ENCLOSURE

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-416/96-03

License: NPF-29

Licensee: Entergy Operations, Inc.
P.O. Box 756
Port Gibson, Mississippi

Facility Name: Grand Gulf Nuclear Station

Inspection At: Port Gibson, Mississippi

Inspection Conducted: January 22-26 and February 12-16, 1996

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

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Accompanying
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Approved: _____ 3-19-96
C. A. VanDenburgh, Chief, Engineering Branch Date
Division of Reactor Safety

Inspection Summary

Areas Inspected: Routine, announced inspection of actions taken by the licensee to complete commitments to Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance."

Results:

Engineering

- The licensee had satisfactorily completed its commitments to Generic Letter 89-10. The program closure was contingent on a commitment made by the licensee to enhance the margin of two motor-operated valves (E51F063 and E51F064), before the end of Refueling Outage RF08, currently scheduled to begin in October 1996 (Sections 1 and 1.7.2).

- The inspection identified a strength, in that the licensee had a large, integrated staff directly involved in the motor-operated valve program, which should provide long-term stability to the program (Section 1).

- The licensee had dynamically tested (in a manner sufficient to quantify valve factor) less than 10 percent of the Generic Letter 89-10 valve population. The inspectors noted that this was considerably less than the approximately 40-60 percent test percentage at most nuclear utilities (Section 1.1).

- The inspectors were concerned that the licensee's contractor (Siemens, Inc.) had developed a grouping study that had not been demonstrated to be capable of predicting major valve damage (Section 1.1).

- The inspectors identified that additional information was needed for the long-term justification of two valve groups, the 150-pound Powell Gate Valve GA1 Group (which was assigned a 0.62 valve factor) and the 600/900-pound Powell Gate Valve GA1 Group (which was assigned a 0.50 valve factor). This item will be followed up as an open item (Section 1.2).

- The licensee did not define a design margin to account for stem lubrication degradation (i.e., aging). Rather they established a small margin to account for packing load increases. The inspectors were concerned that this packing margin may be insufficient to accommodate both packing and lubrication degradation. The licensee plans to validate the adequacy of the margin by performing as-found testing (Section 1.3).

- The inspectors identified a fundamental error in the licensee's calculation of the open valve factor. Although this error resulted in the identification of nonconservative open valve factors, the error did not affect existing margins because the licensee did not use their calculation of open valve factor in valve capability calculations (Section 1.4).

- The inspectors identified that the licensee's use of a design margin of 5 percent to account for load sensitive behavior (i.e., rate of loading) was not supported by their test data. During the inspection, the licensee increased the design margin to 10 percent and recalculated valve capability margins based on the new assumption. As a result, the licensee identified 12 valves with an available valve factor that was less than the factor assigned to the valve's group. However, the licensee was able to demonstrate their operability (Section 1.5).

- The inspectors noted that the licensee had not applied any design margin to account for potential increases in valve factor over time. The licensee plans to justify this assumption when relevant industry test data becomes available (Section 1.6).

- The inspectors identified that the licensee had used a questionable methodology to evaluate the capabilities of two valves (E51F063 and E51F064) and had missed several opportunities over approximately 4 years to eliminate the marginal status of these valves. The inspector's considered the long-term marginal status of the valves to be indicative of a program weakness. The valves were considered currently operable based on a near full-stroke bypass of the torque switch (Section 1.7.2).

- The licensee identified seven valves as being susceptible to pressure locking and had analyzed the current operability status of the valves with satisfactory results (Section 2).

- The inspectors questioned the licensee's method to determine the torque output of Valve B21F016 because it relied on a dimensional measurement which had a larger-than-expected deviation from the manufacturer's nominal value (Section 3.2.1).

- The inspectors concluded that the licensee's use of 110 percent starting torque for a direct-current motor-operated valve was acceptable, but potentially vulnerable to invalidation subject to new information expected to be published by the vendor (Limitorque) in the near future (Section 3.2.2).

- Although the licensee had performed extensive self-assessments of the motor-operated valve program, the inspectors found several instances where corrective actions were not performed for what appeared to be valid findings (Section 7).

Summary of Inspection Findings:

- Inspection Followup Item 416/9603-01 was opened (Section 1.2).
- Inspection Followup Item 416/9603-02 was opened (Section 1.7.2).
- Inspection Followup Item 416/9603-03 was opened (Section 3.2.1).

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, seven supplements to the generic letter have been issued. NRC inspections of licensee actions implementing commitments to Generic Letter 89-10 and its supplements have been 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 contains two sections: Part 1, "Program Review"; and, Part 2, "Verification of Program Implementation." The Part 1 program review inspection at Grand Gulf Nuclear Station was documented in NRC Inspection Report 50-416/92-01. The Part 2 implementation review inspection at Grand Gulf was documented in NRC Inspection Report 50-416/94-01.

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 process 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. The inspectors used the guidance contained in this document during this inspection.

The process of "closing" a licensee's Generic Letter 89-10 program includes verifying that the licensee has satisfactorily applied the principles contained in Generic Letter 89-10 (or suitable alternate methods) to demonstrate, in a rigorous manner, the design basis capability of each motor-operated valve in the program. Closure of a licensee's program will not preclude additional inspections in this area. 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. The program should be updated to incorporate new information. This concept is sometimes described as a "living program."

The inspectors concluded that the licensee had satisfactorily completed its commitments to Generic Letter 89-10. However, the closure of the program was contingent on a licensee commitment to enhance the operating margin of two motor-operated valves (E51F063 and E51F064) before the end of Refueling Outage RF-08, currently scheduled to begin October 1996. The inspection also identified several deficiencies and weaknesses in the motor-operated program, which will require corrective action; however, these actions did not preclude closure of the program. The inspection also identified a strength regarding

the large, integrated staff that was directly involved in the motor-operated valve program. The inspectors concluded that this level of continued involvement should provide long-term stability to the motor-operated valve program.

The inspectors noted that the closure of the licensee's motor-operated valve program 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 two new generic letters, were reviewed on an interim basis only for closure under Generic Letter 89-10.

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

The inspectors reviewed the Generic Letter 89-10 program procedures and associated documents, including the testing summary sheets that documented the current status for each motor-operated valve in the Generic Letter 89-10 motor-operated valve program. These procedures included:

- Mechanical Standard GGNS-MS-25.0, "Mechanical Standard for Motor Operated Valve Torque and Limit Switches," Revision 10, dated January 21, 1996;

- Administrative Procedure 01-S-17-19, "Motor Actuator Thrust Test Program," Revision 5, dated January 18, 1996;

- Plant Operations Manual 17-S-10-16, "Performance and System Engineering Instruction, Safety Related MOV Program," Revision 4, dated May 20, 1994; and,

- Mechanical Standard GGNS-MS-49, "Mechanical Standard for NPE Evaluation of Motor-Operated Valve Flow Test Results," Revision 0.

Using these documents, the inspectors reviewed the motor-operated valve population to assess the methods used by the licensee's program to demonstrate the design-basis capability of these motor-operated valves. These methods included verification by: (1) valve-specific dynamic test at, or near, design-basis conditions; (2) valve-specific test, linearly extrapolated to design-basis conditions; and, (3) application of in-plant and external test data to motor-operated valves that were not practicable to test.

The scope of the licensee's Generic Letter 89-10 program consisted of 234 motor-operated valves. Out of this scope, the licensee dynamically tested 40 valves. However, not all of these dynamic tests resulted in data from which valve factors could be quantified because some of the tests utilized the MOVATS diagnostic system without inclusion of a thrust measurement device. The licensee considered these non-quantified dynamic tests to be "proof tests;" therefore, the actual number of quantifiable tests was approximately 20. The inspectors noted that this was less than 10 percent of the licensee's Generic Letter 89-10 valves and considerably less than the industry average of 40-60 percent.

1.2 Valve Grouping Study

The licensee's thrust calculations typically used standard industry equations to determine the thrust requirements for rising stem gate and globe valves. For rising-stem, motor-operated valves that had been dynamically tested, the licensee used measured valve factors to ensure that the thrust calculations remained conservative. For gate valves that had not been dynamically tested, the licensee typically relied upon the application of in-plant test data using a methodology developed by a contractor (Siemens, Inc.).

The contractor provided the methodology for the application of in-plant data in a series of reports addressing specific families of motor-operated valves. The contractor identified 19 different valve groups and performed a detailed analysis of onsite and external test results pertinent to each group to determine a representative valve factor. This valve factor was then used to calculate the thrust requirements for the untested valves in the group. The inspectors reviewed the reports for each valve group and discussed the report with the licensee and contractor's representatives. These discussions identified several items for additional review.

Specifically, the inspectors noted that the contractor's methodology had been demonstrated to be capable of predicting the conditions under which the motor-operated valves may incur minor damage. However, the methodology had not been shown to be capable of predicting the onset of major damage, where valve performance would be unpredictable. Although, the contractor stated that they would research their records to determine whether this modeling capability could be demonstrated, this question was not resolved at the conclusion of the inspection.

The inspectors were also concerned with the assumptions the contractor used for two of the valve groups: the 150-pound Powell Gate Valve GA1 Group (which was assigned a 0.62 valve factor) and the 600/900-pound Powell Gate Valve GA1 Group (which was assigned a 0.50 valve factor). Both these valve groups contained approximately 36 valves of which only two had been dynamically tested. In addition, there were large differences in the valve sizes (3- to 28-inch diameter) within the 600/900-pound Powell Gate Valve GA1 Group. The inspectors were concerned that the identified valve factors may not bound some of the worst-performing valves in these groups and concluded that additional information would be needed to justify the selected values for long-term resolution. The resolution of this issue and the issue discussed in the preceding paragraph were identified as an inspection followup item (416/9603-01).

1.3 Inadequate Assumptions for Valve Degradation Margin

Administrative Procedure 01-S-17-19, "Motor Actuator Thrust Test Program," Appendix 2, contained the licensee's position regarding the design margin necessary to account for potential valve degradations. This procedure indicated that a margin of 25 percent of the design packing load was set aside ". . . to account for other anomalies that may act to degrade motor-operated

valve performance (stem lubrication degradation, packing friction increase, etc.) . . . ." However, a later section of the same procedure stated that, ". . . P&SE [Performance and System Engineering] does not feel that any margin need be applied specifically for stem lubrication degradation . . . ." The licensee based this position on Electric Power Research Institute (EPRI) testing of the licensee's stem lubricant (Mobilux EP-1), which the licensee applied to every Generic Letter 89-10 motor-operated valve each refueling outage.

The inspectors questioned the licensee's basis for this design margin because the referenced EPRI study only addressed load changes over multiple strokes in a short period of time and did not address stem lubricant degradation (i.e., aging). The inspectors concluded that the identified design margin actually addressed packing friction increases due to hardening of the packing and did not address the additional anomalies that may degrade valve performance, such as stem lubricant degradation. A 25 percent design margin of the typical packing load results in a thrust of approximately 250 pounds-force per inch of stem diameter. This value is well below the degradation margin assumed by most nuclear utilities for most valves (i.e., typically 5 percent of the torque switch trip thrust). The inspectors considered the lack of a design margin for stem lubricant degradation to be acceptable for short-term operation; however, a long-term resolution of the adequacy of this design margin is required. The licensee agreed with the inspectors' observation and stated that as-found testing would be performed to validate their design margin assumptions.

The inspectors also noted that the licensee did not generally rely on an assumed stem friction coefficient. Whenever possible, the licensee measured a motor-operated valve's torque output to ensure that the torque limits were not exceeded. The inspectors noted that the licensee assumed a 0.2 stem friction coefficient during the evaluation of the available thrust capability in the open direction of motor-operated valves that were not differential-pressure tested. In addition, the licensee did not include any degradation margin (or load sensitive behavior margin) when determining the design basis thrust requirements for the open direction. However, the inspectors concluded that this practice was acceptable because most of the measured stem friction results fell in the range of 0.08 to 0.15. Therefore, the assumed stem friction coefficient provided a sufficient open thrust margin to account for these effects.

1.4 Calculation Error in of Open Valve Factor

During review of a dynamic test conducted on Valve P41F016A the inspectors noted a calculation error. This valve is the outboard isolation valve for the Train "A" service water system blowdown to the discharge basin. The inspectors noted that the open valve factor calculation in Appendix C of Mechanical Standard GGNS-MS-49, "Mechanical Standard for NPE Evaluation of Motor-Operated Valve Flow Test Results," did not add the stem rejection force present during the test to the measured opening force needed to overcome the dynamic test conditions. The stem rejection force is an outward force on the

valve stem resulting from the pressure in the valve bowl acting over the area of the valve stem. These forces help to open the valve in the open direction, but are not detected by the diagnostic measurement equipment.

As corrective action for this concern, the licensee revised Mechanical Standard GGNS-MS-49 to correct this calculation error, and stated that all existing open valve factor determinations that used this method would be revised. Although this error in the open valve factor calculation resulted in nonconservative valve factors, the licensee determined that the revisions in the calculation would not adversely affect the previously-calculated capability margin for any motor-operated valve in the Generic Letter 89-10 program. The reason for this is that, for valves that were static tested only, the licensee used the overall group valve factor for the open evaluations; and the contractor, Siemens, Inc., properly accounted for the stem rejection forces in its determination of the bounding valve factors. For valves that were differential pressure tested, the licensee directly extrapolated the thrust to design basis conditions. In either case, the nonconservative open valve factor had no impact on any valve's analyzed capability in the open direction.

1.5 Inadequate Load Sensitive Behavior (Rate of Loading) Margin

The licensee had determined the design margin for the load sensitive behavior (i.e., rate-of-loading) for non-dynamically tested motor-operated valves in Engineering Evaluation Report 96/6008, Attachment 1. The licensee extrapolated this margin from the tests of several motor-operated valves at different differential pressure conditions. Based on these results, the licensee had selected a load sensitive behavior of 5 percent.

The inspectors reviewed this evaluation and noted that the majority of the tests resulted in negative load sensitive behavior. In the context of the licensee's calculational method, this indicated that more thrust was measured at the torque switch trip during the dynamic test, than was measured during the static test. After further discussion, the inspectors determined that the load sensitive behavior data had been adjusted by subtracting the diagnostic equipment uncertainty and torque switch repeatability from the thrust measured at the torque switch trip during the static test. However, this same adjustment had not been made to the thrust measured at torque switch trip during the dynamic test.

The inspectors concluded that this calculation method was not correct because it effectively neglected any load sensitive behavior that was masked by diagnostic equipment uncertainties. To resolve this concern, the licensee recalculated all the test results using the unadjusted values from the diagnostic tests. The results from this evaluation showed that almost all of the negative load sensitive behavior values changed to positive values. As a result, the licensee decided to change the load sensitive behavior (i.e., rate of loading) margin to 10 percent.

The inspectors reviewed the procedural change and determined that the new assumption of 10 percent was consistent with the test data. The licensee stated that the actual load sensitive behavior that was measured would be used for dynamically tested valves. In addition, a review of test data could, in some cases, be used to analytically justify a lower margin for load sensitive behavior in the operability assessments for specific motor-operated valves. The inspectors considered these positions to be acceptable. The resolution of the operability implications of this revision to the load sensitive behavior design margin are discussed in Section 1.7 of this report.

1.6 Valve Factor Degradation

The inspectors reviewed a licensee position statement addressing valve factor degradation, as delineated in Administrative Procedure 01-S-17-19, Appendix 2. This position statement indicated that, ". . . [dynamic] test candidates were selected based on susceptibility to wear induced performance degradation . . . ." The licensee indicated that the observed valve factors would be bounding for all of the untested valves in the groups. The position statement also stated that ". . . no special consideration for valve factor degradation need be instituted at the field level . . . ."

The inspectors noted that the licensee's position assumed that degradations resulting in higher valve factors would not occur in the future. Although the inspectors were not aware of any industry data to support or invalidate this concept, the inspectors were concerned that this position did not account for the possibility that this type of degradation may occur.

As discussed in Section 5 of this report, the NRC is preparing a new generic letter on motor-operated valve periodic verification. The licensee indicated an intention to review onsite and industry periodic test results to determine whether a margin for valve factor degradation should be provided.

1.7 Recalculation of Valve Capability Margins

As discussed in Section 1.5, the licensee revised their assumption for the load sensitive behavior margin from 5 to 10 percent. In order to address the operability effects of this change, the licensee generated a list of capability margins for all gate valves and a select population of globe valves that were affected by this change in design margin. This list was generated by computing an available valve factor and comparing it to the bounding valve factor assigned to the valve group by the contractor's study.

The licensee also reanalyzed the calculations for valves that did not initially meet the revised assumptions to identify sources of extractable conservatism. As a result of this review, the licensee identified 12 valves with an available valve factor that was less than the valve factor assigned to

the valve's group. The licensee reanalyzed each of the 12 valves and found that by using more realistic assumptions for differential pressure conditions, 9 of the valves could be demonstrated to have sufficient margin to support the assumed valve factor. The remaining 3 valves (E51F063, E51F064, and E22F004) are addressed in Sections 1.7.1 and 1.7.2 below.

1.7.1 Valve E22F004

Valve E22F004 is a 12-inch Anchor Darling 655-pound gate valve that functions as the high pressure core spray injection shutoff valve. The inspectors noted that this valve was the only valve in the valve family (designated AD655), and that it had been differential pressure tested. However, the licensee considered this test to be a "proof test," because the licensee did not infer thrust from the MOVATS spring pack displacement measurements taken during the test. Therefore, the dynamic test did not provide a valve factor or load sensitive behavior data.

The licensee considered this test (which was performed at 1370 psid) to be adequate for demonstration of the valve's design-basis capability. However, the inspectors noted that the design-basis differential pressure for Valve E22F004 was 1446 psid. Therefore, the "proof test" was not performed at 100 percent of design-basis conditions, and the test did not take into account the need for the valve to operate under degraded voltage. The inspectors asked for additional information to evaluate the capability of this valve.

The licensee had identified this valve as having a negative design margin of -1.57 percent in Material Nonconformance Report 0015-96. This report took two approaches to demonstrate the valve's operability. First, it used measured packing loads (instead of the higher design loads) to show that the valve had a 3-percent thrust margin. However, this method did not account for any potential load sensitive behavior. Second, the report took some credit for the MOVATS diagnostic measurements in an attempt to infer an apparent valve factor. The report used a diagnostic equipment uncertainty of 20 percent in this analysis. Using a valve factor of 0.45, the licensee extrapolated the test results up to design-basis conditions, and estimated that Valve E22F004 had a 16 percent thrust margin. Again, this second method did not account for any potential load sensitive behavior.

The inspectors reviewed the method used by the licensee to infer the 0.45 valve factor for Valve E22F004 and noted that the licensee was using a relationship between spring pack deflection and thrust recorded during a static MOVATS diagnostic test. The inspectors noted that this method assumed that stem friction was equal for both the static and dynamic stroke. Since load sensitive behavior effects generally result in higher stem friction under dynamic loads, the predicted thrust values were probably overestimated.

However, since this data resulted in a 16 percent thrust margin, the expected load-sensitive behavior effects (nominally assumed to be 10 percent) were still accommodated in the final analysis. Based on these facts, the inspectors concluded that the licensee had adequately justified the margin for this valve.

1.7.2 Valves E51F063 and E51F064

Valves E51F063 and E51F064 are 10-inch, 900-pound, Powell gate valves used as the drywell inboard and outboard isolation valves in the steam supply to the reactor core isolation cooling system. These valves were both in the 600/900-pound Powell Gate Valve GA1 Group to which the licensee's grouping methodology applied a 0.50 valve factor. This valve factor was based on two in-plant tests, a prototype test at Wyle Laboratory, and a 10-inch, 900-pound, Powell gate valve that was tested by the Idaho National Engineering Laboratory as part of the NRC-sponsored test program performed to address Generic Issue 87.

The licensee indicated that the 0.50 valve factor for this valve group was not used in the capability calculation for E51F063 and E51F064. The licensee had used information provided to them by the contractor's (Seimen, Inc.) Phase IV report for the 600/900-pound Powell Gate Valve GA1 group to determine a lower valve factor. The licensee stated that these valves were the same size, type, and manufacturer as the valve tested at the Idaho National Engineering Laboratory. However, the inspectors noted that the valve factor used by the licensee for these two valves (0.36) was not the same as that reported by the researchers at the Idaho National Engineering Laboratory.

Specifically, the Idaho National Engineering Laboratory researchers had reported that a 0.45 valve factor would be the minimum acceptable for the tested valve. The inspectors noted that the licensee had extrapolated the Idaho National Engineering Laboratory testing data using a best-fit line method on a plot of valve factor versus differential pressure. This extrapolation involved four data points corresponding to four different differential pressures applied during the testing at the Idaho National Engineering Laboratory. These differential pressures were all less than the maximum expected differential pressure for these valves (1080 psig). The inspectors considered this extrapolation to be invalid because it did not account for statistical deviations about the best-fit line. The extrapolation generated, in effect, a 50-percent confidence result. Further, the licensee did not apply any margin to account for differences in performance that can be expected between the valve tested at Idaho National Engineering Laboratory and the two valves installed in the plant. Large differences in performance of "identical" valves have been observed in many industry tests.

Based on the fact that the assumed 0.36 valve factor was not well supported, the inspectors questioned the basis for the licensee's operability determination for Valves E51F063 and E51F064. The licensee indicated that the torque switch bypasses for these two valves extended beyond the point of flow cutoff. In addition, the degraded voltage capability of the valves appeared

sufficient to reach the torque switch bypass point in the stroke even if a 0.45 valve factor was assumed. Based on these facts, the inspectors considered the valves operable for a short-term assessment. For long-term disposition of this issue, the licensee committed to enhance the margins of Valves E51F063 and E51F064 prior to startup following Refueling Outage RF08. An inspection followup item (416/9603-02) was identified to verify completion of this commitment.

The inspectors observed that the licensee had not taken advantage of several opportunities (refueling outages) to correct the marginal status of Valves E51F063 and E51F064. Though some action was taken, such as switch setting changes, the marginal status of these valves was not fully addressed. This inaction was apparently based on a misguided confidence in the precise applicability of the Idaho National Engineering Laboratory test data to the valves installed in the plant.

The inspectors considered the failure to consult Idaho National Engineering Laboratory during the analytical review of the test information, the extrapolation of valve factors without consideration of statistical deviation, and the failure to apply a margin to account for expected differences in performance among same-model valves, to represent weaknesses in the licensee's Generic Letter 89-10 program.

2 PRESSURE LOCKING AND THERMAL BINDING

The inspectors reviewed the efforts taken by the licensee to identify and provide corrective actions for motor-operated valves that may become operationally compromised by the mechanisms of pressure locking and thermal binding. Generic Letter 89-10, Supplement 6, stated that pressure locking was considered to be within the existing design basis of susceptible motor-operated valves.

On August 17, 1995, the NRC issued Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves." This generic letter refocused the issue, applied time limits for licensee resolution, and expanded the scope to include pneumatic-, hydraulic-, and solenoid-operated gate valves. For closure of Generic Letter 89-10, the NRC is reviewing existing evaluations and verifying that corrective actions had been taken, where necessary, to ensure immediate operability of susceptible valves. The inspectors reviewed Calculation MC-Q1111-95049, "Flex Disc Valve Analysis for Various Valves," Revision 0. Within this calculation, 18 valves considered susceptible to pressure locking were evaluated to determine the total stem thrust required to open the valves under worst-case pressure-locked conditions. The calculation indicated that 7 of the 18 valves may have insufficient thrust to open when pressure locked at the assumed conditions. The inspectors requested information from the licensee documenting the current operability basis for these valves. The 7 valves of concern were as follows:

Valve No.	Function
E12F004C	RHR "C" Pump Suction from Shutdown Cooling Isolation,
E12F024A	RHR "A" Test Return to Suppression Pool,
E12F024B	RHR "B" Test Return to Suppression Pool,
E12F064A	RHR "A" Minimum Flow to Suppression Pool,
E12F064B	RHR "B" Minimum Flow to Suppression Pool,
E51F013	RCIC Injection Shutoff Valve, and
E51F031	RCIC Pump Suction from Suppression Pool Isolation.

The licensee provided Material Nonconformance Reports 0270-95, 0285-95, 0286-95, and 0287-95 and Engineering Action Requests MC-126-95 and MC-135-95, which collectively addressed the operability basis of the seven valves. The material nonconformance reports used a past operating history showing no signs of pressure locking as the principal basis for immediate operability. The engineering action requests provided a refinement of the evaluation process by, among other methods, taking credit for the measured stem friction coefficient (in lieu of the assumed bounding value) to compute opening thrust capability. The inspector concluded that the engineering action request evaluations provided a valid interim operability basis for all of the valves with the exception of Valves E12F004C and E51F031. The licensee stated that Valve E12F004C did not have any safety-related opening function and, therefore, should not be considered within the scope of the review. This left Valve E51F031 as the principal concern.

The licensee's conclusion regarding the operability of Valve E51F031 included the assumption that a stall condition may occur upon the initial opening start signal. At this time the bonnet would be pressurized to 1391 psig and upstream pressure would be near zero. The upstream pressure would increase as the reactor core isolation coolant pump started and the differential pressure across the upstream valve disc would decrease within 10 seconds to an extent that the valve could open. The inspectors were concerned that the output capability of the valve's motor could be affected by heat generation resulting from the 10-second stall condition. However, the inspectors determined that the licensee's current position was satisfactory for closure under Generic Letter 89-10. Final NRC acceptance of the licensee's pressure locking and thermal binding program will be conferred as a result of review of the licensee's response to Generic Letter 95-07. The inspector also noted that the licensee intended to modify certain valves over the next several refueling outages to eliminate their susceptibility to pressure locking.

3 TRENDING AND FAILURE ANALYSIS

3.1 Trending

The inspectors reviewed the licensee's program to trend motor-operated valve failures and performance parameters. This element of the licensee's Generic Letter 89-10 program is important because it potentially enables the identification of a degrading motor-operated valve in time for corrective actions to preclude an operational failure.

The licensee's program to trend performance characteristics and failures of motor-operated valves was under revision at the time of this inspection, but was operating satisfactorily for closure under Generic Letter 89-10. The inspectors noted that some valve performance elements that are commonly trended by other nuclear facilities, such as torque switch trip thrust and motor current, were not being trended at Grand Gulf Nuclear Station. However, the licensee indicated that these and other parameters may be added to the scope of the trending program in the future. Once the program is fully developed, the licensee stated that procedures would be developed to precisely define the parameters that will be trended.

3.2 Failure Analysis

The inspectors reviewed the following material nonconformance reports to evaluate the effectiveness of the licensee's program to investigate and correct problems associated with motor-operated valves.

- 0338-93, E22F011 yoke broke during static testing
- 0054-95, E12F024B exceeded MS-25.0 limit for as-left switch trip thrust value
- 0131-95, B21F016 overtorque while barely meeting minimum available
- 0146-95, G33F039 sheared torque switch roll pin
- 0302-95, E51045 use of wrong-worm pitch

The inspectors identified two concerns related to the review of the listed material nonconformance reports, as discussed in the following paragraphs.

3.2.1 Use of Measured Worm Pitch that Deviated Significantly from Nominal Value

Material Nonconformance Report 0131-95 documented an overtorque concern with Valve B21F016. This valve is the inboard main steam line drain valve. The torque measured at torque switch trip was greater than the estimated torque available under degraded voltage conditions. This condition could result in the motor stalling during valve closure, subsequent overheating, and motor failure, such that no further remote operation would be available.

Normally, output torque is calculated from the force directly measured by a spring pack tester using standard moment arms published in various sources in conjunction with the spring pack deflection. However, to address this concern, the licensee decided to directly measure the actuator moment arm to more precisely determine the torque being delivered by the motor/actuator at torque switch trip. This process requires counting the number of teeth on the worm gear and measuring the worm pitch (distance between adjacent teeth). For Valve B21F016, the published worm pitch was 0.187 inches. The licensee measured a worm pitch of 0.150 inches--a difference of 0.037 inches. This

changed the moment arm from 0.124 feet to 0.0995 feet. As a result, the estimated torque output at torque switch trip was reduced from 84 to 67.45 foot-pounds. The limiting degraded voltage capability of the motor-actuator was approximately 68 foot-pounds.

The inspectors were concerned that the large variation between the measured and nominal moment arm was more likely to have resulted from mismeasurement of the worm pitch than from a manufacturer's dimensional tolerance deviation of this magnitude during machining of the worm gear. The licensee stated that although a digital micrometer was used, the procedures did not specify exactly how the measurement was performed (e.g., whether the worm pitch was measured at several locations and averaged). Further followup of this issue will be conducted by the NRC to determine whether dimensional deviations of this magnitude can be expected. This item was identified as an inspection followup item (416/9603-03).

3.2.2 Use of 110 Percent of Rated-Motor Torque

Material Nonconformance Report 0302-95 identified that, similar to Valve B21F016 discussed above, Valve E51F045 was delivering more torque at torque-switch trip than the estimated torque available under degraded voltage conditions. Valve E51F045 is the steam supply isolation valve for the reactor core isolation cooling system turbine. In this case, the licensee assumed that the motor was capable of delivering 110 percent of its rated-starting torque. Otherwise, the licensee used standard values in the capability equation. The assumption of 110 percent output was sufficient, by itself, to resolve the analyzed stall problem. However, the inspectors were concerned that use of a torque capability beyond the rated value may not be justified, particularly in light of new information that the valve vendor (Limitorque) is soon scheduled to disseminate regarding the torque capability of direct-current motor-operated valves. The licensee intended to review the new information and take appropriate actions to address this issue.

4 GENERIC LETTER 89-10, SUPPLEMENT 5

The inspectors reviewed the licensee's actions in response to Supplement 5 of Generic Letter 89-10. Supplement 5 had requested that licensees describe the actions they had taken regarding the new information on motor-operated valve diagnostic equipment inaccuracies. This new information could result in uncertainties as to whether motor-operated valve thrust and/or torque settings made with the diagnostic equipment were within operability limits.

The inspectors found that the licensee had described their response to Supplement 5 in a letter to the NRC, dated October 5, 1993. The letter stated that both the MOVATS and the VOTES diagnostic systems had been used in the licensee's Generic Letter 89-10 motor-operated valve program. The licensee

stated that 19 motor-operated valves had been found to have exceeded their maximum allowable thrust based on the new information, but that these motor-operated valves had been evaluated and determined to be operable. Procedure and software revisions were reportedly implemented to ensure that future tests would use appropriate accuracy information.

The licensee's response was acknowledged by the NRC in a letter, dated February 16, 1994. The NRC stated that the licensee's evaluations of the motor-operated valves that had exceeded their thrust limits would be reviewed during a future inspection.

During the current inspection, the inspectors reviewed the licensee's evaluations of their Generic Letter 89-10 motor-operated valves with respect to Supplement 5 equipment uncertainty information. The evaluations were documented in Engineering Evaluation Requests 92/6116 and 92/6312, respectively, for the MOVATS and VOTES systems. The inspectors verified that the current licensee spreadsheet calculation had incorporated appropriate corrections from the engineering evaluation reports for motor-operated valves that had not been retested using the new procedures and software. Additionally, the inspectors reviewed licensee procedures and calculations for valves tested subsequent to the engineering evaluation reports and found that appropriate accuracies were used.

5 PERIODIC VERIFICATION

The inspectors reviewed the method and schedule which the licensee had developed to periodically verify the capabilities of Generic Letter 89-10 motor-operated valves. In a letter to the NRC, dated July 23, 1993, the licensee stated their commitment to periodically test Generic Letter 89-10 motor-operated valves under static conditions with retest periods based on maintenance experience and risk significance. The retest periods given in the letter were divided into four risk priorities:

- Priority (1) - 3 refueling outages,
- Priority (2) - 4 refueling outages,
- Priority (3) - 5 refueling outages, and
- Priority (4) - at intervals based on the licensee's discretion.

During the current inspection, the inspectors found that the licensee had recently revised the test frequencies for their Generic Letter 89-10 motor-operated valves. The revisions were documented in Engineering Evaluation Report 95/6274 approved December 11, 1995. The engineering evaluation report noted that the probabilistic risk assessment ranking of motor-operated valves had been revised since the July 23, 1993, letter to the NRC. There were now three risk priorities rather than the previous four.

The licensee's 245 Generic Letter 89-10 motor-operated valves were assigned to have 3-year (1 valve), 5-year (7 valves), 6-year (40 valves), or 9-year (197 valves) retest frequencies. The frequency selection was based on the probabilistic risk assessment rankings with special evaluations for motor-operated valves having less than 10 percent capability margin.

The valve assigned to be retested every 3 years (Valve E22F004 - the high pressure core spray injection system shutoff valve) was a high probabilistic risk assessment risk valve with a low margin. As a high risk valve, it would previously have been assigned a 5-year interval, but its retest period was reduced because of its low margin. Based on the review of the engineering evaluation report, the inspectors concluded that the frequencies specified did not differ significantly from those specified in the licensee's previous letter to the NRC. The inspectors also reviewed the planning database, which the licensee used for scheduling work, and verified that it specified the retest frequencies provided by the engineering evaluation report.

The inspectors also found that the licensee's procedures did not describe how the results of periodic tests would be evaluated to determine the need for revisions to the retest frequencies and considered this a weakness. Licensee personnel indicated that the adequacy of the frequencies would be evaluated following each cycle and the need for any changes would be documented in an engineering evaluation report. The licensee stated that the results of the earliest tests would be reviewed to assure that the long retest frequencies were still justified.

The inspectors concluded that the licensee had developed a periodic verification program that was adequate for closure of the NRC review of Generic Letter 89-10. However, because the NRC is preparing a generic letter on the periodic verification of motor-operated valve design-basis capability, the inspectors noted that the licensee's periodic verification program may be re-evaluated.

6 POST-MAINTENANCE/MODIFICATION TESTING

The licensee's motor-operated valve post-maintenance and -modification testing guidance and requirements were specified by:

- Plant Operations Manual, Subsections 17-S-03-16, Revision 4 and 01-S-07-2, Revision 100; and,

- Design Engineering Administrative Manual, Subsections EP-G-001-00, effective July 12, 1995; ES-P-002-00, effective January 16, 1996; and ES-P-001-00, effective July 18, 1995.

The inspectors reviewed the above documents and found that guidance and requirements specified were consistent with the licensee's commitments to Generic Letter 89-10.

To assess the licensee's implementation of post-maintenance/-modification test requirements the inspectors selected and reviewed a sample of work completed during the most recent outage, Refueling Outage RF-07. The sample included the following:

Work Order	Description of Work
00130492	Inspect valve internals and repack valve (static diagnostic test performed on Work Order 135313)
00129855	Inspect valve internals and repack valve
00131628	Repack valve
00130717	Replace motor pinion key
00139029	Replace valve with like valve due to steam cutting (static diagnostic test performed on Work Order 141686)
00099360	Replace motor pinion key
00129852	Repack valve

The inspectors found that the testing performed following completion of the above work was in accordance with the licensee's post-maintenance and -modification testing guidance and requirements. The inspectors concluded that the licensee had implemented appropriate post-maintenance and -modification testing in accordance with their commitments.

7 SELF ASSESSMENT

The inspectors reviewed the following licensee self-assessment reports and responses:

- Final Report Grand Gulf Nuclear Station Generic Letter 89-10 Program Assessment dated January 18, 1996;
- Grand Gulf Nuclear Station Response to Generic Letter 89-10 Motor-Operated Valve Program (undated preliminary response to above January 18, 1996 report);
- Grand Gulf Nuclear Station Motor-Operated Valve Program Assessment dated September 29, 1993; and,
- Response to Conclusions and Recommendations (of September 29, 1993, self assessment) dated April 14, 1994.

From their review of the above reports and responses, the inspectors concluded that the licensee had performed comprehensive self assessments that resulted in significant findings. The responses generally provided satisfactory resolution of the findings commensurate with the licensee's commitments to Generic Letter 89-10. However, some exceptions were noted. In particular, the inspectors observed that the licensee's assessments reported that additional justification was needed for the assumed value of load sensitive behavior. The inspectors found that this finding was not adequately resolved.

As described in Section 1.5 above, the inspectors further questioned the adequacy of the assumed load sensitive behavior during the current inspection. Subsequently, the licensee addressed and satisfactorily resolved this issue.

Another self-assessment finding that was not acted upon was that the diagnostic traces were not being maintained as quality records. The licensee reasoned that the transcription of an analyzer's interpretation of a diagnostic trace constituted the safety-related documentation requiring safekeeping. The inspectors agreed with the self-assessment finding that the traces themselves should be maintained as quality records because much of the information on the traces cannot be comprehensively transcribed in a nongraphic document and there may be a need to revisit the traces for a variety of reasons. The inspectors considered the retention of these records to be a good practice.

8 REVIEW OF UPDATED FINAL SAFETY ANALYSIS REPORT UFSAR COMMITMENTS

A recent discovery of a licensee operating their facility in a manner contrary to the UFSAR description highlighted the need for a special focused review that compares plant practices, procedures and/or parameters to the UFSAR descriptions. While performing the inspections discussed in this report, the inspectors reviewed the applicable portions of the UFSAR that related to the areas inspected. The inspectors verified that the UFSAR wording was consistent with the observed plant practices, procedures and/or parameters.

ATTACHMENT

PERSONS CONTACTED AND EXIT MEETING

1 PERSONS CONTACTED

1.1 Licensee Personnel

R. Barnette, Electrical Maintenance Specialist
D. Bost, Director, Design Engineering
C. Bottemiller, Superintendent
C. Brooks, Senior Licensing Specialist
F. Bryan, Senior Engineer
S. Burris, Engineering Supervisor
J. Burton, Manager, Mechanical and Civil Engineering
J. Czaika, Nuclear Specialist
R. Errington, Engineering Support Superintendent
C. Hayes, Director, Quality Programs
T. Hinterscher, Engineer
C. Holifield, Engineer, Licensing
R. Hutchinson, Vice President, Nuclear Operations
R. Jackson, Senior Specialist, Licensing
D. Jones, Senior Project Coordinator
R. McCain, Engineering Supervisor
L. Moulder, Technical Coordinator, Maintenance
D. Pace, General Manager
S. Pittman, Quality Assurance Auditor
D. Smith, Senior Engineer
J. Turner, Technical Specialist
W. White, Senior Engineer
J. Wright, Supervisor, Nuclear Plant Engineering

1.2 NRC Personnel

J. Tedrow, Senior 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 February 16, 1996. 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 inspectors acknowledged that some proprietary information was reviewed during the inspection, but stated that this material would not be divulged in the report. At the exit meeting the licensee confirmed their commitment to enhance the operating margins of Valves E51F063 and E51F064 before the conclusion of Refueling Outage RF-08 as discussed in Section 1.7.2.