U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Reports No. 50-282/88011(DRS); 50-306/88011(DRS)

Docket Nos. 50-282; 50-306 Licenses No. DPR-42; DPR-60

Licensee: Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401

Facility Name: Prairie Island Nuclear Generating Plant Units 1 and 2

Inspection At: Prairie Island Site, Red Wing, Minnesota

Inspection conducted: June 20-23, and July 11-15, 1988

Inspectors: M. P. Huber — Date: 8/4/88

J. F. Smith — Date: 8/4/88

Approved By: D. H. Danielson, Chief, Materials and Processes Section — Date: 8/4/88

Inspection Summary

Inspection on June 20-23 and July 11-15, 1988 (Reports No. 50-282/88011(DRS); No. 50-306/88011(DRS))
Areas Inspected: Special safety inspection of the licensee's activities with respect to IE Bulletin 85-03 "Motor Operated Valve (MOV) Common Mode Failure During Plant Transients Due to Improper Switch Settings" (25573).
Results: Of the areas inspected, no violations or deviations were identified.

- Program implementation was completed, however administrative controls on the valve program needed improvement.
- Maintenance craftsmen/technicians appeared knowledgeable and conscientious in their work, in spite of the weak procedures which will be corrected.
- Engineering support provided to the personnel performing work on the valves was good.
- The bulletin will remain open pending further review on the part of the licensee and future inspection to be conducted by the NRC.

DETAILS

1. Persons Contacted

Northern States Power (NSP)

R. A. Lindsey, Assistant to Plant Manager
*D. Mendele, Plant Superintendent, Engineering and Radiation Protection
*R. G. Fraser, Lead Production Engineer
*A. A. Hunstad, Staff Engineer

NRC

*M. Moser, Resident Inspector

*Denotes those attending the exit meeting held on July 15, 1988.

The inspectors also contacted other licensee personnel during the course of the inspection.

2. Licensee Action on IE Bulletins

(Open) TI 2515/73 and IE Bulletin 85-03 (282/85003-BB; 306/85003-BB): Motor-Operated Valve (MOV) Common Mode Failures During Plant Transients Due to Improper Switch Settings.

a. Limitorque-Operated, Rising Stem, Gate and Globe Valve Switch Setting Evaluation

IE Bulletin 85-03 concerns the proper setting of switches controlling the operation of motor-operated valves. Action Item b of the bulletin requires that correct switch settings be established; Item c requires differential pressure testing preferably, or other justification to demonstrate operability with the settings from Item b.

Because of prevalent industry practice, most valves covered by the bulletin are Limitorque-operated, rising stem, gate or globe valves, as was the case at Prairie Island.

Below is a list of the switches involved and concerns for their proper setting, typical setting approaches that have been taken in the industry, and either the resolution adopted at the Prairie Island plant or an identification of the need for additional information or other action. The switches discussed are named:

- Thermal overload relay
- Torque switch
  - Open torque switch
  - Close torque switch

- Geared limit switch
  - Open limit
  - Open indication
  - Open torque switch bypass

  - Close limit
  - Close indication
  - Close torque switch bypass

(1) Thermal Overload Relay

Discussion: Thermal overloads protect motor winding insulation from high temperature breakdown. These devices consist of heaters which trip a heat sensitive relay at the motor control center. The contacts of the relay either interrupt current to the contactor closure coil (which stops the motor) or initiate an overload alarm, or both.

Circuit designs used to eliminate the threat of inadvertent motor trips include: (1) removing the heaters or relay contacts from use; (2) using the relay contacts for alarm only; (3) bypassing the relay contacts during all operating modes except when a valve is being exercised for testing; (4) bypassing the relay contacts only during the presence of an automatic safety actuation signal; and (5) oversizing the thermal overloads. Each method has advantages and disadvantages.

Although the thermal overload relay is intended to protect the motor windings from thermal damage, its remote location (at the motor control center), prevents it from sensing actual winding temperature. In addition, the motor has a long thermal decay time in comparison to that of the relay. These two factors combine to compromise the effectiveness of thermal overload protection during valve setup and testing when frequent stroking can result in exceeding the motor duty cycle. The solution to this problem is to know valve running currents and stroke times, and to limit the frequency of valve stroke cycles accordingly.

Site Specifics: Thermal overloads are a permanent feature at Prairie Island, stopping valve motion on relay trip. No bypass features are used.

The licensee's thermal overload devices were set, based on motor current assumptions, to assure a conservative heater selection so that inadvertent thermal overload trips should not be a problem. Thermal overload devices and settings used at Prairie Island were established using the criteria outlined in General Electric Overload Heater Selection Tables and Predicted Relay Tripping Time Curves.

The licensee's administrative procedures control the frequency with which valves may be cycled during setup and testing. The need for measurement of motor current and for timing the running time have been avoided in these documents by limiting the number of times that a valve of a given size may be stroked in a given period. The NRC inspectors identified areas in the administrative procedures which failed to provide explicit instructions to cover every application. The licensee acknowledged the oversight and initiated a change to the document before the inspection was completed. This item will be included in the open item for MOV administrative procedures discussed subsequently in this report.

In the final response to IE Bulletin 85-03, the licensee stated that thermal overload settings are sized at 70% of full load current and that this setting provides motor protection, should the motor run in excess of the allowable period (15 minutes) at full load current. In reviewing the General Electric Curves of Projected Relay Tripping Times, none of the curves extended into the fifteen minute region. Any prediction in this area would require extrapolation beyond the data provided by General Electric. When such extrapolation was attempted by the NRC inspectors, it indicated that a motor running at full load current might be expected to trip in as little as three minutes in an ambient of 104°F.

In addition to providing clarification of the tripping time of the relay at full motor load, the licensee was also requested to provide some form of assurance that the relay would not trip prematurely when a motor operated valve drew high current on startup. In the worst case, a motor might require a very high current while the disk unseats. The NRC inspector's interpretation of data on the GE curve indicates that at high current and high ambient temperature, a properly sized relay might trip in as little as eight seconds. The licensee was requested to provide assurance that a properly sized thermal overload will not trip prematurely while the valve disk is still moving out of contact with the seat. The licensee recognized the problem and will provide a resolution. This item will also be included in the open item for administrative procedures discussed subsequently in this report.

(2) Open Torque Switch

Discussion: This switch is normally used as a mechanical fuse to limit the mechanical thrust applied to a valve or operator when stroking the valve in the open direction. It generally provides no normal control function and is a backup for some other failure that may cause its need.

This switch is usually bypassed during the initial valve unseating, which is the most challenging portion of the open stroke. Failure to set it (or its bypass) properly can cause valve failures.

If the switch is used, it must be set properly to enable the valve operator to apply adequate thrust on the valve stem to operate the valve against the limiting differential pressure (dp).

A process pump can be used to test the valves against dp to determine the torque switch setting adequacy. Diagnostic testing can determine the valve thrust available for a given torque switch setting without dp, however it is necessary to show the adequacy of the calculated requirement against which it is compared.

Site Specifics: The open torque switch at Prairie Island is wired into the circuit but is bypassed for no less than 20% of valve stroke. This setting accounts for the unseating of the valve and highest demand portion with respect to thrust requirements, and is sufficient to prevent the torque switch from actuating.

Following the bypassed portion of the stroke, the torque switch is part of the circuit. The licensee established open torque switch settings, using the Motor Operated Valve Analysis and Test System, Inc. (MOVATS) calculation techniques or the maximum torque switch setting as provided by Limitorque, if it was more conservative than the MOVATS setting.

MOVATS Inc. diagnostic equipment was used at Prairie Island to adjust the torque switch in order to achieve the desired thrusts. Dp testing was also performed to provide additional assurance that the valve was properly adjusted.

This is a conservative approach and provides a high confidence that the valve will open. This is an acceptable configuration.

(3) Close Torque Switch

Discussion: The close torque switch is normally used to stop motor rotation on the completion of valve travel in the close direction. Since it provides a normal control function and is exercised on every closure stroke, setting generally needs more careful consideration than for the open torque switch. The limiting requirement for closure is at the end of travel when the thrust requirements are highest. The thrust at torque switch trip should equal the most limiting closure thrust requirement including the thrust needed to overcome the dp across the valve.

Differential pressure testing, using system process pumps with appropriate data gathering and diagnostic evaluation, is a positive means of assuring the adequacy of the close torque switch setting. Other approaches based on similarity and analysis may also be acceptable with sufficient basis.

Site Specifics: The bulletin valves at Prairie Island close with the close torque switch limiting torque for essentially the entire valve stroke. Close torque switch settings were calculated using only the Limitorque calculation technique.

The licensee used MOVATS Inc. diagnostic equipment to establish the desired thrust and its corresponding torque switch setting. The valves were adjusted and differential pressure testing was performed to assure adequate margin exists for valve operability.

(4) Open Limit Switch

Discussion: This switch provides the control function of determining the upper limit of valve stem travel in the open direction and stops motor rotation by opening the circuit to the associated motor contactor coil. The setting of this switch must assure an adequate valve stroke but, normally, must prevent backseating. Deliberate backseating using the power of the motor-operator, or motor inertia, can and has caused valve stem shearing, stem thread twisting, and valve bonnet metal working until stem scoring and packing blowout occur. Hence, it is important to set the open limit switch away from the backseat and with enough margin to allow for motor contactor dropout time and inertia.

Site Specifics: The valves at Prairie Island "open on limit," with the use of the open limit switch stopping the motor before the valve backseats. Diagnostic testing as well as manual verification was performed to assure that the valves, as left, were not backseating. Further, maintenance procedures have been written to assure that future activities affecting this setting will not result in backseating of the valve. No problems were identified in this area.

(5) Open Indication

Discussion: Open indication is usually identified by the presence of a red light that goes out only when the valve is fully closed. Often, the same rotor is used for the open torque switch bypass, and the setting of the point where the rotor turns has conflicting requirements for the two functions.

In setting for ideal position indication, there is not adequate bypass of the torque switch to assure valve operability; conversely, changes to satisfy the bypass requirements have resulted in false valve position indication.

Site Specifics: Prairie Island uses both the open indication and open torque switch bypass. The valves at Prairie Island have four limit switch rotors which allow the two different functions to operate independently on separate rotors. The valves were rewired to allow both functions to operate independently. There were no concerns with this resolution of the problem.

(6) Open Torque Switch Bypass

Discussion: When an open torque switch is used, the bypass switch is required to bypass it during the initial portion of the open stroke so that the torque switch will not prematurely stop valve travel due to the high torque conditions required for initial valve movement. There is no clear answer on where to set the bypass; but, if the valve disk (not the stem) has moved 20% of its total travel distance away from the seat when the bypass opens, this has been accepted as adequate.

Site Specifics: The valves at Prairie Island have the torque switch bypass set at a minimum of 20% of valve travel. This setting is sufficient to prevent the actuation of the open torque switch in the initial high demand at valve unseating. No problems were noted with this configuration.

(7) Close Limit

Discussion: The close limit switch is not often used on rising stem valves. When it is, it is usually related to a special application and takes the place of the close torque switch by opening the motor circuit at the end of valve closure. It may be used with or without a close torque switch in series with it for over torque protection. (The same switch in parallel with the torque switch would be called a close torque switch bypass.)

Site Specifics: None of the bulletin valves at Prairie Island are wired to "close on limit." The circuit is opened for the valves, stopping the motor, in all cases by actuation of the close torque switch.

(8) Close Indication

Discussion: Close indication is usually identified by the presence of a light that goes out only when the valve is fully open. This function is usually derived off the same rotor as the open limit switch, and while concern exists for the setting of the open limit, no problem has been identified with the corresponding closed indication light switch.

Site Specifics: There was no concern for this switch setting based on a review of valve schematic diagrams and discussions with the licensee. Prairie Island has set the switch based on the open limit switch requirements.

(9) Close Torque Switch Bypass

Discussion: The close torque switch bypass acts in the same manner as the open torque switch bypass; however, contrary to its counterpart function, it normally bypasses

the torque switch during the lightest duty portion of the stroke. If utilized, it should be set to operate during the initial part of the stroke.

Site Specifics: The close torque switch bypass is on the same rotor as the open limit which opened early in travel. The licensee used the close torque switch bypass, and since the valves were properly guarded against backseating, there was no concern identified with respect to this switch setting.

b. Valve Testing Program

In response to the bulletin, the licensee developed new procedures and revised existing procedures to reflect the switch setting philosophies. Once procedures were incorporated, a program of testing, maintenance, and resetting of any switches was conducted.

During the course of the inspection, the NRC inspectors reviewed the licensee's program and test records to ensure all testing was performed for all valves identified in accordance with the licensee's approved program.

(1) MOV Maintenance and Test Procedures

During the course of the inspection the NRC inspectors reviewed the procedures listed below:

- D70, Revision 5, "MOV Maintenance Procedures"
- SW1-M-13, Revision 2, "Gould 2200s Recorder Motor Valve Traces"
- SW1-M-14, Revision 1, "MOV Analysis and Test System Operation"

These procedures provided the direction for the work performed on MOV's.

At Prairie Island, the system engineer responsible for the MOV program provides all coordination of the program. He is responsible for all aspects including identification of the valves, testing to be performed, scheduling of preventive maintenance (PM), analysis of valve work packages, and ensuring that all requirements and commitments are met. This was an area of concern for the NRC inspectors. At no point were the requirements, scope, and responsibilities for the different aspects of the program defined. The NRC inspectors discussed this situation with the licensee and indicated that administrative control procedures defining the bulletin MOV operability program should be established. The adequacy of the procedures (mentioned above) was also a concern. Certain valve operability acceptance criteria were vague, unclear, and incomplete in certain areas.

Procedure SW1-M-13 was written to be only understood by the most experienced personnel, specifically trained in that job. Instructions were sketchy and the possibility for error was high unless an adequate amount of training and familiarity with the procedures was obtained by the personnel prior to performing the work. This was discussed with the licensee and the revision of the procedures and creation of a document governing the licensee's bulletin program is considered an Open Item (50-282/88011-01(DRS); 50-306/88011-01(DRS)).

(a) Review of Completed Work Packages and Other Records

Several completed work packages for valve maintenance and switch setting were reviewed by the NRC inspectors for content, completeness, and compatibility with other records. The torque switch settings recorded for the as-found open and close torques in the work package for MV-32238 were not compatible with those reported in the April 8, 1988, response to IE Bulletin 85-03 by NSP. A similar problem was noted with MV-32025. The Prairie Island staff performed an immediate investigation of the cause and extent of the discrepancy. The cause of the problem was that two different sources of data were used. The inspector's data were taken from the work packages. Data for the "response" letter were taken from the Motor Valve Data File, wherein all pertinent data for the valves were accumulated. At some point a change was made in the switch setting without updating the file. This left obsolete data in the file. The work packages showed the correct information. All data in the data file have been reviewed for accuracy and where discrepancies were noted the effect of the error was evaluated. In no case was the operation of any valve jeopardized. The table provided with the IE Bulletin 85-03 Final Response will be corrected and a new letter will be submitted. This is considered an Open Item (50-282/88011-02(DRS)); (50-306/88011-02(DRS)).

Changes will be made in administrative procedures to preclude a repetition of the data collection errors disclosed during this inspection. Additional changes, as discussed in other areas of this report, will be included in this strengthening of MOV administrative procedures.

(b) Personnel Performance

Once the NRC inspectors became familiar with the processes and procedures at Prairie Island, performance of work on a valve was observed.

The NRC inspectors observed the performance of the D70 procedure on valve MV-32189, the Unit 2 Emergency Boration Valve.

The work performed on the valve was extensive, to include grease change-out and the use of signature analysis techniques to set the valve switches. The personnel performed the work in a proficient manner, and were very knowledgeable. The interface between the cognizant system engineer and the maintenance personnel was good. As the work was performed, the maintenance personnel kept the system engineer informed of possible problems with valve components and received approval of corrective actions prior to proceeding with the work. This approach and the way in which the personnel performed the work ensured a highly reliable end product.

(2) Inspection of Completed Motor Operated Valves

The NRC inspectors performed general external inspection of the completed MOV's identified in Bulletin 85-03. As might be expected of equipment recently cleaned and lubricated, they were clean, dry, and showed no grease outside of bearing surfaces. Although the NRC inspectors would have preferred to examine a motor operated valve included in the bulletin, none was available. The alternative was to find a valve which was available for inspection, could be exercised, and which had been adjusted using the MOVATS procedure used on the bulletin valves. The valve chosen was MV-32086, an Emergency Boration Valve.

The Emergency Boration Valve was examined by opening the housing to expose the switches. The motor was disengaged and the valve was manually operated while counting the turns of the handwheel. The proper setting of the open and close light switches was confirmed in both directions and the proper setting of the open torque bypass switch was confirmed in the open position. Operation of the close torque switch could not be achieved with the handwheel.

Although the setting of the switches met all of the objectives of the bulletin, it was necessary to electrically "bump" the actuator in order to declutch the motor and engage the handwheel. The cause of this problem was found to be improper adjustment of the trippers. Recognizing this as a potentially generic problem, the NRC inspectors discussed the matter with the Prairie Island staff.

The staff agreed that the procedure covering switch setting would be strengthened to include such tests as would disclose the presence of any operational deficiency prior to closing the work package. This is part of the open item concerning MOV administrative procedures noted previously in this report.

c. Maintenance of Valve Operability

Action Item d of the bulletin requires plant procedures that will assure the maintenance of correct switch settings throughout plant life. To some extent, this involves all programmatic activities that assure long term valve operability because wear and degradation of either the valve or operator affect the adequacy of the switch settings.

Some factors in assuring adequate switch settings are valve and valve operator mechanical conditions. Gate valve seat friction factors appear to be anywhere from half to twice that assumed in the past using previously accepted formulas; field measurements of stem thrust show that valve stem thread lubrication may impact thrust values by a factor of two; stem packing tightening has been shown to be a significant factor, actually causing motor burnout in more severe cases of overtightening. These concerns have to be addressed by maintenance, surveillance, and post maintenance test programs to assure that operability factors are maintained.

(1) Preventive Maintenance

Valve condition is maintained by implementation of a Preventive Maintenance program. On a five year rotation, all valves would receive a detailed inspection and overhaul. The NRC inspectors reviewed the substance of the program and reviewed the work performed by maintenance personnel (as previously mentioned). Again, work performed on the valve was good, and no problems were noted.

(2) Switch Setting Maintenance

Valve switch settings are maintained in accordance with the ASME Section XI program which requires the valve stroke time to be obtained and trended in order to detect degradation. This in itself is not considered adequate, however, the licensee has other mechanisms in place to ensure that any switch settings will be maintained following valve maintenance.

Prior to maintenance on a valve, the Valve Data File is reviewed to determine valve operating conditions. The information included in the data file consists partly of current and power signature traces, and recommended torque switch settings. If any changes are made on the valve, the file will be updated to provide personnel with information about and a reference for determining the proper operating characteristics of the valve.

The electrical maintenance personnel were cognizant of the necessity of proper settings of the valves. During any maintenance performed on a valve, switch settings were not changed unless the valve was instrumented and tested, thereby verifying the adequacy of the new switch settings.

The NRC inspectors did note one possible concern to the licensee regarding evaluation criteria for current and power traces obtained for review by the system engineer.

During the performance of the MOV maintenance procedure D70, as found and as left motor valve traces are recorded. The traces were subsequently to be reviewed by the Electrical Maintenance Supervisor or the System Engineer. Acceptance criteria were included in the procedure but the NRC inspectors were concerned that the acceptance criteria was not specific enough but more importantly, that not all of the switch settings were being adequately evaluated. The NRC inspectors noted the following examples.

(a) Thermal overload setpoints need evaluation to determine what affect changes in MOV switch settings or thrust demands have on the setpoint of the thermal overload.

(b) The MOV may not be able to deliver adequate thrust if the condition of the operator changes for reasons such as packing load changes.

(c) Motor current is used to compare valve condition at different times, but the current of polyphase induction motors used in MOV's is insensitive to load changes in the range where the motors are normally applied. Current remains fairly constant at the low end through the middle of the loading scale. As the load increases, the phase angle decreases, producing more real power. When the motor is heavily loaded the phase angle approaches zero (and the power factor approaches 1.0). Only then does the current give a true indication of load. In the range mostly used, load is not effectively represented by current.

(d) The current traces available for comparison show little amplitude, so small changes would be difficult to detect on existing records.

The current and power traces were obtained by the licensee for analysis for both as found and as left conditions, and may provide the means to determine the adequacy and the effective maintenance of the switch settings.

The development of additional, more defined acceptance criteria for current traces was discussed with the licensee. Further review of this matter will be performed by the licensee. Pending the presentation of objective evidence that motor current provides a valid criterion for evaluating the effectiveness of switch settings, this is considered an Unresolved Item (50-282/88011-03(DRS); 50-306/88011-03(DRS)).

d. Undervoltage Considerations

Motors provided for these MOVs are guaranteed to provide rated torque at 80% of normal line voltage. If, upon opening, the unseating loads are high when line voltage is low, there can be a significant voltage drop between the motor control center and the motor. If this voltage drop is sufficiently high it can drop the voltage to the motor below the required 80% so that the motor cannot develop sufficient torque to operate. The relatively high current and delay in operation may cause the thermal overload to trip and control of the valve would be lost. Alternatively, in closing the valve, a drop below 80% normal line voltage could prevent operation of the torque switch so that the motor would remain stalled on line with high current passing through it until the thermal overload tripped.

The licensee provided the size and lengths of runs of the conductors from the motor control centers to a sample of motor operator valves selected by the NRC inspectors. The samples included the longest runs, the highest current demand motors and the smallest (relative) cables of any motor operated valves included in the bulletin. Voltage drops were calculated based on locked motor current rating for the motors. This is a conservative approach because it does not consider the current reduction resulting from the reduced voltage supplied to the motor. As indicated in a letter to NRR dated August 17, 1982, minimum voltage to the motor control centers will be 395 volts. Calculation of the line voltage drops between the motor control center and the motors disclosed a maximum of 9.3 volts. Based on a 460 volt nominal line, the remaining voltage provides 83.8% of full required line voltage. This is an acceptable condition.

3. Personnel Training

The review of administrative and technical procedures disclosed a strong reliance on the ability of maintenance personnel to perform work on a motor operated valve with a minimum of written guidance. Maintenance personnel are assumed to be well versed in the adjustment of valves. In order to test the validity of this assumption, the NRC inspectors investigated several areas, one of which was training.

Training in MOVs and in the MOVATS was given by MOVATS, Inc. personnel using selected portions of a course developed by MOVATS. Training was tailored to the needs of the individual with none of the maintenance personnel receiving the full 80 hour course. The reduction in course attendance was based on prior experience and training of personnel.

The Prairie Island engineering staff is small, stable, and specialized in particular areas. In addition to familiarity with their specialty, they are also familiar with maintenance personnel who work in the area of their specialty. Based on this knowledge, they are confident that the people performing work are properly trained and experienced in the work.

The NRC inspectors reviewed the MOVATS Training Course for content and effectiveness. The course is the same one given to maintenance personnel across the country and is complete and effective when administered in its entirety. However, the course was not delivered in its entirely to any student at Prairie Island and there is no definitive record of what was presented to each student. The records show no indication of prior training or experience, no recommendations for needed areas of training and no indication of subjects covered. The training records show only hours of class attended by each student; they do not indicate the course materials to which he was exposed nor give any indication of the proficiency gained. The training appears to have been effective, as evidenced by the NRC inspectors observing personnel activities and discussing the work with them, however the evidence of effective training is not available from training records. The familiarity of the staff with the training and capabilities of maintenance personnel is possible only because of the small staff and stability of plant personnel. Although the system in effect appears to have been effective, it was difficult for an outsider to follow and did not provide objective evidence of personnel training or proficiency.

4. Open Items

Open items are matters which have been discussed with the licensee which will be reviewed further by the inspectors and which involve some action on the part of the NRC or licensee or both. Open items disclosed during the inspection are discussed in Paragraphs 2.b.(1) and 2.b.(1)(a). The bulletin will also remain open.

5. Unresolved Items

Unresolved items are matters about which information is required to ascertain whether they are acceptable items, violations, or deviations. One unresolved item identified during the inspection is discussed in Paragraph 2.c.(2).

6. Exit Interview

The inspectors met with licensee representatives (denoted in Paragraph 1) on July 15, 1988, to discuss the scope and findings of the inspection including the two open and one unresolved items. The inspectors also discussed the likely informational content of the reports and summarized the results. The licensee acknowledged the statements made by the inspectors with respect to the content of this report. The licensee did not identify any documents/processes used in this report as proprietary.