UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

February 2, 1989

NRC INFORMATION NOTICE NO. 89-11: FAILURE OF DC MOTOR-OPERATED VALVES TO DEVELOP RATED TORQUE BECAUSE OF IMPROPER CABLE SIZING

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose:

This information notice is being provided to alert addressees to potential problems resulting from motor-operated valves (MOVs) not developing rated torque because of the failure of the original cable sizing calculations to include the proper current values and cable resistances. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

As a part of the Equipment Qualification and Nuclear Plant Aging Studies, the NRC obtained a motor-operated wedge-gate valve from the Shippingport Atomic Power Station following its decommissioning. The valve had been installed in a secondary system for the 25-year life of the plant. A review of the maintenance records for the valve and the operator indicated that there were no reportable incidents associated with either the valve or the operator. Following removal, the valve and the operator were refurbished by an NRC contractor and tested to demonstrate the valve's ability to operate at the conditions expected during the forthcoming testing. The valve, the operator, and the controller were then transported to Germany where they were installed in the Heissdampfreactor (HDR) decommissioned reactor test facility as part of a jointly sponsored seismic test research program. With the exception of the use of equivalent metric-sized cable, the electrical installation of the operator was identical to that at Shippingport.

Each test of the valve consisted of a closure cycle, an opening cycle, and a final closure cycle. When the data from these tests was analyzed, it was determined that the valve had routinely failed to fully seat during the second closing cycle of each test which had subjected the valve to system pressure and flow and ambient temperature conditions. In addition, the valve had routinely failed to fully seat during both closing cycles of each test which had subjected the valve to system pressure, flow, and elevated temperature conditions. Further evaluation of the data indicated that (1) although the motor had stalled, the output torque had not been sufficient to open the torque switch; (2) the maximum recorded current appeared to be significantly less than that expected for a stalled motor; and (3) the motor voltage at stall was only slightly less than the running voltage. In response to a request from NRC, the contractor conducted a second series of tests at HDR. Because of the concern that degraded voltage might have been a contributor to the failures, the electrical instrumentation inputs were moved from the motor control center to the junction strip in the switch compartment of the motor operator.

The second test series produced the same valve failure pattern that had been obtained in the initial test series. As the second test series was thought to have eliminated degraded voltage as a cause, it appeared that the problem might be improper motor operator sizing. The NRC requested the contractor to conduct additional testing to determine whether the motor and the operator had been properly sized initially or whether they had degraded during their service at Shippingport. To accomplish this testing, the motor operator and the controller were removed from the HDR decommissioned reactor test facility and shipped to the Limitorque manufacturing facilities for dynamometer testing.

The dynamometer testing of the motor operator by Limitorque demonstrated that the performance of the motor operator was better than that at HDR, but that the motor performance was less than that originally specified. It was therefore decided to perform motor dynamometer testing at the motor manufacturer's facilities. To accomplish this testing, the motor was removed from the motor operator and shipped to the motor manufacturer. The motor dynamometer testing by the motor manufacturer demonstrated that the motor's performance did not differ appreciably from that of a new motor.

However, before any additional evaluations could be performed, the NRC contractor became aware of the recent MOV failures at Brunswick Steam Electric Plant, Unit 1, which had been described in NRC Information Notice 88-72, "Inadequacies in the Design of DC Motor-Operated Valves." Because of the similarity of conditions noted in the HDR and Brunswick failures, the NRC contractor, working with Limitorque, focused on the analysis of the cable sizing for the MOV. This analysis pointed out the following two factors:

(1) The first factor concerned the current values that should be used to establish the cable size. As a motor operator is not a continuous-duty device, the normal operating voltage and current data contained on the nameplate are of only limited applicability to cable sizing. Rather, it is the voltage and current required to develop the rated output torque of the motor operator that is important. As the current required for this rated torque must be developed during locked rotor conditions, the cable should be sized on the locked rotor current instead of on the full load current. The ratio of these currents is quite large as the locked rotor current is typically in excess of five times the full load current stated on the nameplate.

(2) The second factor concerned the cable resistance that should be considered in the analysis. The wiring diagram for a typical motor operator is shown in Attachment 1. Significant cable resistances and the location of the voltage measurement during the second HDR tests are also shown. Attachment 2 presents a simplified schematic of the same circuit. As can be seen, any attempt to measure the voltage drop at the power supply bus (i.e., the sum of the voltage drops across the armature and the series field) includes the resistance contribution from four cables. Even taking the voltage measurement at the motor (as was done during the second HDR tests) will result in including the voltage drop across three cables.

From the above information, it can be seen that the required current for the MOV to develop the design torque should be based on the motor resistance and the cable resistance (i.e., four times that of a single cable) under a minimum postulated bus voltage.

As indicated in their August 17, 1988, maintenance update, Limitorque recommends that the cable be sized to allow for five times full load current flow at the minimum voltage condition. This maintenance update also contained a method for calculating the maximum current draw at locked rotor conditions.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact one of the technical contacts listed below or the Regional Administrator of the appropriate regional office.

Charles E. Rossi

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

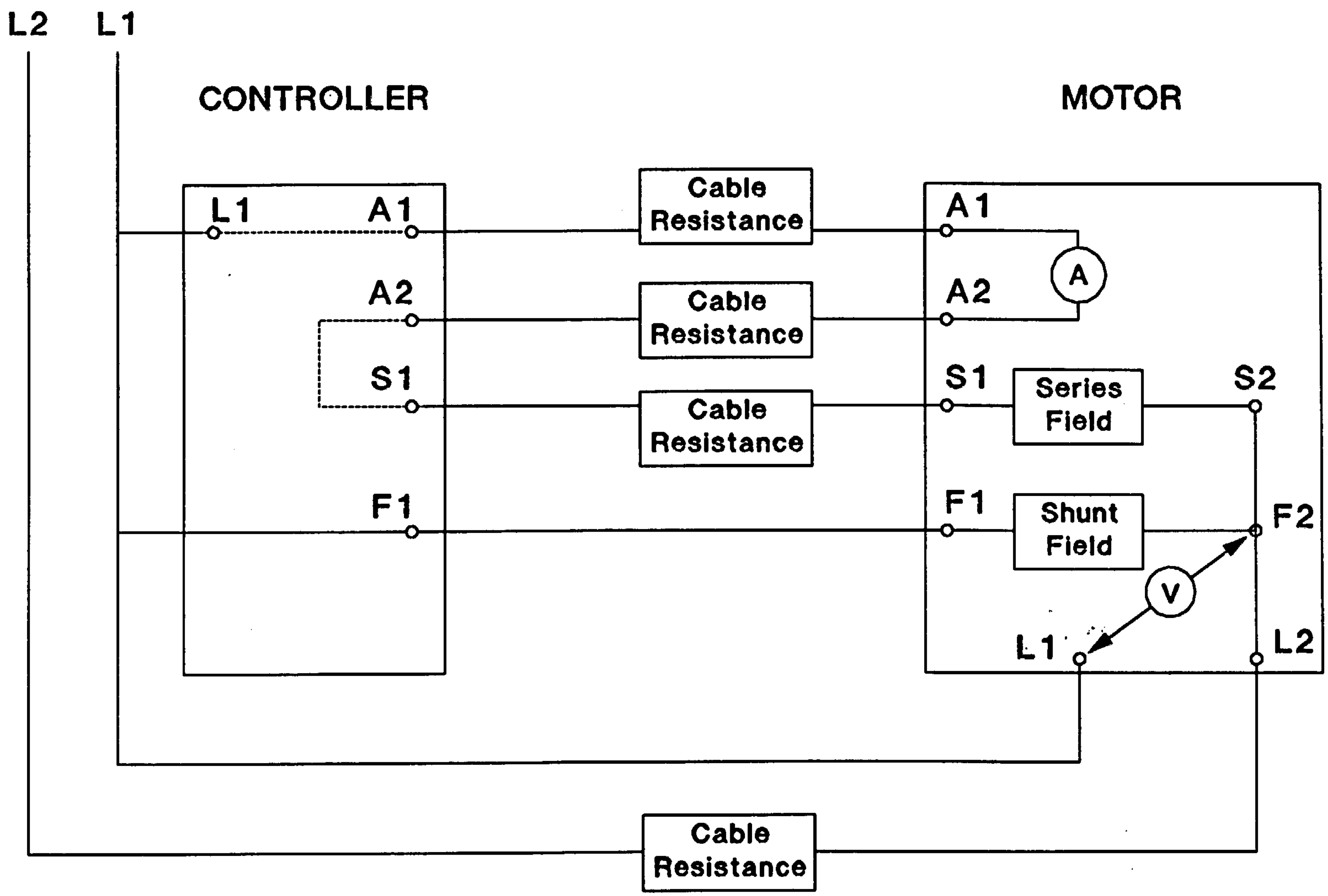
Technical Contacts: Yun-Seng Huang, NRR
(301) 492-0921

Peter J. Kang, NRR
(301) 492-0812

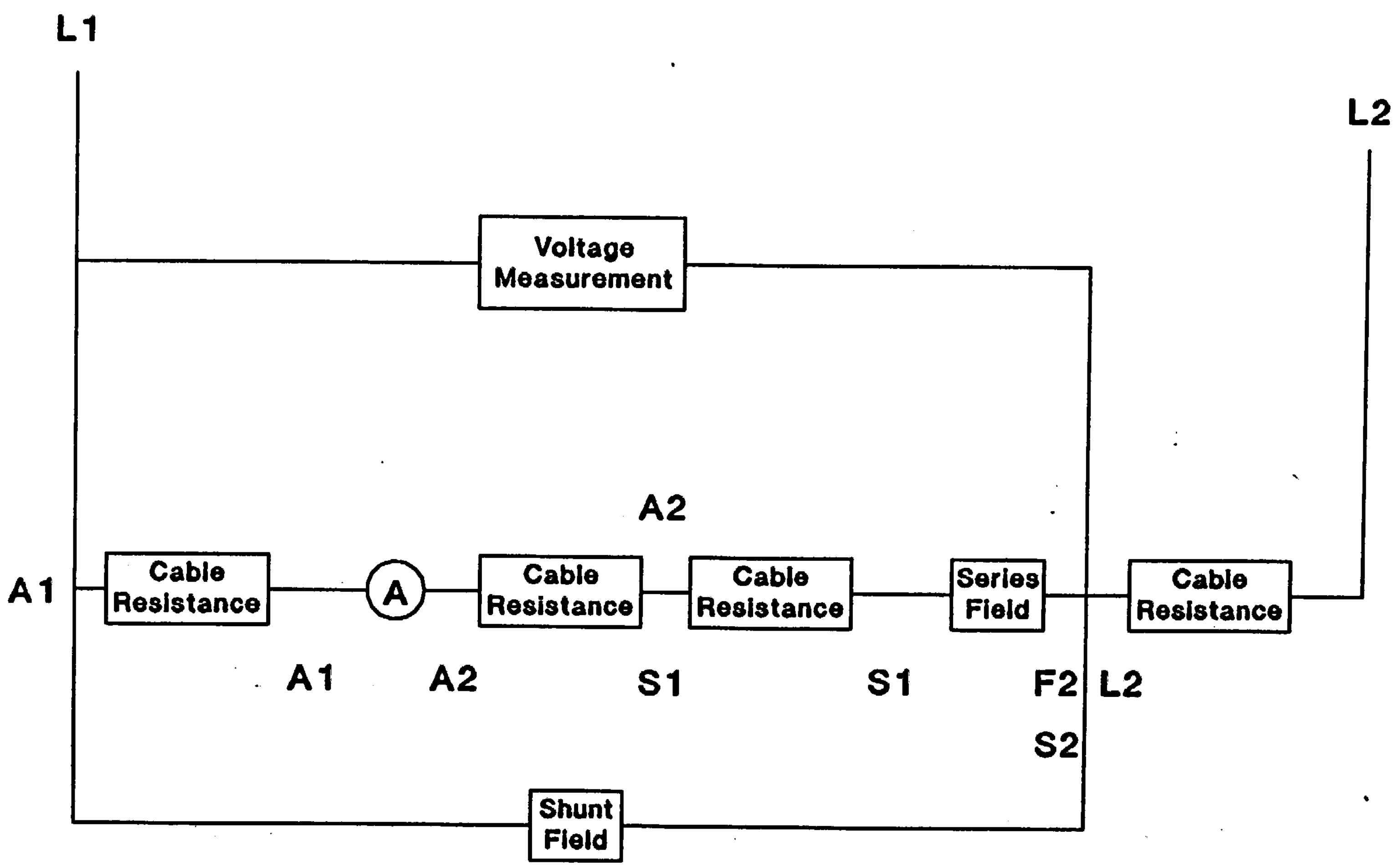
Richard J. Kiessel, NRR
(301) 492-1154

Attachments:
1. Cable Resistances and Voltage Measurements Identified
2. Motor Functional Schematic
3. List of Recently Issued NRC Information Notices

Cable Resistances and Voltage Measurements Identified



Motor Functional Schematic



Attachment 2
IN 89-11
February 2, 1989
Page 1 of 1

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
89-10	Undetected Installation Errors In Main Steam Line Pipe Tunnel Differential Temperature-Sensing Elements at Boiling Water Reactors.	1/27/89	All holders of OLs or CPs for BWRs.
89-09	Credit for Control Rods Without Scram Capability in the Calculation of the Shutdown Margin	1/26/89	All holders of OLs or CPs for test and research reactors.
89-08	Pump Damage Caused by Low-Flow Operation	1/26/89	All holders of OLs or CPs for nuclear power reactors.
89-07	Failures of Small-Diameter Tubing in Control Air, Fuel Oil, and Lube Oil Systems Which Render Emergency Diesel Generators Inoperable	1/25/89	All holders of OLs or CPs for nuclear power reactors.
89-06	Bent Anchor Bolts in Boiling Water Reactor Torus Supports	1/24/89	All holders of OLs or CPs for BWRs with Mark I steel torus shells.
89-05	Use of Deadly Force by Guards Protecting Nuclear Power Reactors Against Radiological Sabotage	1/19/89	All holders of OLs for nuclear power reactors.
89-04	Potential Problems from the Use of Space Heaters	1/17/89	All holders of OLs or CPs for nuclear power reactors and test and research reactors.
89-03	Potential Electrical Equipment Problems	1/11/89	All fuel cycle and major nuclear materials licensees.

OL = Operating License
CP = Construction Permit

(2) The second factor concerned the cable resistance that should be considered in the analysis. The wiring diagram for a typical motor operator is shown in Attachment 1. Significant cable resistances and the location of the voltage measurement during the second HDR tests are also shown. Attachment 2 presents a simplified schematic of the same circuit. As can be seen, any attempt to measure the voltage drop at the power supply bus (i.e., the sum of the voltage drops across the armature and the series field) includes the resistance contribution from four cables. Even taking the voltage measurement at the motor (as was done during the second HDR tests) will result in including the voltage drop across three cables.

From the above information, it can be seen that the required current for the MOV to develop the design torque should be based on the motor resistance and the cable resistance (i.e., four times that of a single cable) under a minimum postulated bus voltage.

As indicated in their August 17, 1988, maintenance update, Limitorque recommends that the cable be sized to allow for five times full load current flow at the minimum voltage condition. This maintenance update also contained a method for calculating the maximum current draw at locked rotor conditions.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact one of the technical contacts listed below or the Regional Administrator of the appropriate regional office.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Yun-Seng Huang, NRR
(301) 492-0921

Peter J. Kang, NRR
(301) 492-0812

Richard J. Kiessel, NRR
(301) 492-1154

Attachments:
1. Cable Resistances and Voltage Measurements Identified
2. Motor Functional Schematic
3. List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCES

D/DOEA:NRR	*C/OGCB:DOEA:NRR	*PPMB:ARM	*AD/SAD:DEST:NRR	*C/SELB:DEST:NRR
CERossi	CHBerlinger	TechEd	ACThadani	FRosa
01/27/89	01/25/89	01/23/89	01/19/89	01/19/89
*OGCB:DOEA:NRR	*EMEB:DEST:NRR	*C/EMEB:DEST:NRR	*AD/EAD:DEST:NRR	*SELB:DEST:NRR
RJKiessel	YSHuang	LBMarsh	JRichardson	PJKang
01/10/89	01/12/89	01/18/89	01/18/89	01/19/89

(2) The second factor concerned the cable resistance that should be considered in the analysis. The wiring diagram for a typical motor operator is shown in Attachment 1. Significant cable resistances and the location of the voltage measurement during the second HDR tests are also shown. Attachment 2 presents a simplified schematic of the same circuit. As can be seen, any attempt to measure the voltage drop at the power supply bus (i.e., the sum of the voltage drops across the armature and the series field) includes the resistance contribution from four cables. Even taking the voltage measurement at the motor (as was done during the second HDR tests) will result in including the voltage drop across three cables.

From the above information, it can be seen that the required current for the MOV to develop the design torque should be based on the motor resistance and the cable resistance (i.e., four times that of a single cable) under a minimum postulated bus voltage.

As indicated in their August 17, 1988, maintenance update, Limitorque recommends that the cable be sized to allow for five times full load current flow at the minimum voltage condition. This maintenance update also contained a method for calculating the maximum current draw at locked rotor conditions.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact one of the technical contacts listed below or the Regional Administrator of the appropriate regional office.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Yun-Seng Huang, NRR
(301) 492-0921

Peter J. Kang, NRR
(301) 492-0812

Richard J. Kiessel, NRR
(301) 492-1154

Attachments:
1. Cable Resistances and Voltage Measurements Identified
2. Motor Functional Schematic
3. List of Recently Issued NRC Information Notices

*SEE PREVIOUS CONCURRENCES

D/DOEA:NRR	C/OGCB:DOEA:NRR	*PPMB:ARM	*AD/SAD:DEST:NRR	*C/SELB:DEST:NRR
CERossi	CHBerlinger	TechEd	ACThadani	FRosa
01/ /89	01/25/89	01/23/89	01/19/89	01/19/89
*OGCB:DOEA:NRR	*EMEB:DEST:NRR	*C/EMEB:DEST:NRR	*AD/EAD:DEST:NRR	*SELB:DEST:NRR
RJKiessel	YSHuang	LBMarsh	JRichardson	PJKang
01/10/89	01/12/89	01/18/89	01/18/89	01/19/89

(2) The second of these factors concerned the cable resistance which must be considered in the analysis. The wiring diagram for a typical motor operator is shown in Attachment 1. Significant cable resistances and the location of the voltage measurement during the second HDR tests are also shown. Attachment 2 presents a simplified schematic of the same circuit. As can be seen, any attempt to measure the voltage drop at the power supply buss (i.e., the sum of the voltage drops across the armature and the series field) includes the resistance contribution from four cables. Even taking the voltage measurement at the motor (as was done during the second HDR tests) will result in including the voltage drop across three cables.

From the above it can be seen that the required current for the MOV to develop the design torque should be based on the motor resistance and the cable resistance (i.e., four times that of a single cable) under a minimum postulated buss voltage.

As indicated in their August 17, 1988, maintenance update, Limitorque recommends that the cable be sized to allow for five times full load current flow at the minimum voltage condition. This maintenance update also contained a method for calculating the maximum current draw at locked rotor conditions.

The information herein is being provided as an early notification of a potentially significant matter that is under further consideration by the NRC staff. If NRC evaluation so indicates, further licensee action may be requested.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the technical contact listed below or the Regional Administrator of the appropriate regional office.

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: Yun-Seng Huang, NRR
(301) 492-0921

Peter J. Kang, NRR
(301) 492-0812

Richard J. Kiessel, NRR
(301) 492-1154

Attachments:
1. Cable Resistances and Voltage Measurements Identified
2. Motor Functional Schematic
3. List of Recently Issued NRC Information Notices

D/DOEA:NRR	C/OGCB:DOEA:NRR	PPMB:ARM	AD/SAD:DEST:NRR	C/SELB:DEST:NRR
CERossi	CHBerlinger	TechEd	ACThadani	FRosa
01/ /89	01/ /89	01/23/89	01/19/89	01/19/89
OGCB:DOEA:NRR	EMEB:DEST:NRR	C/EMEB:DEST:NRR	AD/EAD:DEST:NRR	SELB:DEST:NRR
RJKiessel	YSHuang	LBMarsh	JRichardson	PJKang
01/10/89	01/12/89	01/18/89	01/18/89	01/19/89