AEOD/C203

SURVEY OF VALVE OPERATOR-RELATED EVENTS OCCURRING DURING 1978, 1979 AND 1980

by the

Office for Analysis and Evaluation of Operational Data

May 1982

Prepared by: Earl J. Brown

Frank S. Ashe

Note: This report documents results of studies performed by the Office for Analysis and Evaluation of Operational Data. The findings and recommendations contained in this report are provided in support of other ongoing NRC activities and do not represent the position or requirements of the responsible program offices of the Nuclear Regulatory Commission.

TABLE OF CONTENTS

Tables

EXECUTIVE SUMMARY

This survey report on valve operator-related events provides: (1) a brief summary of related previous reviews and recommendations developed by both the U.S. Nuclear Regulatory Commission and industry groups; (2) a review and evaluation of events that occurred during 1978, 1979 and 1980; and (3) recommendations that would lead to appropriate definition and/or resolution of problems discernible from operating event experience during the three-year time span of the survey. The primary source of information was licensee event reports (LERs).

The survey of LERs provided sufficient information to indicate that motor operator-related events are the greatest single category of valve operator events. Further investigation revealed that events could be grouped in three major categories which are torque switches, limit switches, and motors. The major findings of this survey are:

(1) Torque switch corrective action is the largest single corrective action group which is nearly 25% of all reported motor operator events.

(2) Torque switches do not appear to be a dominant cause of valve assembly inoperability. The reported information suggests the torque switch provides an indication of symptomatic change with time in valve operability characteristics rather than a root cause of valve inoperability.

(3) Repetitive problems are occurring with valve operators. It may occur on the same valve, a valve in similar service in a similar system, or a valve in similar service in a redundant train of the same system.

(4) The plant operating staff objective appears to be a mode of finding measures to return inoperable equipment to operational status rather than to determine root causes of inoperability.

(5) Motor burnout of valve motor operators has occurred quite frequently in High Pressure Coolant Injection (HPCI) and Reactor Core Isolation Cooling (RCIC) systems of BWR units.

The recommendations of this report are summarized as follows:

(1) The existing recommendation or guidance to bypass thermal overload protective devices associated with safety-related valve motor operators should be reassessed.

(2) Improved methods and procedures for the setting of torque switches should be developed and evaluated relative to valve operability and functional qualification under accident conditions.

(3) Signature tracing techniques (such as measurement of electrical current and voltage applied to the motor or the measurement of the actual valve stem torque or thrust during valve operation) should be developed and tried on selected motor-operated valves as part of the periodic inservice testing program. The objectives of such methods should be to utilize them as an indicator of changes in operability characteristics (aging, inadequate adjustment or maintenance, etc.) and a predictor of the remaining margin to failure.

(4) The NRC staff should take positive steps to assure that adequate consideration is given to aging and margin requirements for valve assembly qualification and inservice operability. This could be accomplished through participation in national standards activities during the development phase of the standards and, subsequently, by establishing appropriate staff positions when the standard is endorsed.

(5) Additional action pertaining to IE Circular 77-01, "Malfunctions of Limitorque Valve Operators" is needed because events similar to the concerns identified in the circular continue to be reported.

1. BACKGROUND

1.1 AEOD Perspective on Valve Assembly Operability

This review is a part of an ongoing study of valve assembly operability and reliability by the Office for Analysis and Evaluation of Operational Data (AEOD). The initial emphasis has been on a review of operating experience relative to valve operators. The primary thrust has been to review and assess operating experience relative to its applicability or implications for valve operability during performance of a safety function. The approach has been to analyze Licensee Event Report (LER) data to identify possible trends or patterns. Some questions under consideration are:

- Does LER data indicate whether the root cause or causes of failure was determined or was a primary goal when preparing LERs?
- Are there predominant failure modes of components?
- Does the data provide clues or indications relative to changes in operating characteristics (aging mechanisms) of the equipment?
- Does the data indicate that conditions of operation differ from those specified?
- Can the data for specific equipment provide information about other systems or equipment?
- Are there indications of how licensees use failure data?
- Does the data indicate that certain motor-operated valve components or combinations of components are not appropriate for use in certain specific system applications?

1.2 Other Reviews of Operating Experience

Other actions based on operating experiences have been reported and/or have required some action by licensees. Operating experience involving valve operators has resulted in several reviews and recommendations by both NRC and Industry groups. Some of the relatively recent topics are as follows (References 1 through 9):

IE Circular 77-01: "Malfunctions of Limitorque Valve Operators"

IE Circular 78-16: "Limitorque Valve Operators"

IE Circular 79-04: "Loose Locking Nut on Limitorque Valve Operators"

IE Information Notice 79-03: "Limitorque Valve Geared Limit Switch Lubricant"

IE Information Notice 81-08: "Repetitive Failures of Limitorque Operator SMB-4 Motor-to-Shaft Key"

EPRI NP-241: "Assessment of Industry Valve Problems"

SAND 80-1887: "Proceedings EPRI/DOE Workshop Nuclear Industry Valve Problems"

Proposed Draft Regulatory Guide: "Periodic Testing of Torque Protected Motor-Operated Valves Important to Safety (RS 801-4)"

NUREG/CR - 1363: "Data Summaries of Licensee Event Reports of Valves at U.S. Commercial Nuclear Power Plants, from January 1, 1976 to December 31, 1978"

IE Circular 77-01 addresses specific instances of motor-operated valves that failed to open because the torque switch activated before the valve was fully off the seat. It was subsequently determined that each valve's control circuit contained a limit switch which bypassed the torque switch function when the valve was moving off its seat. This limit switch was out of adjustment and did not suspend the torque switch function as required.

IE Circular 78-16 identifies clutch component wear resulting from manual operation of valves. The change to motor operation from manual operation caused wear of matching lugs because contact was made while one set of lugs was rotating and the other set was at rest. With progressive wear, the lugs would not engage and motor actuation would not drive the valve. The normal safety function of the valve is achieved with the motor operator, but during refueling operations the valve was manually operated as a throttle valve. As a result of a study of these occurrences, a change was made in the material hardening process for the wearing clutch components.

IE Circular 79-04 discusses several instances where locking nuts were not fastened securely in accordance with manufacturer's recommendations. If the locking nut becomes loose, it could result in disengagement of driving splines and loss of drive to the valve stem. Although the locking nut is part of the valve actuator, it would normally be fastened by the valve manufacturer after the operator had been mounted on the valve.

The IE Information Notices 79-03 and 81-08 identify concerns relating to the limit switch gear lubricant and the key between the motor pinion gear and motor shaft respectively. The lubricant in question could dry out and harden with subsequent failure of brass gears in the limit switch. The key material for the particular operator should have been a special steel, rather than the standard steel, when this particular operator is used in specific nuclear applications.

The industry sponsored report, EPRI NP-241, is a review of valve-related problems with a small portion addressing operators. The major conclusions pertaining to operator problems were placed in three general categories:

(1) Oversized operator, and valve inability to accept loads imposed by the operator.

(2) Improper sizes or settings in motor thermal overloads, circuit breaker trips or torque switches.

(3) Undersized operator failure to position the valve properly.

The Sandia Report SAND 80-1887 also concentrates on valve problems in general. In addition, it identifies certain aspects related to operators to indicate that adjustment of valve operators is a significant portion of the maintenance time devoted to valves and that oversized operators and misadjusted limit switches are the predominant cause of numerous structural failures of valve yoke legs and valve stems.

The proposed Draft Regulatory Guide (RS 801-4) addresses torque switches from the point of view of adverse effects on required valve assembly performance. The proposed testing would apply during plant preoperational testing, during refueling shutdowns, and after a valve is replaced or maintenance performed. This proposed regulatory guide has not been released for public comment and is currently in a hold status.

The NUREG/CR-1363 report was directed at establishing LER rates for gross risk and reliability evaluations. A method used to summarize the data was to estimate failure rates (LER rates) for various standby and demand LER rates for selected valves in U.S. commercial nuclear power plants. These estimates were also averaged to obtain rates for all plants provided by a specific NSSS vendor and overall rates for all PWR and BWR plants. The report also suggests caution in application of these LER rates because there may be differences between the estimates in the report and actual failure rates.

Near the completion of this study, we became aware of two separate and independent studies concerning motor operated valve experience (References 12 and 13). Reference 12 is an NRC memorandum of a review conducted by Region III and Reference 13 is a report of a study of operating experience with electrically operated valves on emergency coolant injection systems of plants operated by Ontario Hydro. The results of these reports are similar to the results in this AEOD study in that torque switches, limit switches, and motors or related factors were found to be the predominant items cited.

2. OVERVIEW OF VALVE OPERATOR EVENTS

2.1 Valve Operator Events

The initial search of LER files covered events on all types of valve operators (motor, air, hydraulic, etc.) in order to obtain most events. The search approach introduced the option for ac and dc motor operators in 1978. This study covers the three-year span 1978, 1979, and 1980. Table 1* provides a list (by plant unit) of the number of ac and dc motor operator and valve operator events over these three years. The total number of valve operator events was 444 and of these, 193 were motor operator events.

Table 2 lists ten plant units with the largest number of ac and dc motor operator events, and Table 3 lists the eleven plant units with the largest number of valve operator events during the three years. Included in these tables is Fitzpatrick 1 (although not with the largest number of events) that was identified in Reference 10 concerning elevated failure rates for engineered safety feature (ESF) valves. Nine plant units are common to both Tables 2 and 3. Except for one plant, the motor operator events as a percentage of all valve operator events for a given unit range from 45 percent to approximately 77 percent. This tends to indicate that motor operators represent the greatest single category of LER reports on operators, and prompted AEOD to review motor operator events further for possible trends or patterns.

---

* Tables begin on p. 33.

2.2 AC and DC Motor Operator Events

As indicated in Table 1, 193 of the 444 valve operator events were associated with motor operators. From information obtained during the search, applicable events relating to motor-operated valves may be grouped into three categories for corrective action. These categories are torque switches, limit switches and motors. Of the 193 events, 46 involved corrective actions relating to the torque switches*, and are indicated by plant unit in Table 4. In addition, a brief description of the events appears in Table 5. Typical corrective actions were replacement of the switches, cleaning of the associated switch contacts and/or adjustment of the setpoint. Based on the information obtained for these events, the dominant corrective action for this set of events was the adjustment of torque switches. Tables 6 through 11 contain additional descriptive information concerning torque switch events for specific plants.

For the remaining two categories, 24 events involved corrective actions associated with limit switches and 19 involved motors. Corrective actions for the limit switches were replacement of the switches, cleaning of switch contacts and/or switch position adjustments. For the motors, corrective action was the replacement of the motor in nearly all cases. Tables 12 and 13 contain additional information concerning the specific events which relate to limit switches and motors.

---

* A torque switch is essentially a switch to make or break electrical contact. For a Limitorque Valve Operator, this is accomplished by transferring linear motion of the Belleville spring, which supplies the force or torque to the valve stem, to rotational indication through a rack and pinion gear and shaft arrangement. Rotational motion or location on the torque switch is calibrated with the applied Belleville spring force or torque. If rotation of the torque switch is sufficient to reach the set point, then the electrical circuit is opened. However, the torque switch does not transmit load or torque to perform its function. It serves as a position (load or torque) indication and to open the circuit if load or torque reaches a preset valve.

Regarding the remaining 104 events, 23 were attributed to unknown causes, 9 were attributed to personnel error and the remaining 72 were attributed to a multitude of causes (such as, blown fuse in control circuit, loose pinion gear, worn shaft clutch and clutch gear, broken or loose wiring, inoperable brake mechanism, frozen motor bearing, loose setscrew on motor pinion, loose packing gland and so on) none of which were proportionally consistent enough to be explicitly identified as a separate category similar to the above three categories. The 23 events attributed to unknown causes were not identified as a category since they provided no specific item or items as areas of concern, either directly or indirectly. In this situation, it is reasonable to assign on a proportional basis at least ten of these 23 events to the three primary categories identified. Accordingly, most of the review was conducted for these three categories.

Based on a review of the information contained in the search, it is highly questionable as to whether any of the three categories identified above indicates a dominant root cause or causes of inoperable motor operator valve occurrences. For example, it is questionable as to whether adjustments in torque switch settings indicate changes in the actual torque switch setting (i.e., the torque switch itself is the problem) or indicate changes in the amount of torque required by the valve assembly due to changes in physical condition of the valve assembly or the requirements of the fluid process which it controls. Similar reasoning may be offered for the limit switch and motor corrective actions (i.e., these are corrective actions at least on an interim basis and do not clearly indicate problems associated with the components). Accordingly, based on the review of the information obtained during the search, no dominant root cause of motor operator valve inoperability could be definitely established. However, the survey did establish that the categories identified, and possibly related items or factors, are excellent candidates for further study and may yet lead to a dominant root cause or causes for the valve inoperability concern.

3. FINDINGS AND EVALUATION

3.1 Motor Operator Events in General

The discussion provided in Sections 2.1 and 2.2 of this report reveals several pertinent operational experience items concerning motor operators and associated torque switches. Also, comparison of LER data with the conclusions presented by EPRI NP-241 (Reference 6) and SAND 80-1887 (Reference 7) illustrates some significant differences. However, the results of References 12 and 13 are similar to the AEOD study in terms of predominant items reported. The AEOD survey findings are listed below.

Findings

(1) Motor operator events represent approximately 45% of all reported valve operator events and range as high as 77% of all valve operator events on some plants. This indicates that motor operators represent the greatest single category of LER reports on valve operators.

(2) From information provided in the LER data base, the dominant root cause of failure or malfunction of motor-operated valves cannot be clearly determined.

(3) A review of motor operator events indicates that corrective actions associated with torque switches represent approximately 23% of all reported

events and are the largest single corrective action group. These corrective actions consist of replacing the torque switch, cleaning the associated switch contacts and/or adjusting the torque switch setpoint.

(4) In 1980, adjustment was the largest single corrective action associated with torque switches.

(5) Although torque switches are cited most frequently for corrective actions, they do not appear to be a dominant cause of valve assembly inoperability. However, the adjustment range inherent in the torque switch makes it amenable for use as a corrective measure to restore operability to an inoperable valve. Event reports show that torque switch adjustments (increasing or decreasing the settings) are frequently used to overcome the cited operability problem.

(6) The manner in which the torque switch is referenced, and its adjustment as a corrective action, suggests the torque switch provides an indication of symptomatic change in valve operability characteristics rather than a root cause of valve inoperability.

(7) The LER survey data for 1978, 1979 and 1980 does not indicate oversized operators causing valve damage as a problem (as mentioned in EPRI NP-241 and SAND 80-1887). If these problems still occur, presumably they happen and are corrected prior to the time that the plant begins reporting via the LER system.

(8) Even though there were over 400 valve operator events involving 66 plant units in the three-year period, the event data presented in Table 4 indicates

Table 10

ADDITIONAL INFORMATION CONCERNING OCONEE 3
TORQUE SWITCH-RELATED EVENTS

	Problem and Correction	System	Event Date LER Number
1.	Valve 3PR-9 failed to close; torque switch failed, replaced and new switch adjusted.	Containment isolation	02/02/78 78-003
2.	Valve 3B5-3 failed to open; torque switch failed and was replaced.	Containment heat removal	02/03/78 78-004
3.	Valve 3B5-2 failed in an intermediate position with stem failed; caused or aggravated by a faulty torque switch which was replaced.	Containment heat removal	02/07/78 78-005

Table 11

DESCRIPTION OF TORQUE SWITCH ADJUSTMENT-RELATED EVENTS AND CORRECTIVE ACTIONS FOR 1978-1980

	Problem and Correction	System	Plant (Docket Number), Event Date and LER Number
1.	Valve MDV-94 would not close; torque switch adjusted to higher value.	Containment isolation system and control (RC drain tank)	Crystal River (302) 10/2/80 80-041
2.	Valve CAV-3 would not close (second and third events); valve lubricated after second event and torque switch increased after third event.	Containment isolation system and control (sample pressurizer water space)	Crystal River (302) 11/16/80 11/18/80 80-048
3.	Valve CAV-3 would not close (fourth and fifth events); valve lubricated after fourth event and torque switch replaced after fifth event.	Containment isolation system and control (sample pressurizer water space)	Crystal River (302) 12/8/80 12/9/80 80-053
4.	HPI-LPI cross connect valve would not open, torque switch operated erratic with torque out at less than setpoint torque; replaced torque switch.	Emergency core cooling	Davis Besse (346) 3/9/81 81-017
5.	Valve SI-351A would not open, after manual assist it opened three times remotely but a work request investigation found it stuck closed; torque switch adjusted up.	Emergency core cooling	Kewaunee (305) 3/3/80 80-015
6.	HPSI valve HSI-M-54 failed to operate as required, motor thermal overloads opened because of improper torque switch setting; #.	Emergency core cooling	Maine Yankee (309) 3/7/79 79-006
7.	SCAT valve CS-M-66 failed to operate as required, motor thermal overloads opened because of improper torque switch setting; #.	Emergency core cooling	Maine Yankee (309) 3/7/79 79-006

Corrective action was not stated in the LER.

Table 11 (continued)

Problem and Correction	System	Plant (Docket Number) Event Date and LER Number
8. Outboard isolation valve torqued out, current too high, torque switch found adjusted for maximum torque; #.	Reactor water cleanup	Monticello (263) 3/18/79 79-007
9. Valve V-14-37 circuit breaker tripped on closing with isolation signal and failed to open when signal removed, set screw on torque switch loosened and went to maximum torque; #.	Isolation condenser	Oyster Creek (219) 9/14/78 78-017
10. Valve MO-1-1001-36B tripped on thermal overload, thermal overload reset three times (valve failed three times); torque switch setting reduced.	Low pressure coolant injection	Quad Cities 1 (254) 4/10/80 80-009
11. Valve MO-2-1001-29A failed to open; adjusted bypass of torque switch for more time for disc to lift off the valve seat.	Low pressure coolant injection	Quad Cities 2 (265) 10/10/80 80-023
12. Valve 1CV66 failed closed and opened manually, motor and operator failed; operator replaced from stock and motor sent out for repair.	Emergency core cooling	Salem 1 (272) 10/22/80 80-058
13. Valve 1-FCV-62-136 charging pump suction from RWST would not open; torque spring was adjusted to stop the motor.	Emergency core cooling	Sequoyah 1 (327) 6/26/80 80-141
14. Valve FCV-1-51 motor shorted, motor and operator mismatched, motor rated torque of 24 inch pounds and minimum operator setting of 28 inch pounds; #.	Auxiliary feedwater	Sequoyah 1 (327) 8/11/80 80-151
15. Valve 2MOV-SW0002 failed to stroke to full open; repaired operator and control circuit.	Service water	Zion 2 (304) 11/24/80 80-030

Table 12

DESCRIPTION OF LIMIT SWITCH-RELATED EVENTS AND CORRECTIVE ACTIONS FOR 1978-1980

Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
1. EFW flow control valve failed to fully close; limit stop switch was realigned.	Cooling system for reactor auxiliaries and controls	Arkansas 2 78-068/03L-0 8/12/78
2. RHR injection valve 74-67 failed to close upon isolation signal; limit switch contact was cleaned and adjusted.	Containment isolation system and controls	Browns Ferry 1 80-025/03L-0 3/13/80
3. HPCI steamline flow isolation valve (E41-F003) failed to close; limit switch contact cleaned.	Containment isolation system and controls	Brunswick 1 78-041/03L-0 4/10/78
4. HPCI inboard steam supply isolation valve (E41-F002) closing time was 50.8 seconds, tech spec limit is 50 seconds; valve open limit switch was adjusted.	Emergency core cooling system and controls	Brunswick 2 78-002/03L-0 1/4/78
5. CAC-V5 containment inerting inlet valve would not open; actuator limit travel stops were correctly adjusted.	Containment isolation system and controls	Brunswick 2 79-087/03L-0 10/29/79
6. Isolation time for containment normal sump isolation valve (MOV-5463) was 15.5 seconds, tech spec limit 13.0 seconds; open limit switch was adjusted.	Containment isolation system and controls	Calvert Cliffs 1 78-030/03L-0 6/7/78
7. CFT sample isolation valve would not close; contact rotor number 2 was replaced.	Containment isolation system and controls	Crystal River 3 80-033/03L-0 8/3/80
8. RWCU system isolation valve (MOV-2740) closed in 10.4 seconds, tech spec limit 10 seconds; limit switch adjusted.	Reactor coolant cleanup system and controls	Duane Arnold 80-047/03L-0 9/11/80

Table 12 (continued)

	Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
9.	Off-gas system auto isolation valve (IN62-F527) failed in closed position; limit switch adjusted.	Gas radioactive waste management systems	E. I. Hatch 1 79-099/03L-0 12/6/79
10.	Primary containment isolation valve (27-MOV-113) required 5.7 seconds to reach fully closed position, tech spec limit 5 seconds; open limit switch was adjusted.	Containment isolation system and controls	Fitzpatrick 1 79-016/03L-0 3/20/79
11.	RHR system discharge valve (10-MOV-67) would not open in response to an open signal; open torque (switch) bypass limit switch was adjusted.	Containment isolation system and controls	Fitzpatrick 1 80-035/03L-0 4/15/80
12.	Valve V6-12D in the north service water loop header failed to open; limit switch was replaced.	Station service water system and controls	H. B. Robinson 2 78-020/03L-0 8/25/78
13.	RWST supply to charging pump suction valve (1-CVC-MOV-115D) would not open; MOV close limit switch contact number 4 adjusted.	Emergency core cooling system and controls	Farley 1 80-063/03L-0 10/20/80
14.	RHR isolation valve (MOV-1701) failed to close; limit switch contact adjusted.	Residual heat removal system and controls	North Anna 1 79-051/03L-0 4/16/79
15.	Feedwater flush valve (MO3-2-38A) failed to close; limit switch cleaned and adjusted	Containment isolation system and controls	Peach Bottom 3 80-014/03X-1 6/8/80
16.	RHRS containment cooling valve (MO-2-1001-34A) would only open far enough to give dual position indication; limit switches adjusted.	Residual heat removal system and controls	Quad Cities 2 80-024/03L-0 10/10/80
17.	Containment sump valve (FCV-72-20) to Train B of containment spray would not open due to inoperable permissive from FCV-72-21; limit switches associated with FCV-72-21 was adjusted	Other engineered safety features and their controls	Sequoyah 1 80-081/03L-0 5/27/80

Table 12 (continued)

	Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
18.	FCV-72-20 containment sump valve to containment spray pump failed to open due to inoperable permissive from FCV-72-21; limit switches associated with FCV-72-21 cleaned.	Containment heat removal system and controls	Sequoyah 1 80-189/03L-0 11/19/80
19.	Service water MOV to AFW pump backup supply failed to stroke properly; limit switch adjusted.	Other engineered safety features and their controls	Zion 1 80-018/03L-0 4/2/80
20.	BIT outlet valve (2MOV-S18801A) was not fully closed; limit switch adjusted.	Emergency core cooling system and controls	Zion 2 79-053/03L-0 10/9/79
21.	DHR outlet valve 1LP-14 failed to open; valve position limit switch which bypasses torque switch adjusted.	Emergency core cooling system and controls	Oconee 1 80-006/03L-0 3/6/80
22.	Valve 2E51-F013 would not open fully; bypass wiring around torque switch had not been installed as designed; wiring corrected.	Reactor core isolation cooling system and controls	Brunswick 2 80-067 9/23/80
23.	Valve RHR-MOV-25B would not open remotely, torque switch setting was decreased and bypass wiring around the torque switch had not been installed on RHR-MO-25A&B; wiring corrected.	Residual heat removal system and controls	Cooper 80-050 12/16/80
24.	Valve FW-779 did not fully close even though control room green light indicated close; manually closed valve and adjusted number two rotor contact.	Main feedwater	Davis Besse 78-033 3/25/78

Table 13

DESCRIPTION OF MOTOR BURNOUT EVENTS AND CORRECTIVE ACTIONS FOR 1978-1980

	Occurrence and Corrective Action	System	Plant Unit, LER No. and Event Date
1.	Motor for valve MOV-SI-869A burned up, line starter had failed; operator replaced.	Reactivity Control System	Beaver Valley 1 80-011 2/26/80
2.	Motor failure on valve FCV-71-31, cause unknown; motor replaced.	Reactor core isolation cooling	Browns Ferry 1 79-021 9/2/79
3.	Grounded motor on torus return valve FCV-74-71 caused breaker to trip; motor replaced.	Residual heat removal	Browns Ferry 1 80-072 9/24/80
4.	Motor for valve E51-F010 found inoperable with insulation damage; motor replaced and a space heater was installed.	Reactor core isolation cooling	Brunswick 1 78-059 5/27/78
5.	Motor found burned up on valve 1E 51-045; after first repair found brush shunt shorted to case, repaired a second time and reinstalled.	Reactor core isolation cooling	Brunswick 1 79-032 5/14/79
6.	Motor failed on valve E11-F008 when excessive current was drawn because electromechanical brake failed; motor repaired and reinstalled, mechanical brake system removed.	Residual heat removal	Brunswick 2 78-036 4/3/78
7.	Motor burned up on valve F001 due to binding caused by pinion gear installed backward; damaged parts replaced.	High pressure coolant injection	Brunswick 2 79-053 7/21/79
8.	Motor burned on valve E41-F006, blackened condition of motor internals obscured any evidence of cause; repaired motor and checked for mechanical obstruction.	High pressure coolant injection	Hatch 1 79-004 1/19/79
9.	Valve 1B21-F016 failed in mid position due to failed motor winding believed to be caused by moisture from a valve directly above this valve; motor replaced.	Main steam	Hatch 1 80-004 1/6/80

Table 13 (continued)

	Occurrence and Corrective Action	System	Plant Unit, LER No. and Event Date
10.	Valve 1E11-F015A failed to open, motor windings and rotor severely burned; motor replaced.	Residual heat removal	Hatch 1 80-095 8/8/80
11.	Valve, 2E41-F001, failed to open during quick start, motor shunt field insulation degradation by heat and valve stem was rough; motor rewound and stem replaced.	High pressure coolant injection	Hatch 2 78-056 10/27/78
12.	Valve 2E41-F041 failed to open in specified time of 60 seconds, motor winding overheated and burned due to loose connection in shunt field; motor replaced.	High pressure coolant injection	Hatch 2 79-050 6/9/79
13.	Breaker tripped during quick start of valve 2E41-F001 due to motor failure, motor has a five minute duty rating and was operated 12 times in a five-hour period; motor reworked, bench tested, and reinstalled.	High pressure coolant injection	Hatch 2 79-067 7/7/79
14.	Valve 2E41-F041 failed to close due to burned motor, pinion key had slipped out of position; new motor installed, key replaced and locked.	High pressure coolant injection	Hatch 2 79-086 7/30/79
15.	Valve 2E41-F041 failed to open due to burned motor, cause unknown but moisture or high humidity suspected; design package change for continuous current saturation of winding.	High pressure coolant injection	Hatch 2 79-118 11/3/79
16.	Valve 23-MOV-57 would not operate due to burned motor; replaced motor.	High pressure coolant injection	Fitzpatrick 1 78-060 8/6/78
17.	Reactor recirculation system valve motor failed; motor replaced.	Reactor recirculation	Monticello 1 80-020 4/27/80
18.	Outboard HPCI steam supply valve failed due to breakdown of motor winding insulation; installed new motor.	High pressure coolant injection	Monticello 1 80-025 7/29/80
19.	Inboard isolation valve failed to close due to burned motor and seized contactor; motor and contactor replaced.	Reactor core isolation cooling	Pilgrim 1 80-047 8/1/80

indicates that "Overload relays should be included to provide the necessary impedance to maintain short-circuit ratings and to protect cable." It should be noted, however, that operating experience to date includes several events with circuit breaker trips in which the motor thermal overload protective device bypassed the attendant control circuitry and in such events we are not aware of any instances where the circuit breaker failed to provide the intended protection.

However, Regulatory Guide 1.106 could be modified to clarify that bypassing of motor overload protective devices should not include bypassing of their associate heating elements, since bypassing of these elements could lead to exceeding short circuit ratings of the attendant circuit breakers with resulting unacceptable circuit and other types of damages.

Finally, regarding actuation repeatability of the bimetallic thermal overload devices, the review of this area indicated these devices are repeatable for practical application purposes provided their upper temperature limit has not been exceeded and their surrounding ambient temperature remains essentially constant. However, if the motor current increases significantly, the upper temperature limits of these devices can be exceeded and the trip actuation setpoint will tend to increase due to the associated thermal stresses which the device will experience. Therefore, if the trip actuation setpoint of the bimetallic overload relay changes (increases) and motor terminal voltage along with the surrounding ambient temperature of the device has remained essentially constant, it would indicate that motor current has increased significantly to permit the motor to overcome increased mechanical load including aging mechanisms.

Findings

(1) There are a few reports where torque switch contacts were oxidized or corroded. The number of these is a small percentage of all corrective action events related to switches.

(2) Limit switch adjustment is quite common to correct problems associated with valves that will not open, close, or isolate in the specified time limit (stroke response time).

(3) Valve operator motor burnout has occurred quite frequently in BWRs (the survey data contained only one report at a PWR plant).

(4) Most of the motor burnout events which occurred at BWR stations are in the HPCI and RCIC systems. Some failures were reported to be caused by electromechanical failures of other parts and perhaps moisture. There may be a relationship between recommendation number one in Regulatory Guide 1.106 concerning bypass of thermal overload devices and the relatively large number of motor burnouts reported. Also, there appears to be a relationship between permanent bypassing of torque switches, improper usage of motor operators, and motor burnout occurrences.

(5) Actual operating plant experience with motor operators indicates that bypassing motor thermal overload protective devices during surveillance testing has not resulted in an increased operability of the valve assembly on demand. This tends to suggest that bypassing motor thermal overload protective devices during accident conditions would not increase the operability of the valve assembly on demand.

(6) The review of selected nuclear units which are bypassing protective devices on motor operators shows that this recommendation is being implemented by removal of the protective device contacts from the associated control circuitry while retaining the heater elements within the motive power circuit. If bypassing of the protective devices on motor operators is to be implemented, then the practice just mentioned is desirable since complete bypassing of the protective devices could result in exceeding the short circuit rating of the attendant circuit breaker with resulting unacceptable circuit and other types of damages.

(7) If the trip actuation setpoint of a bimetallic overload relay changes and motor terminal voltage along with the surrounding ambient temperature of the device has remained essentially constant, it would indicate that motor current has increased significantly to permit the motor to overcome increased mechanical load including aging mechanisms.

4. DISCUSSION AND RECOMMENDATIONS

4.1 Discussion

The findings and evaluations phase of this survey suggests there are two general aspects that can contribute to resolution of the inoperability problem of valve motor operators. One aspect pertains to primarily technical issues that can be addressed by definitive recommendations for action and the other addresses possible approaches or methods that would be useful to aid in identification and definition of valve motor-operator related problems. The intent of the following discussion is to provide constructive illustration of approaches that would be useful in identification and definition of problems. Specific recommendations are provided in Section 4.2.

Since each plant has only a few reported events, it is most likely that data analysis for trends and patterns is not feasible for individual licensees. However, it would seem that a single group (national, industry, etc.) with overview cognizance could perform a valuable service with additional detailed review and evaluation of operational data on valve motor operator events. Such a review could be limited to events involving torque switches, limit switches and motors together with related factors. The objective of this review could be to explicitly identify root cause of events related to these three areas and recommend specific solutions to eliminate them. Such a group could consist of individuals possessing detailed knowledge of valve motor-operator designs, specific nuclear plant operational experience with these designs, specific surveillance and maintenance practices and procedures for these designs when they are used in a nuclear power station, and particular usage of given designs in a given nuclear power plant application. Our perception of this group is that it would concentrate on positive actions and and recommendations to solve or correct problems in contrast to a response of a study group. As an action group it would provide constructive responses to the problems cited by References 12 and 13 and this AEOD study.

Also, based on this survey of LER data, it appears that efforts by a review group could be enhanced with additional effort on past reports and possible improvements in reporting of future events. Some areas for consideration are:

(1) Individual plant units could review past reportable occurrences, if readily available, of valve motor-operator events to obtain additional detailed information with the objective of determining root cause or causes of the event. This review should give special consideration to repetitive and similar occurrences involving the same valve, a valve in

similar service in a similar system, or a valve in similar service in a redundant train of the same system.

(2) Based on the frequent number of LER reports that identify or describe multiple, but independent, valve motor-operator events, and the inadequacy of the information reported, the following could be considered for future LER reports.

(a) An LER should address a single valve motor operator event unless there is an interaction or sequential dependence between occurrences.

(b) Consistent with current reporting requirements, information reported in an LER should be explicit and factual relative to improper operation of a valve motor operator. In particular, the report should identify the component; explain what happened; determine and discuss why it happened (if possible within a reasonable time period); identify implications for operability of the component within the system (or other components in similar or redundant trains of the system); and state the corrective action.

In addition to the preceding comments, it also seems worthwhile to mention some rather general observations resulting from this survey of valve motor-operator LER data. First, one should exercise caution and discretion in attempting to use the number of reported LERs as a data base for component reliability estimates because this number may not be indicative of the actual number of occurrences for a component of a given type. Further, the level of detail and the clarity of information provided in LERs may, in many cases, not be useful for such reliability estimates. Second, it would seem that valve assembly operability could be enhanced if initial valve assembly selections (motor, operator, valve components) took into consideration the possible effects on required operational characteristics due to changes in related items, such as leakage of upstream check valves, temperature and other variations in process fluids, and variable factors such as gland packing tightening, lubrication, and manual operation of valves. Lastly, operational experience with motor-operated valves indicates that torque switches and/or associated related factors are relatively broad based (nearly 25% of all reported valve motor-operator events) and may warrant specific guidance, either through regulatory actions (such as a Regulatory Guide or by the Standard Review Plan) or a national standard.

4.2 Recommendations

(1) The existing recommendation or guidance to bypass thermal overload protective devices associated with motor-operator safety-related valves (even based upon the presence of an accident signal) should be reassessed to consider such factors as:

(a) Design details of the valve assembly and associated control and support electrical circuitry.

(b) Specific valve assembly use in a particular system (or systems) or expected usage during and following transients or accidents.

(c) Evaluation of whether the bypass is effective in providing the desired valve operability compared to the potential for increased motor, valve and/or attendant component damage with a commensurate reduction in safety.

While the intent of the bypass recommendation may be appropriate from a safety viewpoint for certain motor-operated valves in specific system applications, it is equally clear from operational experience that it is not desirable (also from a safety viewpoint) for other applications. The operational experience supports a strong relationship between the bypassing of these devices, electrical motor burnout events, valve and attendant component damage, and/or associated perturbations in the supporting electrical system. The latter item may possibly be more significant with respect to safety. Further when these factors are considered, it may be desirable to modify Regulatory Guide, 1.106, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves," so as to emphasize implementation of recommendation C.2 including the proper sizing of motor thermal overload protective devices.

(2) In view of the many reported corrective actions pertaining to adjustment of torque switches, methods and procedures for initial setting of these devices should be reviewed. Actual application experience (which may include information obtained by applying the techniques of item 3 below) should be used to identify more accurate and reliable approaches. In addition, the initial torque switch settings, including those made during or immediately following valve assembly maintenance and subsequent adjustments, should be evaluated relative to operability and functional qualification under accident conditions:

(a) Does operability under test conditions imply a known margin exists such that the valve assembly will operate under accident conditions?

(b) When the torque switch is adjusted to permit operation under test conditions, what accountability is there to ensure that margin is adequate (the same or perhaps additional margin may be needed) for safe operation under accident conditions?

(3) Signature tracing techniques (such as measurement of electrical current and voltage applied to the motor or the measurement of the actual valve stem torque or thrust during valve operation) should be developed and tried on selected motor-operated valves as part of the periodic inservice testing program. In addition, the developed method should be applied immediately following maintenance work on valve assemblies so as to ensure that maintenance has not adversely affected valve assembly operation. The objectives of such a method should be to utilize it as an indicator of changes in operability characteristics (aging, inadequate adjustment or maintenance, etc.) and a predictor of the remaining margin to failure. This approach would also assist in determining root causes of operability problems such as changes in valve operability characteristics, changes in torque switch characteristics, or changes in other factors. Further, this method requires that accurate records for time, date, plant conditions, system conditions and actual measured value of parameters be maintained so that meaningful time/history information concerning valve assembly operability can be determined.

(4) The NRC staff should take positive steps to assure that adequate consideration is given to aging and margin requirements for valve assembly qualification and inservice operability. This could be accomplished through participation in national standards activities during the developmental phase of the standards and, subsequently, by establishing appropriate staff positions when the standard is endorsed.

(5) Followup action pertaining to IE Circular 77-01, "Malfunction of Limitorque Valve Operators" should be conducted because events similar to the concerns identified in the circular continue to be reported.

5. REFERENCES

1. IE Circular 77-01, "Malfunction of Limitorque Valve Operators," dated January 4, 1977.

2. IE Circular 78-16, "Limitorque Valve Operators," dated July 26, 1978.

3. IE Circular 79-04, "Loose Locking Nut on Limitorque Valve Operators," dated March 16, 1979.

4. IE Information Notice 79-03, "Limitorque Valve Geared Limit Switch Lubricant," dated February 9, 1979.

5. IE Information Notice 81-08, "Repetitive Failures of Limitorque Operator SMB-4 Motor-to-Shaft Key," dated March 20, 1981.

6. EPRI NP-241, "Assessment of Industry Valve Problems," dated November 1976.

7. SAND 80-1887, "Proceedings EPRI/DOE Workshop Nuclear Industry Valve Problems," in Washington, D.C., May 20-21, 1980, dated January 1981.

8. Proposed Draft Regulatory Guide, "Periodic Testing of Torque Protected Motor-Operated Valves Important to Safety," (RS 801-4), Working Paper 1, dated June 3, 1980.

9. NUREG/CR-1363, "Data Summaries of Licensee Event Reports of Valves at U.S. Commercial Nuclear Power Plants," published date June 1980.

10. Memorandum, W. E. Vesely to A. Thadani, "Elevated Failure Rates for ESF Valves," dated April 29, 1981.

11. IE Circular 81-13, "Torque Switch Electrical Bypass Circuit for Safeguard Service Valve Motors," dated September 23, 1981.

12. NRC Memorandum for E. L. Jordan from R. L. Spessard, "Motor Operated Valve Problems," dated March 25, 1981.

13. RMEP-IR-03600-32, "NGD Operational Experience with Electrically Operated Valves on Emergency Coolant Injection Systems," dated September 1981, Ontario Hydro, Toronto, Canada.

REFERENCES

14. A. W. Richards and C. D. Formica, "Motor Overload Protection for Motor Protection for Motor Actuated Valves." IEEE Trans. on Power Apparatus and Systems, Vol. PAS-100, No. 1, January 1981.

15. F. D. Baxter, "The Dangers of Bypassing Thermal Overload Relays in Nuclear Power Plant Motor Operated Valve Circuits," F 80 260-0, a paper presented at the IEEE PES Winter Meeting, New York, N.Y., February 3-8, 1980.

16. General Electric, GET-3101H, "Selection and Specification Guide for 7700 Plus Motor Control Centers," page 28.

17. A. F. Kolb and H. W. Thom, "Motor Protection Characteristics of Ambient Insensitive Overload Devices," IEEE Trans. on Industry Applications, Vol. IA-15 No. 3, May/June 1979.

Table 1

AC AND DC MOTOR OPERATOR
AND VALVE OPERATOR EVENTS
For 1978-1980

Plant Unit	AC and DC Motor Operator Events	Valve Operator Events
Arkansas 1	6	10
Arkansas 2	13	18
Beaver Valley 1	1	6
Big Rock Point	0	1
Browns Ferry 1	4	5
Browns Ferry 2	1	1
Browns Ferry 3	3	6
Brunswick 1	6	13
Brunswick 2	7	14
Calvert Cliffs 1	1	10
Calvert Cliffs 2	0	6
Catawaba 1	0	1
Cooper 1	6	13
Crystal River 3	5	7
Davis Besse 1	10	28
D. C. Cook 1	4	5
D. C. Cook 2	5	9
Dresden 1	2	2
Dresden 2	3	7
Dresden 3	3	8
Duane Arnold	5	11
Edwin Hatch 1	8	13

Table 1 (continued)

Plant Unit	AC and DC Motor Operator Events	Valve Operator Events
Edwin Hatch 2	8	13
FitzPatrick 1	10	15
Ft. Calhoun 1	1	3
Ft. St. Vrain 1	1	2
H. B. Robinson 2	3	5
Joseph Farley 1	3	8
Indian Point 2	0	1
Kewaunee 1	2	3
Maine Yankee	2	4
Millstone 1	1	4
Millstone 2	0	1
Monticello 1	5	9
Nine Mile Point 1	0	2
North Anna 1	2	10
North Anna 2	0	2
Oconee 1	2	2
Oconee 2	3	5
Oconee 3	4	5
Oyster Creek 1	2	7
Palisades	0	1
Peach Bottom 2	2	7
Peach Bottom 3	7	15

Table 1 (continued)

Plant Unit	AC and DC Motor Operator Events	Valve Operator Events
Pilgrim 1	2	9
Point Beach 2	1	1
Prairie Island 1	2	3
Prairie Island 2	0	3
Quad Cities 1	1	9
Quad Cities 2	5	13
Rancho Seco 1	1	2
Robert Ginna 1	1	1
Salem 1	4	11
San Onofre	0	6
Sequoyah 1	4	10
St. Lucie 1	3	6
Surry 1	3	5
Surry 2	4	6
Three Mile Island 1	2	3
Three Mile Island 2	2	2
Turkey Point 3	1	6
Turkey Point 4	0	1
Vermont Yankee 1	1	7
Yankee Rowe	0	1
Zion 1	2	14
Zion 2	3	7
Totals (for 66 plant/units)	193	444

Table 2

PLANT UNITS WITH LARGEST NUMBER OF AC AND DC MOTOR OPERATOR EVENTS FOR 1978-1980

Plant Unit	Number of Events
Arkansas 2	13
Davis Besse 1	10
FitzPatrick 1	10
Hatch 1	8
Hatch 2	8
Brunswick 2	7
Peach Bottom 3	7
Arkansas 1	6
Brunswick 1	6
Cooper 1	6

Table 3

PLANT UNITS WITH LARGEST NUMBER OF VALVE OPERATOR EVENTS FOR 1978-1980

Plant Unit	Number of Events
Davis Besse 1	28
Arkansas 2	18
FitzPatrick 1	15
Peach Bottom 3	15
Brunswick 2	14
Zion 1	14
Brunswick 1	13
Cooper 1	13
Hatch 1	13
Hatch 2	13
Quad Cities 2	13

Table 4

EVENTS RELATING TO TORQUE SWITCHES

Plant Unit	Docket Number	Number of Events
Arkansas 1	50-313	5
Hatch 2	50-366	5
Davis Besse 1	50-346	3
D. C. Cook 2	50-316	3
Oconee 3	50-287	3
Crystal River 3	50-302	2
Kewaunee	50-305	2
Maine Yankee	50-309	2
Peach Bottom 2	50-277	2
Quad Cities 2	50-265	2
Sequoyah 1	50-327	2
Browns Ferry 3	50-296	1
Brunswick 2	50-324	1
Cooper Station	50-298	1
D. C. Cook 1	50-315	1
Dresden 2	50-237	1
Dresden 3	50-249	1
Duane Arnold	50-331	1
Monticello	50-263	1
North Anna 1	50-338	1
Oconee 1	50-269	1
Oyster Creek 1	50-219	1
Point Beach 2	50-301	1

Table 4 (continued)

Plant Unit	Docket Number	Number of Events
Quad Cities	50-254	1
St. Lucie 1	50-335	1
Surry 2	50-281	1
Totals (for 26 plant units)		46

Table 5

DESCRIPTION OF TORQUE SWITCH-RELATED EVENTS AND CORRECTIVE ACTIONS FOR 1978-1980

Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
1. Inside containment isolation seal return valve (CV-1272) for RCP failed to fully close; torque switch was replaced.	Chemical, volume control and liquid poison system and controls	Arkansas 1 79-021/03L-0 11/15/79
2. CV-7444 Hydrogen purge supply isolation valve failed to close; torque switch contacts cleaned.	Containment combustible gas control systems and controls	Arkansas 1 80-001/03L-0 1/14/80
3. CV-7448 Hydrogen purge exhaust isolation valve failed to close; torque switch contacts cleaned.	Containment combustible gas control systems and controls	Arkansas 1 80-002/03L-0 1/14/80
4. Main steam supply valve (CV-2667) to P-7A did not fully open; torque switch was adjusted.	Feedwater system and controls	Arkansas 1 80-023/03L-0 7/9/80
5. RCS makeup block valve (CV-1234) failed to fully close; torque switch was adjusted.	Chemical, volume control and liquid poison system and controls	Arkansas 1 80-033/03L-0 9/6/80
6. RCIC minimum flow bypass valve FCV-3-71-34 failed to go close; torque switch contacts cleaned.	Reactor core isolation cooling systems and controls	Browns Ferry 1 80-026/03L-0 7/14/80
7. RWCU suction inboard valve (F001) failed in the mid-position, torque switch torqued out early; valve manually shut then cycled four times.	Reactor coolant cleanup system and controls	Brunswick 2 79-078/03L-0 8/31/79
8. Service water valve (SW 888) failed to open; replaced torque switch (Crane Teledyne Company).	Station service water system and controls	Cooper 1 78-038/03L-0 12/8/78

Table 5 (continued)

Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
9. RC drain tank isolation valve (V-94) would not close; torque switch adjusted.	Containment isolation system and controls	Crystal River 3 80-041/03L-0 10/2/80
10. Containment isolation valve (CAV-3) would not close while sampling the pressurizer water space; valve stem lubricated and torque switch adjusted.	Containment isolation system and controls	Crystal River 3 80-048/03L-0 11/16/80
11. RHR discharge valve (ICM-111) to cold legs 2 and 3 failed to open completely; torque switch removed, cleaned and lubricated.	Residual heat removal system and controls	D.C. Cook 1 79-057/03L-0 10/29/79
12. CMO 414 failed to operate in its prescribed time; torque switch contacts were cleaned and adjusted.	Cooling system for reactor auxiliary and controls	D.C. Cook 2 78-027/03L-0 4/22/78
13. Containment spray pump discharge valve IMO-220 failed to open; torque switch and drive motor replaced.	Emergency core cooling system and controls	D.C. Cook 2 79-051/03L-0 12/17/79
14. Suction valve (VMO-102) for the containment equalization fan failed to open; torque switch adjusted.	Containment air purification and cleanup system and controls	D.C. Cook 2 80-010/03L-0 2/16/80
15. Auxiliary feedwater valve (AF3869) could not be closed; replaced torque switch with one of a heavier duty design.	Feedwater system and controls	Davis Besse 1 79-030/03L-0 2/20/79
16. Decay heat removal valve DH-2735 failed to close after being opened; valve stem closed, valve repacked and torque switch setting increased.	Containment isolation system and controls	Davis Besse 1 79-041/03L-0 3/20/79

Table 5 (continued)

Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
17. Main steam inlet to AFW pump turbine 1-1 isolation valve torqued out early; torque switch setting adjusted.	Feedwater system and controls	Davis Besse 1 79-073/03L-0 7/8/79
18. HPCI steam supply valve failed to open; torque switch was replaced.	Emergency core cooling system and controls	Dresden 2 80-039/01T-0 10/11/80
19. MSIV leakage control system outboard isolation valve (MOV 8402B) did not close properly; torque switch contacts were cleaned.	Containment isolation system and controls	Duane Arnold 78-022/03L-0 4/6/78
20. RCIC line isolation valve MOV-2401 would not open; torque switch was replaced.	Reactor core isolation cooling system and controls	Duane Arnold 80-050/03L-0 9/17/80
21. Service water valve (2P41-F315) was closed but would not reopen electrically; torque switch and associated contacts cleaned.	Station service water system and controls	E.I. Hatch 2 79-057/03L-0 6/24/79
22. Hydrogen recombiner valve (2T49-F003A) failed to open; torque switch was replaced.	Containment combustion gas control system	E.I. Hatch 2 80-004/03L-0 1/18/80
23. RCIC outboard steam supply line isolation valve (2E51-F008) failed to isolate; torque switch was repaired.	Reactor core isolation cooling system and controls	E.I. Hatch 2 80-055/03L-0 5/6/80
24. RCIC steamline outboard isolation valve (2E51-F008) failed to close fully; torque switch was repaired.	Reactor core isolation cooling system and controls	E.I. Hatch 2 80-123/03L-0 8/12/80
25. Valve 2E11-F007A failed leak rate test; torque switch adjusted.	Residual heat removal system and controls	E.I. Hatch 2 80-152/03L-0 11/4/80
26. Containment isolation valve would not shut completely; torque switch contacts were cleaned.	Cooling system for reactor auxiliary and controls	Kewaunee 1 78-008/03L-0 2/28/78

Table 5 (continued)

Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
27. Valve SI-351A would not open; open torque switch adjusted.	Residual heat removal system and controls	Kewaunee 1 80-015/03L-0 3/3/80
28. HPSI pump suction valve and CS-M-66 outlet valve failed to operate as required; torque switches adjusted.	Containment heat removal system and controls	Maine Yankee 79-006/03L-0 3/7/79
29. MOV-QS 102A would not return to its normal close position; torque switch contacts cleaned.	Containment air purification and cleanup system	North Anna 1 78-115/03L-0 11/7/78
30. 3PR-9 failed to close; torque switch replaced and properly adjusted.	Containment isolation system and controls	Oconee 3 78-003/03L-0 2/2/78
31. BS-3 failed to open; torque switch replaced.	Containment heat removal system and controls	Oconee 3 78-004/03L-0 2/3/78
32. BS-2 failed in an intermediate position; torque switch replaced.	Containment heat removal system and controls	Oconee 3 78-005/03L-0 2/7/78
33. Valve V-14-37 would not close; torque switch adjusted and set screw tighten.	Emergency core cooling system and controls	Oyster Creek 1 78-017/03L-0 9/14/78
34. Main steamline drain isolation valve failed to close; torque switch to be replaced.	Main steam isolation system and controls	Peach Bottom 2 78-042/03L-0 10/19/78
35. Inboard main steamline drain isolation valve (MO-2-74) failed to close; torque switch to be replaced.	Main steam isolation system and controls	Peach Bottom 2 78-030/03L-0 6/12/78
36. Starter breaker overload for containment spray valve (2-MOV-860C) tripped; torque switch was replaced.	Containment heat removal system and controls	Point Beach 2 78-007/03L-0 6/16/78
37. Thermal overload relay for chamber cooling valve MO-1-1001-36B tripped; torque switch adjusted	Emergency core cooling system and controls	Quad Cities 1 80-009/03L-0 4/10/80

Table 5 (continued)

	Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
38.	Valve MO-2-1402-3A would not reopen; temporary sticking of the torque switch on the valve operator.	Containment heat removal system and controls	Quad Cities 2 80-021/03L-0 9/14/80
39.	MO-2-1001-29A initially failed to open fully; torque switch adjusted.	Containment heat removal system and controls	Quad Cities 2 80-023/03L-0 10/10/80
40.	1-FCV-62-136 would not open; torque switch adjusted.	Emergency core cooling system and controls	Sequoyah 1 80-111/03L-0 6/26/80
41.	AFW pump failed to start, torque switch failed to function properly causing valve FCV-1-51 motor operator to short and thermal overloads to melt; #.	Feedwater systems and controls	Sequoyah 1 80-151/03L-0 8/11/80
42.	MV-07-1B failed to open; torque switch replaced.	Emergency core cooling system and controls	St. Lucie 1 78-044/03L-0 11/21/78
43.	MOV-CW-200A failed with the valve approximately 75% open; torque switch replaced.	Ultimate heat sink facilities	Surry 2 80-034/03L-0 11/22/80
44.	Containment isolation valve CAV-3 would not close; torque switch was replaced.	Containment isolation system and controls	Crystal River 3 80-053/03L/0 12/8/80
45.	HPCI steam supply outside No. IV operator motor failed; motor rewound and torque switch replaced.	Emergency core cooling system and controls	FitzPatrick 1 80-085/01T-0 12/8/80
46.	Valve MO3-1501-28B, both indicating lights went out and the motor stopped; shaft pin on the torque switch was replaced.	Containment isolation system and controls	Dresden 3 78-026/03L-0 6/6/78

Corrective action was not stated in the LER.

Table 6

ADDITIONAL INFORMATION CONCERNING ARKANSAS 1
TORQUE SWITCH-RELATED EVENTS*

Problem and Correction	System	Event Date LER Number
1. Valve CV-2667 to turbine drive failed to open; torque switch defective and replaced.	Emergency feedwater	01/13/78 78-002
2. Valve CV-7449, H2 purge isolation failed to torque out and bent stem; torque switch failed and replaced.	Combustible gas control	04/19/78 78-010
3. Valve CV-1272 inside isolation seal return line for RCP "B" failed to close; torque switch failed to make up in fully open position and replaced.	Chemical and volume control	11/15/79 79-021
4. Valve CV-7444, H2 purge supply isolation failed to close; torque switch contacts cleaned and valve verified operational.	Combustible gas control	01/14/80 80-001
5. Valve CV-7448, H2 purge exhaust isolation failed to close; torque switch contacts cleaned and valve verified operational.	Combustible gas control	01/14/80 80-002
6. Valve CV-2617 failed to close remotely, stem was binding; stem was repacked.	Emergency feedwater	03/06/80 80-005
7. Valve CV-2667 failed to fully open; lubricated stem and adjusted the torque switch.	Emergency feedwater	04/06/80 80-012
8. Valve CV-2667 failed to open, stem was binding; loose bolts securing operator to body were tightened.	Emergency feedwater	04/07/80 80-012
9. Valve CV-2617 failed (cause and correction not provided).	Emergency feedwater	04/07/80 80-012
10. Valve CV-2667 failed to fully open, torqued out early; torque switch given a small adjustment.	Emergency feedwater	07/09/80 80-023
11. Valve CV-1234 failed to close (block valve in makeup system) due to high differential pressure; torque switch setting increased.	Chemical and volume control	09/06/80 80-033

* The number of events is greater than shown in Table 4 because more than one event was reported in a single LER, an additional search was made for the early months of 1978, or an LER referenced another LER.

Table 7

ADDITIONAL INFORMATION CONCERNING E. I. HATCH 2
TORQUE SWITCH-RELATED EVENTS*

Problem and Correction	System	Event Date LER Number
1. Valve 2P41-F315A failed to open, torque switch had corroded to the switch shaft; torque switch repaired.	Service water	06/24/79 79-057
2. Valve 2T49-F003A failed to open; torque switch defective and replaced.	Hydrogen recombiner	01/18/80 80-004
3. Valve 2E51-F008 failed to close; torque switch defective and replaced.	Reactor core isol. cooling	05/06/80 80-055
4. Valve 2E51-F008 failed to close; torque switch defective and replaced.	Reactor core isol. cooling	08/12/80 80-123
5. Valve 2E41-F007A failed to close (failed leak rate test); torque switch adjusted.	Residual heat removal	11/04/80 80-152
6. Valve 2E41-F049 failed leak rate test, torque switch adjusted.	High pressure coolant injection	11/04/80 80-152

* The number of events is greater than shown in Table 4 because more than one event was reported in a single LER.

Table 8

ADDITIONAL INFORMATION CONCERNING DAVIS BESSE 1
TORQUE SWITCH-RELATED EVENTS*

Problem and Correction	System	Event Date LER Number
1. Valve MS-603 would not open on the steam generator drain; torque switch setting increased from 1.5 to 3.0.	Main steam	08/29/77 NP-33-77-72
2. Valve AF-3872 for AFP 1-2 would not open due to high differential pressure from leaking check valve; torque switch defective and replaced.	Auxiliary feedwater	10/25/77 77-083
3. Valve AF-3870 for AFP 1-1 would not open due to high differential pressure from leaking check valve and torqued out before opening; limit switch which bypasses the torque switch was adjusted.	Auxiliary feedwater	03/16/78 78-027
4. Valve AF-3869 for system 1-1 failed to close; torque switch faulty and replaced with heavier duty design.	Auxiliary feedwater	02/20/79 79-030
5. Valve DH-2735 failed to close because of boric acid buildup on stem; valve stem cleaned, repacked and torque switch setting increased.	Decay heat removal	03/20/79 79-041
6. Valve MS-106 torqued out on opening, believed due to normal wear of valve internals; torque switch setting increased but valve later failed to close and adjusted limit switch.	Auxiliary feedwater	07/08/79 79-073

* The number of events is greater than shown in Table 4 because an additional search was made for the early months of 1978 or an LER referenced another LER.

Table 9

ADDITIONAL INFORMATION CONCERNING COOK 2 TORQUE SWITCH-RELATED EVENTS

Problem and Correction	System	Event Date LER Number
1. Valve CMO-414 failed to operate in prescribed time; torque switch contacts required burnishing and were out of adjustment.	Auxiliary cooling	04/22/78 78-027
2. Valve IMO-220 failed to open; torque switch was binding the operator mechanism.	Emergency core cooling	12/17/79 79-051
3. Valve VMO-102 failed to open; torque switch out of adjustment.	Containment air purification	02/16/80 80-010

Table 10

ADDITIONAL INFORMATION CONCERNING OCONEE 3 TORQUE SWITCH-RELATED EVENTS

	Problem and Correction	System	Event Date LER Number
1.	Valve 3PR-9 failed to close; torque switch failed, replaced and new switch adjusted.	Containment isolation	02/02/78 78-003
2.	Valve 3B5-3 failed to open; torque switch failed and was replaced.	Containment heat removal	02/03/78 78-004
3.	Valve 3B5-2 failed in an intermediate position with stem failed; caused or aggravated by a faulty torque switch which was replaced.	Containment heat removal	02/07/78 78-005

Table 11

DESCRIPTION OF TORQUE SWITCH ADJUSTMENT-RELATED EVENTS AND CORRECTIVE ACTIONS FOR 1978-1980

Problem and Correction	System	Plant (Docket Number), Event Date and LER Number
1. Valve MDV-94 would not close; torque switch adjusted to higher value.	Containment isolation system and control (RC drain tank)	Crystal River (302) 10/2/80 80-041
2. Valve CAV-3 would not close (second and third events); valve lubricated after second event and torque switch increased after third event.	Containment isolation system and control (sample pressurizer water space)	Crystal River (302) 11/16/80 11/18/80 80-048
3. Valve CAV-3 would not close (fourth and fifth events); valve lubricated after fourth event and torque switch replaced after fifth event.	Containment isolation system and control (sample pressurizer water space)	Crystal River (302) 12/8/80 12/9/80 80-053
4. HPI-LPI cross connect valve would not open, torque switch operated erratic with torque out at less than setpoint torque; replaced torque switch.	Emergency core cooling	Davis Besse (346) 3/9/81 81-017
5. Valve SI-351A would not open, after manual assist it opened three times remotely but a work request investigation found it stuck closed; torque switch adjusted up.	Emergency core cooling	Kewaunee (305) 3/3/80 80-015
6. HPSI valve HSI-M-54 failed to operate as required, motor thermal overloads opened because of improper torque switch setting; #.	Emergency core cooling	Maine Yankee (309) 3/7/79 79-006
7. SCAT valve CS-M-66 failed to operate as required, motor thermal overloads opened because of improper torque switch setting; #.	Emergency core cooling	Maine Yankee (309) 3/7/79 79-006

Corrective action was not stated in the LER.

Table 11 (continued)

Problem and Correction	System	Plant (Docket Number) Event Date and LER Number
8. Outboard isolation valve torqued out, current too high, torque switch found adjusted for maximum torque; #.	Reactor water cleanup	Monticello (263) 3/18/79 79-007
9. Valve V-14-37 circuit breaker tripped on closing with isolation signal and failed to open when signal removed, set screw on torque switch loosened and went to maximum torque; #.	Isolation condenser	Oyster Creek (219) 9/14/78 78-017
10. Valve MO-1-1001-36B tripped on thermal overload, thermal overload reset three times (valve failed three times); torque switch setting reduced.	Low pressure coolant injection	Quad Cities 1 (254) 4/10/80 80-009
11. Valve MO-2-1001-29A failed to open; adjusted bypass of torque switch for more time for disc to lift off the valve seat.	Low pressure coolant injection	Quad Cities 2 (265) 10/10/80 80-023
12. Valve 1CV66 failed closed and opened manually, motor and operator failed; operator replaced from stock and motor sent out for repair.	Emergency core cooling	Salem 1 (272) 10/22/80 80-058
13. Valve 1-FCV-62-136 charging pump suction from RWST would not open; torque spring was adjusted to stop the motor.	Emergency core cooling	Sequoyah 1 (327) 6/26/80 80-141
14. Valve FCV-1-51 motor shorted, motor and operator mismatched, motor rated torque of 24 inch pounds and minimum operator setting of 28 inch pounds; #.	Auxiliary feedwater	Sequoyah 1 (327) 8/11/80 80-151
15. Valve 2MOV-SW0002 failed to stroke to full open; repaired operator and control circuit.	Service water	Zion 2 (304) 11/24/80 80-030

Table 12

DESCRIPTION OF LIMIT SWITCH-RELATED EVENTS AND CORRECTIVE ACTIONS FOR 1978-1980

Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
1. EFW flow control valve failed to fully close; limit stop switch was realigned.	Cooling system for reactor auxiliaries and controls	Arkansas 2 78-068/03L-0 8/12/78
2. RHR injection valve 74-67 failed to close upon isolation signal; limit switch contact was cleaned and adjusted.	Containment isolation system and controls	Browns Ferry 1 80-025/03L-0 3/13/80
3. HPCI steamline flow isolation valve (E41-F003) failed to close; limit switch contact cleaned.	Containment isolation system and controls	Brunswick 1 78-041/03L-0 4/10/78
4. HPCI inboard steam supply isolation valve (E41-F002) closing time was 50.8 seconds, tech spec limit is 50 seconds; valve open limit switch was adjusted.	Emergency core cooling system and controls	Brunswick 2 78-002/03L-0 1/4/78
5. CAC-V5 containment inerting inlet valve would not open; actuator limit travel stops were correctly adjusted.	Containment isolation system and controls	Brunswick 2 79-087/03L-0 10/29/79
6. Isolation time for containment normal sump isolation valve (MOV-5463) was 15.5 seconds, tech spec limit 13.0 seconds; open limit switch was adjusted.	Containment isolation system and controls	Calvert Cliffs 1 78-030/03L-0 6/7/78
7. CFT sample isolation valve would not close; contact rotor number 2 was replaced.	Containment isolation system and controls	Crystal River 3 80-033/03L-0 8/3/80
8. RWCU system isolation valve (MOV-2740) closed in 10.4 seconds, tech spec limit 10 seconds; limit switch adjusted.	Reactor coolant cleanup system and controls	Duane Arnold 80-047/03L-0 9/11/80

Table 12 (continued)

Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
9. Off-gas system auto isolation valve (IN62-F527) failed in closed position; limit switch adjusted.	Gas radioactive waste management systems	E. I. Hatch 1 79-099/03L-0 12/6/79
10. Primary containment isolation valve (27-MOV-113) required 5.7 seconds to reach fully closed position, tech spec limit 5 seconds; open limit switch was adjusted.	Containment isolation system and controls	Fitzpatrick 1 79-016/03L-0 3/20/79
11. RHR system discharge valve (10-MOV-67) would not open in response to an open signal; open torque (switch) bypass limit switch was adjusted.	Containment isolation system and controls	Fitzpatrick 1 80-035/03L-0 4/15/80
12. Valve V6-12D in the north service water loop header failed to open; limit switch was replaced.	Station service water system and controls	H. B. Robinson 2 78-020/03L-0 8/25/78
13. RWST supply to charging pump suction valve (1-CVC-MOV-115D) would not open; MOV close limit switch contact number 4 adjusted.	Emergency core cooling system and controls	Farley 1 80-063/03L-0 10/20/80
14. RHR isolation valve (MOV-1701) failed to close; limit switch contact adjusted.	Residual heat removal system and controls	North Anna 1 79-051/03L-0 4/16/79
15. Feedwater flush valve (MO3-2-38A) failed to close; limit switch cleaned and adjusted	Containment isolation system and controls	Peach Bottom 3 80-014/03X-1 6/8/80
16. RHRS containment cooling valve (MO-2-1001-34A) would only open far enough to give dual position indication; limit switches adjusted.	Residual heat removal system and controls	Quad Cities 2 80-024/03L-0 10/10/80
17. Containment sump valve (FCV-72-20) to Train B of containment spray would not open due to inoperable permissive from FCV-72-21; limit switches associated with FCV-72-21 was adjusted	Other engineered safety features and their controls	Sequoyah 1 80-081/03L-0 5/27/80

Table 12 (continued)

	Occurrence and Corrective Action	System	Plant Unit, LER Number and Event Date
18.	FCV-72-20 containment sump valve to containment spray pump failed to open due to inoperable permissive from FCV-72-21; limit switches associated with FCV-72-21 cleaned.	Containment heat removal system and controls	Sequoyah 1 80-189/03L-0 11/19/80
19.	Service water MOV to AFW pump backup supply failed to stroke properly; limit switch adjusted.	Other engineered safety features and their controls	Zion 1 80-018/03L-0 4/2/80
20.	BIT outlet valve (2MOV-SI8801A) was not fully closed; limit switch adjusted.	Emergency core cooling system and controls	Zion 2 79-053/03L-0 10/9/79
21.	DHR outlet valve 1LP-14 failed to open; valve position limit switch which bypasses torque switch adjusted.	Emergency core cooling system and controls	Oconee 1 80-006/03L-0 3/6/80
22.	Valve 2E51-F013 would not open fully; bypass wiring around torque switch had not been installed as designed; wiring corrected.	Reactor core isolation cooling system and controls	Brunswick 2 80-067 9/23/80
23.	Valve RHR-MOV-25B would not open remotely, torque switch setting was decreased and bypass wiring around the torque switch had not been installed on RHR-MO-25A&B; wiring corrected.	Residual heat removal system and controls	Cooper 80-050 12/16/80
24.	Valve FW-779 did not fully close even though control room green light indicated close; manually closed valve and adjusted number two rotor contact.	Main feedwater	Davis Besse 78-033 3/25/78

Table 13

DESCRIPTION OF MOTOR BURNOUT EVENTS AND CORRECTIVE ACTIONS FOR 1978-1980

	Occurrence and Corrective Action	System	Plant Unit, LER No. and Event Date
1.	Motor for valve MOV-SI-869A burned up, line starter had failed; operator replaced.	Reactivity Control System	Beaver Valley 1 80-011 2/26/80
2.	Motor failure on valve FCV-71-31, cause unknown; motor replaced.	Reactor core isolation cooling	Browns Ferry 1 79-021 9/2/79
3.	Grounded motor on torus return valve FCV-74-71 caused breaker to trip; motor replaced.	Residual heat removal	Browns Ferry 1 80-072 9/24/80
4.	Motor for valve E51-F010 found inoperable with insulation damage; motor replaced and a space heater was installed.	Reactor core isolation cooling	Brunswick 1 78-059 5/27/78
5.	Motor found burned up on valve 1E 51-045; after first repair found brush shunt shorted to case, repaired a second time and reinstalled.	Reactor core isolation cooling	Brunswick 1 79-032 5/14/79
6.	Motor failed on valve E11-F008 when excessive current was drawn because electromechanical brake failed; motor repaired and reinstalled, mechanical brake system removed.	Residual heat removal	Brunswick 2 78-036 4/3/78
7.	Motor burned up on valve F001 due to binding caused by pinion gear installed backward; damaged parts replaced.	High pressure coolant injection	Brunswick 2 79-053 7/21/79
8.	Motor burned on valve E41-F006, blackened condition of motor internals obscured any evidence of cause; repaired motor and checked for mechanical obstruction.	High pressure coolant injection	Hatch 1 79-004 1/19/79
9.	Valve 1B21-F016 failed in mid position due to failed motor winding believed to be caused by moisture from a valve directly above this valve; motor replaced.	Main steam	Hatch 1 80-004 1/6/80

Table 13 (continued)

	Occurrence and Corrective Action	System	Plant Unit, LER No. and Event Date
10.	Valve 1E11-F015A failed to open, motor windings and rotor severely burned; motor replaced.	Residual heat removal	Hatch 1 80-095 8/8/80
11.	Valve, 2E41-F001, failed to open during quick start, motor shunt field insulation degradation by heat and valve stem was rough; motor rewound and stem replaced.	High pressure coolant injection	Hatch 2 78-056 10/27/78
12.	Valve 2E41-F041 failed to open in specified time of 60 seconds, motor winding overheated and burned due to loose connection in shunt field; motor replaced.	High pressure coolant injection	Hatch 2 79-050 6/9/79
13.	Breaker tripped during quick start of valve 2E41-F001 due to motor failure, motor has a five minute duty rating and was operated 12 times in a five-hour period; motor reworked, bench tested, and reinstalled.	High pressure coolant injection	Hatch 2 79-067 7/7/79
14.	Valve 2E41-F041 failed to close due to burned motor, pinion key had slipped out of position; new motor installed, key replaced and locked.	High pressure coolant injection	Hatch 2 79-086 7/30/79
15.	Valve 2E41-F041 failed to open due to burned motor, cause unknown but moisture or high humidity suspected; design package change for continuous current saturation of winding.	High pressure coolant injection	Hatch 2 79-118 11/3/79
16.	Valve 23-MOV-57 would not operate due to burned motor; replaced motor.	High pressure coolant injection	Fitzpatrick 1 78-060 8/6/78
17.	Reactor recirculation system valve motor failed; motor replaced.	Reactor recirculation	Monticello 1 80-020 4/27/80
18.	Outboard HPCI steam supply valve failed due to breakdown of motor winding insulation; installed new motor.	High pressure coolant injection	Monticello 1 80-025 7/29/80
19.	Inboard isolation valve failed to close due to burned motor and seized contactor; motor and contactor replaced.	Reactor core isolation cooling	Pilgrim 1 80-047 8/1/80