results. A stem friction coefficient of 0.15 was used for determination of actuator output thrust capability in those cases where valve-specific test data were not available. During valve setup, margin was included to cover diagnostic equipment uncertainty and torque switch repeatability.

The licensee had divided WKM gate valves into two valve groups based on valve size, ANSI-pressure class rating, and valve orientation. The licensee used in-plant data for justification of valve factors for non-dynamically tested motor-operated valves in all groups. These valve groups are discussed below.

- Group 8 (8 and 16 inch WKMs) This group consisted of 3 subgroups. The second and third subgroups consisted of 20 MOVs that do not experience differential pressure loads. Therefore, the licensee determined that differential pressure testing was not required for these valves.

  Subgroup 1 consisted of 16 motor-operated valves (8 inch). Eight valves relied on 1992 dynamic tests to provide open valve factor. The other 8 valves were dynamically tested with strain gages and have reliable valve factors for both the open and close direction. This provided adequate test information to meet the recommendations of Supplement 6 for this subgroup.

- Group 9 (3 inch WKMs) This group consisted of two subgroups that were divided based on pressure class and valve orientation. Each subgroup contained eight valves. The first subgroup had complete tests for only two motor-operated valves which yielded low valve factor results. Each valve in the second subgroup was dynamically tested. The licensee conservatively used the test results of the second subgroup for the first subgroup. Given the horizontal orientation of the second subgroup, the inspectors considered that this was a conservative basis for establishing the initial group valve factor. The licensee planned to obtain additional applicable valve factor information (e.g., from more in-plant testing for Group 9, subgroup 1) as part of its periodic verification program.

The inspectors reviewed dynamic test evaluation packages and associated test reports for the selected motor-operated valves. The purpose of this review was to assess the licensee's efforts to establish design-basis capability for all motor-operated valves in their Generic Letter 89-10 program.

The inspectors noted that Group 9 (3-inch WKMs) contained some motor-operated valves with low apparent thrust margin. This group consisted of 16 motor-operated valves. Seven motor-operated valves had margins that were less than 20 percent, with valve 3HV9307 being the most limiting with 5 percent margin.

Anomalous Behavior

During dynamic testing of valve 2HV-9348, the licensee had noted that the open force trace exhibited a rapid force increase at approximately midstroke. The licensee also noted a change in the seating characteristic which was observed in the static test that was performed after the dynamic test. Based on these observations, the licensee performed maintenance on the valve internals with involved replacement of uneven disc springs, and some minor machining and polishing of the internal wedging surfaces and other non-seating surfaces. A post-maintenance static test showed that the seating anomaly had been eliminated and the licensee considered that the opening anomaly had also been eliminated.

However, the inspectors were concerned that the opening anomaly evidenced during dynamic testing appeared to indicate internal interference during stroking of the valve which was unrelated to the seating anomaly. After comparison with other similar WKM gate valves, it was determined that the open dynamic test's anomaly occurred at the initiation of flow. It was not clear that the removal of the close seating anomaly (observed during a static test) could also be assumed to have corrected the open anomaly observed midstroke during the open stroke under dynamic conditions. Therefore, the inspectors questioned the basis for the licensee's conclusion that the opening anomaly had been eliminated. The licensee had not performed a post-maintenance dynamic test to demonstrate that the maintenance was effective in correcting the a condition that was affecting motor-operated valve performance under dynamic conditions.

The inspectors noted similar anomalous behavior in the opening dynamic trace for valve 3HV-9306. Although all operating forces were determined to be acceptable, seat drag forces before flow initiation inexplicably exceeded the peak unwedging force at the start of disk motion. The inspectors were concerned that the disk assembly may have been installed in the non-preferred direction resulting in premature wedging and double disk drag. The licensee acknowledged the inspectors' concern for the uncharacteristic behavior of valve 3HV-9306, but did not consider the anomaly to indicate improper assembly. The licensee had established positive procedural control to assure proper orientation of the disk during reassembly. The licensee considered the anomaly to be unexpected but acceptable.

The inspectors were concerned that the anomalous behavior of the valves was not well understood by the licensee to assure that it was predictable and would not become a challenge to the adequacy of the actuator capability or switch settings. In response to the inspectors concerns, the licensee identified that repeat dynamic testing of 2HV-9348 and 3HV-9306 was planned for the upcoming outage, at which time additional confirmation of the elimination of the opening anomaly would be obtained. The inspectors considered the planned licensee actions to be adequate. Review of the diagnostic traces for valves 2HV-9348 and 3HV-9306 following dynamic testing during the Cycle 9 refueling outage in November 1996 will be a inspection followup item (50-361/9610-01;50-361/9610-01).

Emerging Issues

The inspectors emphasized the need for the licensee to remain aware of emerging issues which can affect the adequacy of the license's program. The inspectors pointed out the issues recently highlighted in Information Notice 96-48, which included concerns for the use of run efficiency. The licensee currently used run efficiency in the close direction in analyzing actuator capability. Then licensee was evaluating Information Notice 96-48 for its applicability and planned to incorporate appropriate measures to assure that its motor-operated valve program remained based on the best available data for predicting motor-operated valve performance. Review of the licensee's evaluation of Information Notice 96-48 will be an inspection followup item (50-361/9610-02;50-362/9610-02).

c. Conclusions

The licensee had properly grouped its Generic Letter 89-10 valves for the purpose of evaluating valve factors and stem friction coefficients. After addressing several concerns raised by the inspectors, the licensee had assigned well-supported valve factors to each valve group. Initially, the licensee had not adequately addressed rate of loading for some applications, but, by the end of the inspection, the licensee had revised its program to adequately account for this phenomenon.

The inspectors concluded that the licensee had satisfactorily demonstrated the design basis capability of each Generic Letter 89-10 motor-operated valve. Several valves were marginal, and in light of the fact that no margin had been applied for valve factor degradation, the licensee placed additional emphasis on its periodic verification program to ensure that the Generic Letter 89-10 valves would continue to possess adequate capability to perform their design safety functions.

E1.2 Mispositioning (TI 2515/109)

a. Inspection Scope

Supplement 7 to Generic Letter 89-10 deleted the original recommendation to assure that motor-operated valves in pressurized water reactors can recover from inadvertent mispositioning resulting from operator error. The inspectors reviewed the licensee's consideration of inadvertent motor-operated valve repositioning due to faults postulated to occur during a fire in the control room.

b. Observations and Findings

The inspectors reviewed the licensee's actions related to a potential design deficiency identified in Information Notice 92-18, "Potential for Loss of Remote Shutdown Capability During a Control Room Fire." Information Notice 92-18 addressed a concern for spurious uncontrolled operation of motor-operated valves caused by hot shorts occurring in control cables during a control room fire. Information Notice 92-18 identified wiring changes in the valve actuator control circuit that would prevent damage from hot-short operation, allowing subsequent valve repositioning if required. The licensee had determined that the original wiring configurations at San Onofre Nuclear Generating Station, Units 2 and 3, were not vulnerable to inadvertent operation due to hot shorting in the control room wiring.

The inspectors reviewed two typical motor-operated valve control power wiring diagrams and found that the torque and limit switches were located downstream of the control room wiring in the wiring configuration as recommended in Information Notice 92-18.

c. Conclusions

The inspectors concluded that the licensee had adequately addressed the potential for hot-short mispositioning of motor-operated valves.

E1.3 Pressure Locking and Thermal Binding (TI 2515/109)

a. Inspection Scope

Supplement 6 to Generic Letter 89-10 identified that pressure locking and thermal binding were considered to be within the existing design basis of susceptible motor-operated valves. The design basis reviews required for Generic Letter 89-10 should include pressure locking and thermal binding when determining worst-case design basis conditions. Most licensees had not initially considered pressure locking and thermal binding to be within their design basis reviews, but had initiated separate reviews in response to industry notifications. For closure of Generic Letter 89-10, licensees were expected to have made progress in identifying susceptible motor-operated valves and take corrective actions. These corrective

actions could 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 NRC inspection of pressure locking and thermal binding under Generic Letter 89-10 was superseded by the issuance of Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves." Final NRC reviews of the licensee's program to address pressure locking and thermal binding will be performed under Generic Letter 95-07. For purposes of closure of this issue under Generic Letter 89-10, the inspectors focused on licensee corrective actions taken to date in response to those motor-operated valves that had been determined to be susceptible to pressure locking or thermal binding.

b. Observations and Findings

The inspectors reviewed the licensee's Generic Letter 95-07 180-day submittal dated February 13, 1996, and Calculation A-96-NM-MOV-PL/TB-003, "GL 95-07 Pressure Locking and Thermal Binding Performance Evaluation," Revision 0. The licensee had determined that an internal relief valve in WKM valves would limit bonnet pressure and that the thrust required for operation under those conditions would be within the capability of the actuator. As such, the licensee had determined that no modification of the valve internals was required to preclude the potential for pressure locking.

Based on the licensee's current pressure locking calculation method, one valve in each unit (2/3HV9336, Shutdown Cooling Suction Containment Isolation Valve") was determined to have less actuator capability than required to open under worst-case pressure locking conditions. For these valves, the available open thrust was 46974 pounds-force and the maximum pressure locking force was 57905 pounds-force. The licensee intended to replace the existing SB-1 actuators in these valves with SB-4 actuators during the next refueling outage for each unit. To address interim operability, the licensee issued Action Request 960100390, which concluded that any pressure trapped in the bonnet following termination of shutdown cooling (which is the postulated pressure locking scenario for these valves) would have been relieved by subsequent inservice testing stroke testing. The licensee stated that there are no thermal sources that could cause pressurization of the bonnet. The inspectors concluded that the interim operability basis for these valves was valid.

c. Conclusions

Because no apparent operability concerns existed, the inspectors considered the area of pressure locking and thermal binding to be closed under Generic Letter 89-10.

E1.4 Periodic Verification (TI 2515/109)

a. Inspection Scope

The inspectors reviewed the licensee's Document M-42652, "Generic Letter 89-10 Motor-Operated Valves PM Requirements and Intervals," Revision 1, for conducting periodic verification of the adequacy of motor-operated valve switch settings to assure design basis capability. In addition, the inspectors reviewed Technical Paper 14, "Guidelines for the Periodic Performance Verification Testing of Safety Related Motor-Operated Valves."

b. Observations and Findings

The licensee planned to conduct a stroke test of each Generic Letter 89-10 motor-operated valve under static or dynamic conditions every refueling cycle. The licensee planned to develop the use of motor-power monitoring for use in this stroke verification testing. The licensee further planned to perform a quantitative diagnostic test under static or dynamic conditions for each valve at an interval no greater than three refueling cycles. Furthermore, the licensee planned to dynamically test (if practicable) all low margin gate valves within its program (i.e. with less than 20 percent thrust margin or less than 0.8 valve factor capability) at an interval no greater than three refueling cycles.

c. Conclusions

The inspectors found the licensee plans in this area to be adequate for closure of the staff's review of Generic Letter 89-10 at San Onofre Nuclear Generating Station. Further NRC review of this subject area will be conducted under Generic Letter 96-05, "Periodic Verification of Design-Basis Capability of Safety-Related Motor-Operated Valves."

E1.5 Post-Maintenance Testing (TI 2515/109)

a. Inspection Scope

The inspectors reviewed Maintenance Procedure SO23-I-6.31, "WKM Model M Gate Valve Overhaul," Revision 3; and Procedure SO123-I-6.75, "WKM Model D-2 Gate Valve Disassembly, Cleaning, Inspection and Reassembly," Revision 1.

The inspectors reviewed the post maintenance/modification testing requirements identified in licensee Procedure SO23-XV-1, "Post-Maintenance Retest Guide," Revision 2.

b. Observations and Findings

The licensee had incorporated static and dynamic diagnostic testing following maintenance activities or modifications that could affect the design basis capability of motor-operated valves.

The inspectors noted that the licensee had established procedural controls to assure positive control of maintenance activities which could affect valve design basis performance. For example, the licensee match-marked reassembly of valve disks for fitup of the valve internals.

Lubrication of Valve Internals

The inspectors noted that the licensee's maintenance procedure directed lubrication of valve internals following valve internal maintenance to aid in fitup and reassembly. The lubricant was applied to the seating surfaces and all individual components of the valve internal assembly. The procedures directed the use Castor Oil USP Grade in the reassembly of the WKM internals. The inspectors questioned whether the licensee's maintenance practice may temporarily enhanced the valve performance immediately following maintenance. The inspectors were especially concerned that the lubrication may affect the pullout forces and valve factor, making the measured parameters non-representative of expected long-term performance or design-basis performance. The measured pullout force was usually the controlling parameter in assessing the opening capability of the motor-operated valves. The valve factor determined from measured thrust under differential pressure testing was the controlling parameter in assessing the closing capability of the motor-operated valve. The inspectors were also concerned that anomalous behavior attributed to disk sticking or cocking may be temporarily abated by the presence of the lubricant only to reoccur in later service. The inspectors also questioned the compatibility of the lubricant with reactor coolant system chemistry.

The inspectors found that the licensee's engineering personnel were not aware of the maintenance practice of lubricating the valve internals. The inspectors found no precaution against lubrication in the licensee's static or dynamic test procedures.

The licensee considered that any lubricant would be quickly removed under service conditions and after several valve strokes. The licensee further estimated that all valves would have been stroked at least five or six times before undergoing testing following such maintenance. The licensee further justified their opinion based on similar experience with lubricated valve internals at another facility (Diablo Canyon).

The inspectors reviewed the licensee's dynamic test results and did not observe any unusually low valve factors. The licensee acknowledged the inspectors' concern and initiated Action Request 961100657 to review of the effect of lubricants on

valve performance. The licensee performed an interim operability assessment and concluded that the lubricant was not expected to affect the diagnostic data or valve performance. The licensee revised their maintenance procedure to eliminate lubrication of valve internals.

After the onsite exit meeting, the licensee performed testing of a spare 3-inch WKM valve in a test loop that was capable of generating approximately 120 psi differential pressure. The valve was tested initially, lubricated with castor oil, retested, cleaned of the oil, and then tested a third time. According to the licensee, the test results were not useful because of a limited amount of throttling thrust.

The licensee determined that only three valves had actually been serviced (with castor oil applied) and then subsequently tested. The three valves were 2HV-9348, "ECCS Pumps Combined Miniflow to RWST, Train B"; 2HV-9306, "ECCS Pumps Combined Miniflow to RWST, Train A"; and 2HV-6369, "CCW from Emergency Cooling Unit 2E400 Containment Isolation Valve." Valves 2HV-9348 and 2HV-9306 had been dynamically tested approximately 20 months after the application of castor oil, whereas for valve 2HV-6369, dynamic testing occurred approximately one month after the castor oil application. The dynamic valve factors measured for these valves were:

Valve	Closing	Opening
2HV-9348	0.53	0.43
2HV-9306	0.38	0.25
2HV-6369	0.28	0.31

The licensee determined that these valve factors were not abnormally low and did not indicate a trend attributable to castor oil. The licensee stated that the bounding valve factors for the two WKM gate valve groups (8 and 9) would not have been affected had these tests been invalidated and not used in the analysis.

The existing insitu-thrust margins for these three valves were as follows:

Valve	Closing	Opening
2HV-9348	7 percent	51 percent
2HV-9306	46 percent	162 percent
2HV-6369	117 percent	68 percent

The inspectors concluded, in light of the above margins and the fact that bounding valve factors were not affected by this issue, that the only capability concern was the closing function of valve 2HV-9348, possessing only a 7 percent margin. However, since this valve was differential pressure tested 20 months after the application of castor oil, it is likely that either the castor oil had dissipated by the time of the test or, if the lubricating effect was still present to some extent, the effect was more or less permanent at that level.

The licensee planned to retest valve 2HV-9348 during the upcoming outage in November 1996. The licensee stated that the test results will be reviewed to confirm its conclusions regarding the effect of lubrication. Review of the licensee's test results for lubrication effects for valve 2HV-9348 following the November 1996 outage will be included in inspection followup item (50-362/9610-01).

Based on review of the above information, the inspectors considered the issue to be resolved and that no immediate capability concerns existed. Long-term concerns were eliminated by the licensee's intent to no longer use castor oil during maintenance of WKM valves.

The licensee stated that castor oil was an approved lubricant and was compatible in this service application. Also, the licensee stated that other gate valves in the program (Westinghouse, Target Rock, and Walworth/Aloyco) had not been lubricated during maintenance activities.

c. Conclusions

The inspectors concluded that the licensee had established adequate controls for post-maintenance/-modification testing to maintain design basis capability consistent with its Generic Letter 89-10 program. The licensee planned to retest valve 2HV-9348 during the upcoming outage in November 1996 to confirm its conclusions regarding the effect of lubrication of valve internals.

E1.6 Trending of Motor-Operated Valve Failures and Test Results (TI 2515/109)

a. Inspection Scope

The inspectors reviewed Engineering Procedure SO123-V-3.4, "MOV Data Trending," Revision 1, which identified the licensee's performance and failure trending program for motor-operated valves. The inspectors observed a demonstration of the licensee's computer-based trending activity and reviewed "MOV Trend Report," dated August 30, 1996.

b. Observations and Findings

The licensee acquired and reviewed motor-operated valve diagnostic data from testing under static and dynamic conditions. The licensee derived several measures of motor-operated valve performance from the diagnostic data which the licensee trended to detect degradation in design basis capability. The performance measures which the licensee trended were available seating thrust/torque margin, pullout torque margin, stem factor margin, spring pack preload, and stem nut wear. In addition, the valve factor determined from differential pressure testing was trended along with any anomalous trace indications. The license trended both individual valve performance and valve group performance. The licensee also utilized motor-power monitoring as an additional diagnostic tool to monitor motor

performance. Motor-operated valve failure types were coded and trended as part of the licensee action request/non-comformance report program. The trend data was periodically reviewed for feedback into the preventative maintenance program. The licensee planned to further develop its trending activities to establish meaningful performance indicators based on the results of periodic verification testing.

c. Conclusions

The inspectors concluded that the licensee's trending activities were adequate for closure of the NRC review of Generic Letter 89-10.

E1.7 Evaluations and Corrective Actions Taken in Response to Motor-Operated Valve Failures (TI 2515/109)

a. Inspection Scope

The inspectors reviewed selected condition reports to assess the adequacy of the licensee's corrective actions for recent motor-operated valve problems. The inspectors sampled 17 of 85 action request and non-conformance reports for motor-operated valves problems encountered during the last 2 years.

b. Observations and Findings

The inspectors observed consistently thorough root cause evaluations for motor-operated valve problems and action taken in a timely manner to correct the problems. As an example, the inspectors considered the corrective actions in Non-Conformance Report 9400022 for a design deficiency in motor-operated valve control circuit voltage to be a timely and thorough.

Anomalous performance displayed during diagnostic testing prompted valve disassembly for inspection, rework, and retesting prior to returning to service.

The inspectors did not identify any examples of inadequate corrective actions for the identified problems.

c. Conclusions

The inspectors concluded that the licensee's corrective actions were consistent with its Generic Letter 89-10 program for assuring the design basis capability of motor-operated valves.

E1.8 Generic Letter 89-10, Supplement 5, "Inaccuracy of Motor-Operated Valve Diagnostic Equipment" (TI 2515/109)

a. Inspection Scope

Supplement 5 to Generic Letter 89-10 informed licensees of the need to verify that vendor recommendations concerning uncertainties associated with diagnostic test systems were properly incorporated into the licensee's motor-operated valve program. The inspectors reviewed the licensee's program to verify that the application of diagnostic uncertainties was consistent with the licensee's response to Supplement 5.

b. Observations and Findings

The inspectors found the licensee's method of applying diagnostic uncertainties to be consistent with its response to Supplement 5 of Generic Letter 89-10.

E2 Engineering Support of Facilities and Equipment

a. Inspection Scope

A recent discovery of a licensee operating their facility in a manner contrary to the Updated Safety Analysis Report description highlighted the need for a special focused review that compares plant practices, procedures and/or parameters to the Updated Final Safety Analysis Report descriptions. While performing the inspections discussed in this report, the inspectors questioned the licensee concerning the accuracy of Safety Analysis Report that related to the areas inspected.

b. Observations and Findings

The licensee was in the process of performing a comprehensive review of the Units 2 and 3 Safety Analysis Reports including motor-operated valves and the Generic Letter 89-10 program. According to the licensee, no discrepancies have been identified.

E7 Quality Assurance in Engineering Activities (TI 2515/109)

a. Inspection Scope

An important element in closing the Generic Letter 89-10 program is the degree to which the licensee's quality assurance organization is involved in the oversight of the program.

The inspectors reviewed quality assurance audits, surveillances, and self assessments of the motor-operated valve program performed during the past 2 years.

b. Observations and Findings

The inspectors found that quality assurance had been involved throughout the implementation of the licensee's program. However, the inspectors considered the licensee's oversight activities to be limited, with little technical depth. The inspectors noted that two self assessments of certain areas of the licensee' program had been performed in 1993; however, the licensee had not performed a recent comprehensive assessment of the Generic Letter 89-10 program to verify that all elements of the Generic Letter had been satisfactorily implemented. Also, the inspectors noted that audits performed in this area lacked technical depth and did not identify any significiant program deficiencies.

c. Conclusions

Although oversight of the program was weak, the licensee's quality assurance involvement of the motor-operated valve program was adequate for closure of Generic Letter 89-10. At the exit meeting on November 8, 1996, the licensee acknowledged the inspectors' concerns and identified that recent organizational changes had been made to improve the technical depth of the nuclear oversight department. The inspectors encouraged further attention to the oversight of the long-term aspects of the licensee's motor-operated valve program.

E8 Miscellaneous Engineering Issues (92903)

E8.1 (Closed) Inspection Followup Item 50-361/9515-02;50-362/9515-02: No Hard Seating Required in Signature Analysis

Background

During a previous motor-operated valve inspection, the inspectors noted that the closing dynamic diagnostic trace of valve 3TV-9267 did not indicate that the valve had reached hard-seat contact. The licensee stated that upstream and downstream pressure traces provided positive indication that the valve had closed. Although the inspectors agreed with this assessment, a concern was expressed that since valve 3TV-9267 is a containment isolation valve, the soft closure indicated on the diagnostic trace may not sufficiently isolate flow to meet specified leakage limits.

Followup

The licensee readjusted the torque switch setting for valve 3TV-9267 to achieve additional sealing force. During this inspection, the inspectors reviewed the diagnostic traces for static tests conducted before and after the torque switch for

valve 3TV-9267 had been raised to a higher setting. The inspectors also reviewed a dynamic diagnostic trace of the identical valve in Unit 2. Although valve 3TV-9267 was not retested dynamically, the inspectors concluded, based on the test information discussed above, that the thrust at torque switch trip for valve 3TV-9267 was clearly sufficient to achieve positive hard-seat contact under design dynamic conditions.

E8.2 (Open) Inspection Followup Item 50-361/9507-01;50-362/9507-01: Refueling Water Storage Tank Outlet Valve Periodic Maintenance

Background

Two concerns remained open regarding this item from previous inspections. The first concerned the frequency of scheduled preventative maintenance for the refueling water storage tank outlet valves. The licensee had established an 8-year preventive maintenance interval. The second concerned the licensee's determination of the safety function for the valves. The licensee had determined that the refueling water storage tank outlet valves did not have a active safety function to close.

Followup

During this inspection, the inspectors reviewed the licensee's basis for the preventative maintenance interval for the refueling water storage tank outlet valves. The licensee had replaced the stem protectors for the refueling water storage tank outlet valves with a totally enclosed stem protector to prevent water intrusion into the actuator. The inspectors found that the licensee had established a periodic verification interval consistent with their Generic Letter 89-10 program. The licensee had established an annual stem lubrication frequency and diagnostic testing every 2 years until results could justify a reduction in the frequency of periodic verification testing.

According to the licensee, repeat diagnostic testing in February 1995 and July 1996 for these valves in both units were successful. The inspectors concluded that the additional activities of replacement of the stem protector, annual stem lubrication, and biannual diagnostic testing adequately supported the licensee's preventative maintenance schedule consistent with its Generic Letter 89-10 program.

The second concern regarding the licensee's determination that the refueling water storage tank outlet valves did not have a active safety function to close has been referred to the Office of Nuclear Reactor Regulation for further review. This item will remain open pending completion of the review by Office of Nuclear Reactor Regulation.

E8.3 (Closed) Inspection Followup Item 50-361/9526-01;50-362/9526-01: WKM Valve Guide Rails

Background

This item involved the failure of shutdown cooling containment isolation valve 3HV-9339 to fully open. The WKM gate valve failed because of a dislodged guide rail. Several questions existed and certain licensee actions were unfinished at the time this item was opened.

Followup

The licensee addressed the NRC concerns in Non-Regulatory Action Tracking System Item 9602000386, Items 1 through 4, dated April 30, 1996. The inspectors reviewed this document and examined a WKM valve model as it relates to this event. The inspectors agreed with the licensee that the separation of a guide rail would not likely affect the closing function of the valve.

The licensee had completed its review of all WKM diagnostic traces to detect "subtle effects" that may be indicative of guide rail damage or shearing and had determined that these traces gave no evidence of guide rail problems. The licensee had shortened the opening stroke of the WKM valves to minimize the impact loading of the "Lev-R-Loc" shoes against the top surface of the guide rails during the subsequent closing stroke.

The inspectors concluded that the licensee had satisfactorily addressed this issue. The licensee had adequately demonstrated the low safety impact of the event and had taken reasonable actions to lessen the probability of recurrence.

V. Management Meetings

X1 Exit Meeting Summary

The inspectors presented the inspection results to members of licensee management at the conclusion of the inspection on November 8, 1996 and during conference calls conducted on December 5 and 12, 1996. The licensee acknowledged the findings presented. The licensee did not identify as proprietary any of the information presented to the inspectors during the inspection.

ATTACHMENT

PARTIAL LIST OF PERSONS CONTACTED

Licensee

M. Anderson, Supervisor, Nuclear Engineering Design Organization
D. Axline, Engineer, Nuclear Regulatory Affairs
D. Bradford, Engineer, Nuclear Engineering Design Organization
D. Breig, Manager, Station Technical
J. Curran, Project Manager, Nuclear Engineering Design Organization
E. David, Lead Engineer, Nuclear Engineering Design Organization
G. Gibson, Manager, Compliance
D. Irvine, Manager, Technical Support
J. Leavitt, Supervisor, Maintenance
D. Niebruegge, Supervising Engineer, Station Technical
D. Nunn, Vice President, Engineering and Technical Services
K. Slagle, Manager, Nuclear Oversight
M. Wharton, Manager, Nuclear Engineering Design Organization

NRC

J. Sloan, Senior Resident Inspector
C. VanDenburgh, Chief, Engineering Branch, Region IV

LIST OF INSPECTION PROCEDURES USED

TI 2515/109	Inspection Requirements for Generic Letter 89-10, Safety-Related Motor-Operated Valve Testing and Surveillance
IP 92903	Followup - Engineering

LIST OF ITEMS OPENED AND CLOSED

Opened

50-361;362/9610-01	IFI	Repeat Testing of Valves 3HV-9348 and 2HV-93-6 (Sections E1.1.b and E1.5.b)
50-361;362/9610-02	IFI	Evaluation of Information Notice 96-48 (Section E1.1.b)

Closed

50-361;362/9515-02	IFI	No Hard Seating Required in Signature Analysis (Section E8.1)
50-361;362/9526-01	IFI	WKM Valve Guide Rails (Section E8.3)

Discussed

50-361;362/9507-01 IFI RWST Outlet Valve Periodic Maintenance (Section E8.2)