U.S. NUCLEAR REGULATORY COMMISSION

OFFICE OF NUCLEAR REACTOR REGULATION

Division of Reactor Inspection and Safeguards

Report No.: 50-261/89-200
Docket No.: 50-261

Licensee: Carolina Power and Light Company (CP&L)

Facility: H. B. Robinson Steam Electric Plant Unit No. 2

Inspection Conducted: May 22-26, 1989

Inspection Team Members:

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Jeffrey B. Jacobson, Team Leader — 7/11/89 Date Signed

Reviewed By: for Eugene V. Imbro, Chief, Team Inspection Development, Section B — 7/11/89 Date Signed

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1. Introduction, Summary and Licensee Commitments

1.1 Introduction

As a result of the numerous findings involving motor-operated valves (MOVs) that were identified during the performance of other NRC team inspections, a team inspection specific to the area of MOVs was developed. The purpose of this Motor Operated Valve Inspection (MOVI) was to determine whether the MOVs in the H. B. Robinson plant are designed, installed, and being maintained in a manner that would ensure their capability to perform their intended safety-related functions. During the inspection, programmatic reviews were conducted of engineering, maintenance, training, and operations as applicable to the assessment of the MOVs.

1.2 Summary

As a result of this inspection, two potential enforcement findings and two open items were identified. The first potential enforcement finding concerned the inadequate documentation and/or evaluation of equipment failures. Three examples of this finding were noted during the inspection, including the failure to document and evaluate a thermal overload to a MOV that had tripped during the last three unit startups. The second potential enforcement finding concerned four examples of inadequate, improperly engineered design modifications to the plant. The examples noted included a case in which the licensee replaced valves with those of a different type without performing the calculations necessary to ensure adequate motor actuator sizing. As a result, several safety-related motor actuators installed in the plant are now undersized and require replacement. The two open items identified during the inspection pertained to the lack of a basis for motor actuator torque switch settings and for thermal overload sizing.

In addition to these weaknesses, the team identified several strengths within the H. B. Robinson MOV program. Specifically, the training of maintenance personnel, the quality of applicable maintenance procedures, and the review of MOV generic communication were identified as strengths by the inspection team.

1.3 Licensee Commitments

On June 6, 1989, a conference call was held between Carolina Power and Light (CP&L,) NRR, and Region II staff concerning the two open items identified during the inspection. During the call, CP&L committed to performing the following actions:

(1) Within 90 days, a review will be performed of the adequacy of torque switch settings for all safety-related MOVs installed at the H. B. Robinson plant.

(2) Within 90 days, a review will be performed of the thermal overload sizing relative to all safety-related MOVs where either the valve, the motor actuator, or the overload protective device has been modified since original plant construction.

2. Inspection Areas

2.1 Actuator Sizing

In order to assess the sizing of the motor actuators installed in the Robinson plant, the team requested data for eight specific MOVs from a list of all safety-related MOVs. The data requested included the valve type, size, stem diameter, stem pitch, stem lead, and seat diameter, as well as the motor actuator overall gear ratio, type, motor size, motor speed, and spring pack type. In addition, data were requested pertaining to the applicable line pressures, the maximum differential pressures, and the motor or motor control center voltages. The line pressures, the differential pressures, and the voltages given to the team were then evaluated by the appropriate mechanical or electrical specialist team members. From these data, calculations were generated for each MOV selected for valve-required thrust, torque, and for maximum operator-available thrust or torque. From the calculations, it was determined that all eight motor actuators could deliver enough torque or thrust to stroke the selected valves under all design-basis conditions.

In addition to the eight selected valves, a review was performed of the licensee's sizing calculations relative to the 11 MOVs subject to NRC Bulletin No. 85-03. Of the 11 bulletin valves, the licensee had determined that 6 actuators might not be sized sufficiently to complete valve stroking under all design-basis conditions. As a result, the licensee had prepared a justification for continued operation (JCO) for the six steam-driven auxiliary feedwater pump valves affected. The JCO, Engineering Evaluation ENG-87191, was reviewed in detail by the team during this inspection. The JCO was based upon licensee calculations that showed that the subject valves would open but might not close under all design-basis conditions. Specifically, it was calculated that valves V1-8A, B, and C on the steam admission lines to the auxiliary feedwater pump turbines would not be able to be remotely closed as a result of the motor actuator undersizing. These valves would have to be closed following a steam-generator tube rupture in order to prevent an unmonitored release to the environment through the steam driven auxiliary feedwater pump steam exhaust line. Although the valves are not capable of being remotely closed (from the control room), the team verified that these valves could be manually closed because of their close proximity and accessibility to the control room. The V2-14A, B, and C steam-driven auxiliary feedwater pump discharge isolation valves were also calculated to be undersized; however, the postulated accident scenarios for these valves would not require closing at maximum differential pressure.

During review of this JCO, the team determined that the licensee had used normal bus voltages in lieu of actual postulated degraded voltages in their sizing calculations. For instance, on the V2-14A, B, and C valves the licensee had used 208 volts instead of the actual 180 volts calculated to exist at the motor actuator during accident conditions. As a result, the licensee recalculated the thrusts available at the motor actuators and determined that although less than previously calculated, the actuators could still open but not close the valves under design-basis conditions. In addition, the V2-16A, B, and C valves, not subject to the original JCO, are now calculated to be marginally sized. The licensee has committed to replacing the nine motor actuators for valves V1-8A, B, and C; V2-14A, B, and C and V2-16A, B, and C during its next refueling outage currently scheduled for March 1990.

2.2 Torque Switch Settings

During the inspection, it was determined that CP&L did not have calculations to support the torque switch settings of safety-related MOVs except for the 11 valves subject to NRC Bulletin No. 85-03. Additionally, CP&L did not have information relative to the original torque switch settings as determined by either Limitorque or the valve vendor. Although the actual torque switch settings on the valves are known, it is not known whether or not these settings are correct. Except for the 11 MOVs subject to NRC Bulletin No. 85-03 and the particular MOVs that may have been tested under design-basis differential pressure, no assurance exists that the torque switch settings on the remaining MOVs correspond to those necessary to ensure operability. If the settings were too low, power to the MOV would be interrupted before the MOV could complete its intended function.

Using the data supplied by CP&L for the eight selected MOVs, calculations were generated to determine the acceptability of the present torque switch settings. Of the eight MOVs selected, one had its torque switch bypassed in the closed direction. Of the remaining seven MOVs, calculations showed that five had adequate torque switch settings. The other two had settings that calculationally appeared to be marginal. The licensee was able to demonstrate that one of these MOVs had indeed been tested at full differential pressure. For the other valve, the V6-12B auxiliary feedwater discharge cross-connect, the licensee could not demonstrate that testing at full differential pressure had been performed.

In addition to the team's sample inspection, it was noted that the licensee had to increase the torque switch settings on the majority of its 11 bulletin valves. As a result of these findings, the licensee was asked to expeditiously evaluate the current torque switch settings on those MOVs on which full differential pressure testing had not been performed. During a conference call on June 6, 1989, with NRR and Region II, CP&L committed to performing this review within 90 days. This item is identified as Open Item 50-261/89-200-01.

2.3 Voltage Study

In order to ensure that the installed MOVs will function under design-basis conditions, the team reviewed the voltage calculations used as inputs into the MOV sizing calculations. As the available MOV motor torque decreases with the square of the ac voltage, the ability of an MOV to operate under less than nominal voltage requires specific analysis. During the inspection, the team determined that CP&L does not currently have calculations that delineate the motor terminal voltage at any specific MOV under design-basis conditions. Although the team did review CP&L calculations RNP-E.0002 concerning a recently performed voltage study, it was determined that this study did not address bus voltages that were supplied from the plant's emergency diesel generators. In addition, the study did not analyze what effects short-term transients such as motor startups might have on the voltage being supplied to the MOVs. Until a thorough electrical voltage study is completed, the actual voltage expected to be delivered to a specific MOV under design basis-conditions cannot be determined, however, due to the large margins identified during the teams review of motor actuator sizing, no immediate safety concern was identified in this area.

2.4 Thermal Overloads

During the inspection, a review was conducted of CP&L's program for sizing and testing thermal overloads to MOV circuits at the H. B. Robinson plant. The team determined that at Robinson, overload protection devices to safety-related MOVs are installed and are not bypassed during the actuation of the emergency core cooling systems. These thermal overload devices are also not periodically tested. In addition, no direct indication exists in the control room if a thermal overload trips and interrupts power to a safety-related MOV. As a result of the above findings, and in lieu of the two inadequate design modifications pertaining to thermal overloads cited in Section 2.6 of this report, CP&L was asked to expeditiously review the sizing of thermal overload devices in applications in which either the actuator, valve, motor, or overload device itself may have been changed since original plant design. During a conference call on June 6, 1989, with NRR and Region II, CP&L committed to completing such a review within 90 days. This item is identified as Open Item 50-261/89-200-02.

2.5 Maintenance History Review and Evaluation

The licensee utilizes work request (WRs) to administratively control corrective maintenance associated with MOVs. The inspectors reviewed WRs processed in 1988 and 1989 that required safety-related MOV maintenance. The purpose of this review was to verify that adequate corrective action was being performed when MOV problems were identified. The results of this review indicated that in several instances valves repeatedly failed to operate because of insufficient corrective action.

The first example concerned valve V2-16A, the auxiliary feedwater pump discharge valve. On two occasions, May 14 and September 2, 1988, the valve could not be shut electrically. For both failures the corrective action involved cleaning the torque switch contacts and cycling the valve to verify operation. The corrective action did not address how the torque switch contacts got dirty or why two failures for the same reason occurred in such a short interval. During the subsequent refueling outage, as a result of a 10 CFR Part 21 notification received from Limitorque, CP&L performed inspections for cracked melamine torque switches on several MOVs. Although exact records of the inspection were not kept, a severely damaged torque switch was said to have been removed from either valve V2-16A or B. It is therefore thought that this cracked torque switch was the likely cause of failure for valve V2-16A and that had a thorough inspection been performed when the valve originally failed to stroke, this deficiency might have been discovered.

The second example concerned valve CC-730, the reactor coolant pump bearing, component cooling water return, isolation valve. On January 10, 1989, the valve could not be fully opened electrically. Corrective action involved lubricating the stem and cycling the valve several times to achieve proper operation. On April 6, 1989, valve CC-730 again failed, but this time the valve could not be shut electrically. Corrective action involved cleaning the torque switch contacts and cycling the valve to verify proper operation. Review of periodic maintenance records revealed that on November 28 and 29, 1988, the CC-730 valve stem had been lubricated and the torque switch contacts cleaned. The corrective action for the valve CC-730 failures did not address why the stem had to be relubricated and the torque switch contacts recleaned at such short intervals. The failures associated with valve CC-730 are similar to the failures described

in the 10 CFR Part 21 Limitorque notification previously discussed. CC-730 has been identified by the licensee as possibly containing a melamine torque switch; however, an inspection of this torque switch has not yet been performed. As a result, it appears that the true problems associated with this valve have neither been identified nor corrected.

The third example of inadequate corrective action was associated with valve V2-6A, a main feedwater isolation valve. On October 28, 1988, WR 88-ALCC1 was written which stated that during the last three unit startups the valve would not stroke. Upon investigation it was determined that the thermal overload device for this valve had tripped. No evaluation of this problem was performed and corrective action consisted of merely resetting the thermal overload device and restroking the valve. During the inspection, discussions with operations revealed that the thermal overload trips had occurred when transferring from the startup to the normal mode of steam generator feeding. Under these conditions, a higher than normal differential pressure existed across the valve, resulting in more current being required by the motor actuator. In addition, it was determined that the motor for the V2-6A actuator had previously been replaced with a motor that drew more current. During the modifications, no review of thermal overload sizing was performed. As a result of the team's review of this one work request, three separate deficiencies were identified. First, the thermal overload trips were not documented until the third occurrence. The team informed CP&L that all thermal overload trips must be documented and evaluated and that the CP&L practice of only documenting repetitive thermal overload trips was unacceptable. Second, when the thermal overload trip was finally documented, no engineering evaluation was performed. Third, the motor for the V2-6A actuator was replaced without performing an evaluation on thermal overload sizing. All three of these practices led to the repetitive failure of valve V2-6A.

These examples of MOV failures illustrate that licensee corrective action was inadequate to preclude additional similar failures and that valve failures were sometimes not documented to initiate corrective action. Failure to take adequate corrective action in response to MOV failures and to properly document MOV failures so that corrective action could be initiated is identified as Potential Enforcement Item 50-261/89-200-03.

2.6 Modifications

In order to ensure that properly designed original equipment is not being adversely altered a review was conducted of several modifications to the plant that involved MOVs. From this review, it was apparent that, although equipment may have originally been properly designed, CP&L made changes that may have compromised equipment performance and operability. The following examples involve modifications performed to the plant in which the modification's effect on overall system performance was either overlooked or improperly evaluated.

Modification 551 - This modification performed during 1980-81 replaced valves V2-16A, B, and C and valves V2-14A, B, and C, which are on the discharge side of the motor-driven auxiliary feedwater pumps and the steam-driven auxiliary feedwater pumps, respectively. The original valves were replaced with 4-inch gate valves with flange ratings of 900 psi from the Anchor/Darling Valve Co. During review of this modification package, it was noted that no sizing or

thrust calculations had been performed for these valves and that the modification indicated that the old valve actuators were to be used. No justification for assuming the old actuators were still adequate was found.

During the testing and calculations required by NRC Bulletin No. 85-03, CP&L determined that the V2-14A, B and C valve actuators were undersized. Additionally, the V2-16A, B, and C valve actuators were calculated as being only marginally large enough. As a result of these findings, CP&L is to replace all six valve actuators during the next refueling outage. Had proper sizing calculations been performed during the modification, this problem probably would have not occurred.

Modification 939 - This modification was performed as a result of an inspection conducted by CP&L Corporate Nuclear Safety that revealed a number of cases of improperly coordinated protective devices. Modification 939 was initiated in August 1988 to upgrade circuit breakers and overload devices in motor control centers 5, 6, 9, and 10 and to ensure that protective devices could clear system faults in a safe and efficient manner. The overload devices and circuit breakers for approximately 10 safety-related MOVs were replaced. After the installation of Modification 939, spurious trips of motors started to occur, including trips of MOVs. The spurious trips were attributed to inadequately sized thermal overloads and circuit breakers installed by the modification. Corrective action involved the replacement or adjustment of the newly installed circuit breakers, the reinstallation of the original thermal overload devices, or the installation of re-sized thermal overload devices. The apparent cause for the miscalculations was that the actual locked-rotor currents for the motors were unavailable and estimated values were used as inputs for thermal overload sizing calculations during preparation of the modification. The locked rotor currents were underestimated by CP&L.

Modification 638 - This modification performed during June 1982 involved the replacement of the V1-3A, B, and C main steam isolation bypass valves. The replacement valves were 2-inch, 900 psi rated gate valves with Limitorque SMB-000-02 motor actuators. No thrust calculations or actuator sizing calculations were found in the modification package. Valve Specification L2-M-011, Revision 1, included in the modification package delineated a motor actuator voltage of 120/2000 volts. Later this was changed in Design Change Notice 638-1 to 208/416 volts. The actual voltage that will be supplied to these MOVs was calculated by CP&L during the inspection to be as low as 180 volts. Motors rated at 208 volts may not be able to deliver the torque required under postulated degraded voltage conditions.

Work Requests 87-AFBRI and 87-AFWSI - These work requests authorized the replacement of the motor on valve actuator V2-6A. The motor on this valve was replaced because it had a magnesium rotor that had been identified as being susceptible to degradation. Although the new motor was said to have the same torque output ratings, it required more current to achieve its rated value. No thermal overload sizing calculation was performed in the work request. Subsequently, the thermal overload device to this valve tripped upon valve actuation at least three times as reported by Work Request 88-ALCC1. Had a thermal overload device calculation been performed before the replacement, the problem with the overload device prematurely tripping would probably not have occurred.

CP&L's failure to properly consider the effects of the modifications on overall system functionality is identified as Potential Enforcement Item 50-261/89-200-04.

2.7 Training

The training and qualification program at H. B. Robinson specifically includes a subprogram for MOVs. The qualification requirements are only applicable to the shop personnel. Under the guidance of the foreman and supervisors, an initial qualification is obtained and documented on a qualification card. After initial qualification, each qualified individual must be requalified at regular intervals. Currently, the MOV requalification period is 2 years.

MOV qualification is specialized for either a power plant mechanic or a power plant electrician. In both cases, a basic MOV course must be successfully completed at the Harris Energy and Environmental Center. The mechanics take Valve Operator Repair Course ME 400G and then obtain further on-the-job training at H. B. Robinson. The electricians take Motorized Valve Operator Course EL S37G, followed by an advanced course, Motorized Valve Operator Course EL 537R, at H. B. Robinson. On-the-job training is also provided for both mechanics and electricians. Shop foremen then approve completion of the MOV qualification cards.

Requalification for all shop personnel is at the discretion and approval of the responsible foreman. This decision is based on the training, job performance, and experience of the personnel being requalified. For power plant mechanics, this approval includes satisfactory performance by the individual of the following: explanation of the fundamentals of MOVs, troubleshooting of an MOV, and repair of an MOV. Power plant electricians must demonstrate satisfactory performance by explaining the functions and operations of MOVs and components, verifying valve travel positions and indications, operating a valve operator in the manual mode, and cycling the valve operator in the electrical mode. Each foreman tracks the requalification requirements for his assigned personnel. There is no in-house training program for MOV diagnostic testing. The licensee, however, has sent personnel, including a foreman and two electricians, to a MAC Testing Course provided by Limitorque. No further training of this type is currently planned. In summary, the training and qualification program at H. B. Robinson was identified as a strength in that it provides adequate initial training and required demonstration of satisfactory performance to maintain qualifications for those personnel assigned to work on MOVs.

2.8 Maintenance Procedures

Three preventive maintenance procedures were reviewed. These were PM-112, "Limitorque Inspection No. 1," Revision 6, dated July 15, 1987; PM-113, "Limitorque Inspection No. 2," Revision 3, dated June 7, 1988; and PM-423, "Limitorque Inspection No. 3," Revision 5, dated July 2, 1987.

The main purposes of the procedures are to provide guidelines for lubrication of the main gearbox (PM-112), lubrication of the geared limit switch (PM-113), and maintenance of the valve switches and controls (PM-423). The procedures automatically schedule the maintenance at specified intervals.

The three procedures had been properly approved, were very detailed and easy to follow, and provided space for reporting findings and collecting maintenance data. Specifically, the control of the grease and lubricants, the inspection of grease and switches, and the verification of torque switch settings, were well defined in the procedures. In general, all three procedures appeared to be adequate for the provision of the proper preventive maintenance for MOVs. Additionally, the maintenance data sheets for each of the three procedures were reviewed for eight different MOVs. The sheets and the maintenance data were found to be properly complete and acceptable in each case.

Although most Limitorque preventive maintenance recommendations were followed strictly, the licensee did not do so in one case. Limitorque recommends an initial interval of 18 months for inspection and cleaning of MOV switches, recognizing that the interval could be changed, based on plant experience and judgment. The licensee established this maintenance interval as 36 months. When questioned concerning the extended interval, the licensee cited the allowance by Limitorque and the maintenance history record of the MOVs. No specific documentation discussing or justifying the change was available. In light of some of the current operational problems discussed elsewhere in this report, and with new programs regarding problem trending and root cause analysis being implemented, proper documentation of any changes to recommended maintenance intervals would be appropriate and expected. No action is required of, or anticipated by, the licensee at this time; however, it is expected that based on the developing maintenance histories, changes to the preventive maintenance intervals will be made as appropriate. In general, the quality of the maintenance procedures was seen as a strength within the licensee's MOV program.

2.9 Evaluation of Generic Communication

During the inspection, a review was conducted of CP&L's evaluations of MOV-related generic communication. Evaluations of the following NRC information notices, NRC bulletins, and 10 CFR Part 21 reports were reviewed by the inspection team.

IE Notice No. 79-03, dated February 9, 1979, "Limitorque Valve Geared Limit Switch Lubricant" - The licensee's response was reviewed and found acceptable. By procedure, the licensee does not use Beacon 325 lubricant in the geared limit switch.

IE Circular No. 79-04, dated June 7, 1979, "Loose Locking Nut on Limitorque Valve Operators" - In accordance with the licensee's trouble ticket ENG-090, all Limitorque-type SMB valve operators were inspected and the locknuts were properly staked. No mention of SMC-type valves was made in the licensee's internal response, but licensee personnel have stated that none of these type valves were installed in the plant at that time. The response was satisfactory.

IE Notice No. 84-36, Supplement 1, dated September 11, 1984, "Loosening of Locking Nut of Limitorque Operator" - The supplement corrected information provided in IE Notice No. 84-36. The supplement identified that the bearing locknut on the actuator worm shaft was backed out as a result of the loosening of a set screw, which subsequently led to inoperability of a safety-related valve. The problem occurred because the design incorporated a left-handed

thread which is unusual in these types of valves. The licensee evaluation stated that the licensee valves did not have this particular design and, therefore, the notice was not applicable. It appears that the response was properly evaluated at the time and that the response is satisfactory.

IE Notice No. 84-13 dated February 28, 1984, "Potential Deficiency in Motor-Operated Valve Control Circuits and Annunciation" - The licensee's evaluation determined that the thermal overload devices installed in Robinson MOV circuits are not bypassed during actuation of the safety systems. The problem of not knowing whether an overload device has tripped is applicable to the Robinson plant, however, because the control room valve position lights are not extinguished nor are thermal overload alarm circuits installed at the Robinson plant. The licensee is aware of this potential problem and plans on taking no specific action at the current time.

NRC Information Notice No. 88-84, dated October 20, 1988, "Defective Motor Shaft Keys in Limitorque Motor Actuators" - This information notice, which concerned nonconforming shaft key materials, had been received by CP&L but had not yet been evaluated because of a backlog of work. During the inspection, Action Item No. 89-027 was assigned by CP&L for completion of this evaluation.

IE Information Notice No. 86-02, dated January 6, 1989, "Failure of Valve Operator Motor During Environmental Qualification Testing" - The licensee's evaluation of this information notice, which concerned failure of magnesium rotor motors in harsh environments, was found to be very thorough. During this evaluation, CP&L determined that not only is the problem with magnesium rotor motors apparent in a harsh environment, but also that these types of motors can also exhibit failures in relatively mild environments. As a result, CP&L is replacing all magnesium rotor motors at the Brunswick plant.

Limitorque 10 CFR Part 21 Modification, dated November 3, 1988 - CP&L's evaluation of this Part 21 notification concerning melamine torque switch failures was reviewed during the inspection. The licensee has identified 36 safety-related and 24 nonsafety-related Limitorque actuators that will require torque switch inspections to verify whether melamine torque switches are installed. The licensee has scheduled to complete the inspection and replacement of all affected torque switches by March 16, 1990.

IE Notice No. 86-29, dated April 28, 1986, "Effects of Changing Valve Motor Operator Switch Settings" - This information notice was provided to alert recipients to the consequences of changing switch settings without adequate prior evaluation. The inspectors' review of the licensee's internal response to IE Notice No. 86-29 indicated that the contents of the IE notice were incorporated into the licensee MOV program. Review of the licensee's program indicated that switch settings were controlled and maintained, and changes to switch settings were adequately evaluated.

3.0 Exit Meeting

Upon completion of the inspection an exit meeting was held on May 26, 1989. The following individuals attended:

S. G. Tingen	NRC - Region II
A. J. Szczepaniec	NRC - Region II
M. C. Singla	NRC - Consultant
T. G. Scarbrough	NRC - NRR
J. B. Jacobson	NRC - NRR
Russell F. Powell	CP&L - Engineering Supervisor
Keith R. Jury	NRC - Resident Inspector
Ronnie Lo	NRC - NRR - Project Manager
L. W. Garner	NRC - Sr. Resident Inspector
R. D. Crook	Sr. Specialist - Regulatory Compliance
E. M. Harris, Jr.	Director - Onsite Nuclear Safety
John F. Benjamin	Engineering Supervisor - Plant Systems (Technical Support)
C. R. Dietz	Manager - RNPD
Gary D. Shartzer	Senior Engineering - Technical Support - RNP
Richard V. Cady	Senior Engineering - Configuration Control - RNP
C. A. Bethea	Manager - Training
D. R. Quick	Acting General Manager - RNPD
S. V. Athavale	Electrical Engineer - NRR
J. M. Curley	Director Regulatory Compliance
Gene Imbro	NRC - NRR - Section Chief - RSIB