

AEOD/T94-02

TECHNICAL REVIEW REPORT  
REVIEW OF MISPOSITIONED EQUIPMENT EVENTS  
MAY 1994

Prepared by:  
Sanford Israel

Reactor Operations Analysis Branch  
Division of Safety Programs  
Office for Analysis and Evaluation  
of Operational Data

9405310029 940317  
PDR ORG NEXD  
PDR

## SUMMARY

Over 190 mispositioning events were reviewed for the period 1990 to 1993. Most of the events involved mispositioned valves and about 15 percent involved mispositioning multiple components. The personnel errors associated with these events cover a wide range of lapses. The independent verification process meant to catch mispositioned equipment is not always successful. The licensees generally discipline or counsel the personnel involved in the error rather than make tangible plant modifications such as status alarms and position markers. The overall safety impact of these deficiencies appears to be small.

## INTRODUCTION

An Enforcement Action (EA) (\$100,000 fine) for mispositioned root valves at Catawba in 1990 prompted this review of mispositioned equipment caused by personnel errors. Restoration errors occur following maintenance, surveillance, and refueling outages. The Catawba event happened during a reactor vessel refill evolution that involved isolated pressure sensors that simultaneously defeated overpressure protection actuation and reactor vessel pressure readout in the control room (CR) and resulted in an unnoticed plant pressurization. Similarly, closed valves in the emergency feedwater system contributed to the initiation of the Three Mile Island (TMI) accident. Subsequent to that accident, the NRC issued Bulletin 79-06 which in part required verification of the operability of all safety-related systems when they are returned to service following maintenance or testing. TMI Action Plan, Item I.C.6 (NUREG-0737), required verification of system configuration when returning from maintenance and testing. Information Notice (IN) 84-51 provided additional amplification on independent verification and summarized several mispositioned equipment events observed after the TMI accident.

The NRC has a long standing concern about mispositioned equipment going back to Criterion XIV, "Inspection, Test, and Operating Status," of 10 CFR 50, Appendix B and Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems." This guidance calls for automatic indication in the CR of inoperable trains of safety systems. In addition to the above verification requirements, the NRC required post-maintenance testing in Generic Letter (GL) 83-28, "Required Actions Based on Generic Implications of Salem ATWS Event" which was issued in response to the Salem ATWS event. Post-maintenance testing may capture some of the mispositioned equipment situations, but it may also be the source of mispositioning equipment (inadequate system restoration following the test). The NRC Inspection Manual has modules that include monitoring independent verification of system status and operability testing of equipment being returned to service.

The industry has produced more than 10 studies on mispositioned equipment; the most recent was issued in 1992. These reports provide suggestions for remedial actions based on licensee corrective actions. In 1986, AEOD issued a technical review report (AEOD/T612) on this subject.

A program will be developed that will clearly identify instruments within the Control Room that are either out of service or known to be out of calibration.

**River Bend - IR 458/93-20** - The inspectors noted several situations related to system alignment. The following are excerpts from the report:

The inspectors observed portions of a high pressure core spray (HPCS) valve and pump test. Several steps during the restoration of the HPCS system required an independent verification of the proper valve alignment. During one such verification, the operator performing the procedure handed the verifier the procedure, pointed to the valve switches to be verified, and requested that he perform an independent verification of these valves. The first performer did not appear to realize that he could have defeated the independence of the verifier by pointing out the specific valve switches to be verified.

The licensee's administrative procedure ADM-0022 states, "Independent verification is intended to mean a second check of the position or status of a component or system. The independent verification will be performed separately without visual or audible contact with the first performer."

In another instance, the licensee noted that a test fixture on a source range monitor remained installed for four months since the previous test. A review of the previous test document indicated that the removal of the test fixture had been signed off by an independent verifier.

The corrective actions included:

Modifications of procedures by removing unnecessary verifications, in-process verifications were clearly identified as requiring completion before proceeding, and restoration verifications were in a separate section at the end of the procedure. A human performance engineer was designated to set up a consistent and effective independent verification program. Operations and maintenance departments would be provided instructions on independent verification that would be unique to their respective disciplines. Plant management would hold individual verifiers personally accountable for their actions.

**Indian Point 3 - IR 286/91-14** - During a walkdown, an NRC resident inspector noted a boron injection valve fully open (according to the local stem indicator) while tagged in a shut position under an operating order providing reactor coolant system (RCS) protection during mid-loop operations. The valve was presumably set at a throttled position one month earlier. The licensee never determined how the valve became backseated in the full open position.

It was surmised that the reactor operator who was supposed to close the valve for mid-loop operation never moved the valve off of its backseat. Based on a similar incident, the licensee concluded that the reactor operator turned the handwheel only enough turns

the inspectors did not identify why the valves were open. The documentation associated with the testing indicated that the testing was complete and the independent verification step of the restoration process, which required the valves to be shut, had been completed even though previous steps of the restoration section had not been performed.

A review of the watch station turnover sheets in the CR contained a note that the valves should be closed following recharging of the nitrogen cylinders. The inspector noted "Although the operations department administrative procedures allow procedure steps to be performed out of sequence with the unit/shift supervisor approval, and the entry on the unit supervisor's turnover sheet satisfies the intent of the administrative procedures regarding control of components manipulated outside of prescriptive procedures, the lack of a unit log entry indicating the manipulation of major components and the lack of awareness by the reactor operator of the valves' positions and purpose was identified by the inspectors to the licensee as a poor operating practice."

After soliciting suggestions from the operating staff, the licensee instituted a valve manipulation log sheet to record the manipulations of any valve performed without specific procedural control.

## DISCUSSION

### Background

The requirements for configuration control arise from the regulations in 10 CFR 50, Appendix B and 10 CFR 50.55a which embraces IEEE Standard 279-1971. Regulatory Guide 1.47 expands on IEEE Standard 279 by defining an acceptable method for implementing this requirement with respect to indicating the bypass or inoperable status of portions of the protection system, systems actuated or controlled by the protection system, and auxiliary or supporting systems:

1. Administrative procedures should be supplemented by a system that automatically indicates at the system level the bypass or the deliberately induced inoperability of the protection system and the systems actuated or controlled by the protection system.
2. The indicating system of one above should also be activated automatically by the bypassing or deliberately induced inoperability of any auxiliary or supporting system that effectively renders inoperable the protection system and the systems actuated or controlled by the protection system.
3. Automatic indication in accordance with 1 and 2 above should be provided in the CR for each bypass or deliberately induced inoperable status.

This guidance was to be implemented, where practical, recognizing all the possible means by which safety related systems could be completely or partially rendered inoperable.

## SUMMARY

Over 190 mispositioning events were reviewed for the period 1990 to 1993. Most of the events involved mispositioned valves and about 15 percent involved mispositioning multiple components. The personnel errors associated with these events cover a wide range of lapses. The independent verification process meant to catch mispositioned equipment is not always successful. The licensees generally discipline or counsel the personnel involved in the error rather than make tangible plant modifications such as status alarms and position markers. The overall safety impact of these deficiencies appears to be small.

## INTRODUCTION

An Enforcement Action (EA) (\$100,000 fine) for mispositioned root valves at Catawba in 1990 prompted this review of mispositioned equipment caused by personnel errors. Restoration errors occur following maintenance, surveillance, and refueling outages. The Catawba event happened during a reactor vessel refill evolution that involved isolated pressure sensors that simultaneously defeated overpressure protection actuation and reactor vessel pressure readout in the control room (CR) and resulted in an unnoticed plant pressurization. Similarly, closed valves in the emergency feedwater system contributed to the initiation of the Three Mile Island (TMI) accident. Subsequent to that accident, the NRC issued Bulletin 79-06 which in part required verification of the operability of all safety-related systems when they are returned to service following maintenance or testing. TMI Action Plan, Item I.C.6 (NUREG-0737), required verification of system configuration when returning from maintenance and testing. Information Notice (IN) 84-51 provided additional amplification on independent verification and summarized several mispositioned equipment events observed after the TMI accident.

The NRC has a long standing concern about mispositioned equipment going back to Criterion XIV, "Inspection, Test, and Operating Status," of 10 CFR 50, Appendix B and Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems." This guidance calls for automatic indication in the CR of inoperable trains of safety systems. In addition to the above verification requirements, the NRC required post-maintenance testing in Generic Letter (GL) 83-28, "Required Actions Based on Generic Implications of Salem ATWS Event" which was issued in response to the Salem ATWS event. Post-maintenance testing may capture some of the mispositioned equipment situations, but it may also be the source of mispositioning equipment (inadequate system restoration following the test). The NRC Inspection Manual has modules that include monitoring independent verification of system status and operability testing of equipment being returned to service.

The industry has produced more than 10 studies on mispositioned equipment; the most recent was issued in 1992. These reports provide suggestions for remedial actions based on licensee corrective actions. In 1986, AEOD issued a technical review report (AEOD/T612) on this subject.

## DESCRIPTION OF EVENTS

Over 190 licensee event reports (LERs) and inspection reports (IRs) involving mispositioned equipment were collected for the period 1990 through 1993. Summaries of these situations are presented in the Appendix. The reports are about evenly divided between LERs and IRs. Violations were reported in about one-third of the references and eight licensees were fined \$25,000 to \$150,000 for infractions related to mispositioned equipment.

The number of events reviewed in this study does not reflect the frequency of this problem. Note that only half of the events were reported in LERs, while the others were uncovered by the NRC inspectors. One licensee indicated that he recorded 10 times more mispositioned equipment events than were reported in LERs. Since these additional events did not meet the reporting threshold, they may have less safety significance. However, the high incidence may be indicative of the general issue of configuration control.

Several of the more illuminating events are described below:

**Catawba** - Special Report (DPC, 4/26/90) - On March 20, 1990, the plant was in Operating Mode 5 performing a pressure vessel fill and vent evolution. The operators at the controls were unaware of the primary system pressure increase because the root valves for system pressure transmitters were valved out by instrumentation and electrical (I&E) personnel on February 7, 1990, for previously scheduled maintenance on compression fittings. This maintenance work was completed on February 21, 1990. These pressure transmitters not only provided indication in the CR, they also actuated the power operated relief valves (PORVs) as part of the low temperature overprotection system (LTOP). The pressure increase occurred when the head vents were isolated while the charging system continued to add fluid to the primary system. Relief valves in the residual heat removal (RHR) suction lines relieved the charging flow so the repressurization stayed within acceptable limits.

As noted in a human factors review of the Catawba event in Ref. 1, "No permanent record or tag-out of the inoperability of these three pressure instruments is made in the CR, (i.e., no out-of-service tag is hung on the indicators). The I&E group is considered to have operational responsibility for instruments..." The licensee's corrective actions to avoid further violations (Ref. 2) were:

The program to assure equipment operability during mode and condition changes was more fully described in station procedures. Procedure sign-offs for other groups are being incorporated into the controlling procedures for identified condition changes.

The outage schedule will provide logic for scheduling of Technical Specification plant conditions as identified.

A program will be developed that will clearly identify instruments within the Control Room that are either out of service or known to be out of calibration.

**River Bend - IR 458/93-20** - The inspectors noted several situations related to system alignment. The following are excerpts from the report:

The inspectors observed portions of a high pressure core spray (HPCS) valve and pump test. Several steps during the restoration of the HPCS system required an independent verification of the proper valve alignment. During one such verification, the operator performing the procedure handed the verifier the procedure, pointed to the valve switches to be verified, and requested that he perform an independent verification of these valves. The first performer did not appear to realize that he could have defeated the independence of the verifier by pointing out the specific valve switches to be verified.

The licensee's administrative procedure ADM-0022 states, "Independent verification is intended to mean a second check of the position or status of a component or system. The independent verification will be performed separately without visual or audible contact with the first performer."

In another instance, the licensee noted that a test fixture on a source range monitor remained installed for four months since the previous test. A review of the previous test document indicated that the removal of the test fixture had been signed off by an independent verifier.

The corrective actions included:

Modifications of procedures by removing unnecessary verifications, in-process verifications were clearly identified as requiring completion before proceeding, and restoration verifications were in a separate section at the end of the procedure. A human performance engineer was designated to set up a consistent and effective independent verification program. Operations and maintenance departments would be provided instructions on independent verification that would be unique to their respective disciplines. Plant management would hold individual verifiers personally accountable for their actions.

**Indian Point 3 - IR 286/91-14** - During a walkdown, an NRC resident inspector noted a boron injection valve fully open (according to the local stem indicator) while tagged in a shut position under an operating order providing reactor coolant system (RCS) protection during mid-loop operations. The valve was presumably set at a throttled position one month earlier. The licensee never determined how the valve became backseated in the full open position.

It was surmised that the reactor operator who was supposed to close the valve for mid-loop operation never moved the valve off of its backseat. Based on a similar incident, the licensee concluded that the reactor operator turned the handwheel only enough turns

(1-2/3) in order for the clutch keys on the clutch sleeve to mate with the lugs on the bottom of the handwheel thus allowing the resistance of the backseat to be felt. The operations personnel did not trust the local valve stem indication because a temporary procedure change had deleted reference to the stem indicator because it was considered unreliable.

The corrective actions included:

The training department would stress the importance of evaluating a situation when plant indication contradicts the expected plant conditions. The valves were modified with permanent reliable position indicators. The long disconnected motor operators on the valves were removed and replaced with manual operators.

**Summer** - IR 395/90-18 - An auxiliary operator discovered the motor of a component cooling water pump to be hotter than normal. Investigation revealed that a chiller water outlet valve was closed instead of open and a crossconnect valve was open instead of closed. The valves were apparently mispositioned about a week earlier during a train swap-over evolution. The sign off sheets on the swap-over of the outlet valve were signed off by two auxiliary operators. The crossconnect valve should not have been disturbed by the evolution. The valves were separated by 15 feet, easily identifiable, and located above each motor.

**Turkey Point** - IR 250/93-22 - Prior to a maintenance activity, the NRC inspector reviewed the clearance and determined that the tags were clearly printed and positioned. During a follow-up inspection after the system was restored, the inspector identified a mispositioned valve that was locked open instead of closed. The clearance documentation indicated that the valve was locked closed by one operator and verified closed by another operator 17 minutes later. The two individuals involved were an experienced non-licensed auxiliary nuclear plant operator and an experienced senior reactor operator (SRO) who was nuclear watch engineer. Both individuals were disciplined.

**Braidwood** - IR 456/91-24 - An operator attempted to change out a seal filter on Unit 2, but instead the filter was partially ejected from the housing and contaminated water spilled. The investigation revealed that, earlier, the technician and independent verifier had entered the valve room for Unit 1 to isolate the filter. The inspector noted that the out-of-service restoration required several sets of anti-contamination clothing to complete the task. Subsequently, the licensee determined that the independent verifier had not taken an adequate number of sets and concluded that the verifier attempted to verify the valve positions associated with the event from beyond the radiological barrier.

The licensee installed more visible valve tags, disciplined the individuals involved, and remarked the valve rooms to clearly indicate the contaminated valve's respective unit.

**Comanche Peak 2** - IR 445/93-26 - While performing a control board walkdown following testing of feedwater isolation valves, the inspectors observed that all four valves were opened. A review of the unit log and questioning the operator at the controls by



the inspectors did not identify why the valves were open. The documentation associated with the testing indicated that the testing was complete and the independent verification step of the restoration process, which required the valves to be shut, had been completed even though previous steps of the restoration section had not been performed.

A review of the watch station turnover sheets in the CR contained a note that the valves should be closed following recharging of the nitrogen cylinders. The inspector noted "Although the operations department administrative procedures allow procedure steps to be performed out of sequence with the unit/shift supervisor approval, and the entry on the unit supervisor's turnover sheet satisfies the intent of the administrative procedures regarding control of components manipulated outside of prescriptive procedures, the lack of a unit log entry indicating the manipulation of major components and the lack of awareness by the reactor operator of the valves' positions and purpose was identified by the inspectors to the licensee as a poor operating practice."

After soliciting suggestions from the operating staff, the licensee instituted a valve manipulation log sheet to record the manipulations of any valve performed without specific procedural control.

## DISCUSSION

### Background

The requirements for configuration control arise from the regulations in 10 CFR 50, Appendix B and 10 CFR 50.55a which embraces IEEE Standard 279-1971. Regulatory Guide 1.47 expands on IEEE Standard 279 by defining an acceptable method for implementing this requirement with respect to indicating the bypass or inoperable status of portions of the protection system, systems actuated or controlled by the protection system, and auxiliary or supporting systems:

1. Administrative procedures should be supplemented by a system that automatically indicates at the system level the bypass or the deliberately induced inoperability of the protection system and the systems actuated or controlled by the protection system.
2. The indicating system of one above should also be activated automatically by the bypassing or deliberately induced inoperability of any auxiliary or supporting system that effectively renders inoperable the protection system and the systems actuated or controlled by the protection system.
3. Automatic indication in accordance with 1 and 2 above should be provided in the CR for each bypass or deliberately induced inoperable status.

This guidance was to be implemented, where practical, recognizing all the possible means by which safety related systems could be completely or partially rendered inoperable.

The scope and depth of the implementation of this guidance varies among the plants. At some plants, all the components in the support systems are included in the safety system status indication; at others, status indication includes only limited frontline components.

The Three Mile Island accident was initiated because discharge valves on the auxiliary feedwater system were incorrectly closed. Immediately following the accident, the NRC issued Bulletin 79-06 which required, in part, that procedures be reviewed to assure that valves remain positioned in a manner to ensure the proper operation of engineered safety features and that they are returned to their correct positions following necessary manipulations. Further, procedures were to be reviewed and modified to ensure verification of the operability of all safety related systems when they are returned to service following maintenance or testing.

About 1 year later, this bulletin was followed by TMI Action Plan Item, I.C.6, which required in part that procedures be reviewed and revised to assure that for the return-to-service of equipment important to safety, a second qualified operator should verify proper system alignment unless functional testing can be performed without compromising plant safety, and can prove that all equipment, valves, and switches involved in the activity are correctly aligned.

In a related circumstance, the Salem ATWS event in 1983 precipitated GL 83-28 which required, in part, that licensees review procedures to assure that post-maintenance operability testing of all safety related equipment is required to be conducted and that the testing demonstrates that the equipment is capable of performing its safety functions before being returned to service.

In 1984, the NRC issued IN 84-51, "Independent Verification," because of continuing mispositioned equipment events. Three observations were made in this IN:

"Functional tests used in lieu of independent verification, should be examined to ensure they test the entire portion of the system affected by the previous actions. For example, performing a normal surveillance by running a pump on recirculation may not verify correct alignment of all valves in the system.

Independent verification should be independent with respect to personnel, i.e., two appropriately qualified individuals, operating independently, should verify that equipment has been properly returned to service. Both verifications are to be implemented by procedure and documented by the initials or signature of the two individuals performing the alignment and verification.

In certain instances it may be possible to accomplish one verification from observing CR instruments, annunciators, valve position indicators, etc. This is acceptable as long as the CR indication is a positive one and is directly observed and documented."

Thus, on numerous occasions the NRC has clearly enunciated a concern about restoration of system function following equipment manipulations. This concern is

further reenforced by the use of inspection modules to monitor the licensee's tag-out process, independent verification of equipment status, and operability testing when returning equipment to service.

Based on discussions with several licensees, there appears to be a general format for administrative controls of equipment status. Standard check lists and independent verification are used at each plant to assure that safety systems are operable when changing operating modes during a return to power. These check lists and verification processes vary from plant to plant and new items are added when omissions are discovered. The verifier may be someone who accompanies the restorer or someone truly independent who walks down the system with a check list after it is restored.

Administrative controls for taking systems out of service and restoring them following maintenance or testing are more variable depending on the equipment in question. The most stringent controls appear to be applied to work orders for mechanical components such as pumps, valves, and piping. There is a detailed tagging process that includes detailed procedures identifying specific boundary components that will be manipulated, maintenance or test procedures that identify specific components that will be manipulated within the service boundary, a dedicated reactor operator in the CR who processes these work orders to assure the specified component lists are complete, approval by the shift supervisor of the work package, and independent verification that the specified components have been restored.

Generally, there is no tagging process for work orders on electronic components, although there may be status indication in the CR. The instrumentation and control (I&C) personnel do not have detailed procedures with check-off lists identifying manipulated components. There is no CR review similar to that imposed on maintenance activities and the "independent verifier" accompanies the technician during his activities. The argument for this approach is that the I&C perform troubleshooting which can not be easily prescribed beforehand so they are given latitude in their activities. The second person (verifier) is supposed to assure that all the various reconnections and root valve manipulations are performed based on his continuous observation of the technician's activities.

Chemistry personnel have similar latitude in their actions and may not have a second verifier in tow. The procedures may be more specific regarding opening and closing valves in sample lines. In one instance, a technician forgot to close a redundant sampling valve in an evolution that he had previously performed over 50 times.

### Evaluation of Operational Data

Examination of the events in the appendix indicates that most involved mispositioned valves with mispositioned switches a distant second. Mispositioned drain plugs, circuit breakers, fire barriers, dampers, and sensors accounted for less than 10 percent of the events. Only 15% of the events involved multiple components. The occurrence of these events does not appear to be changing significantly over the past 4 years.

The reasons for the mispositioned equipment cover a wide range of human foibles. A sampling of the errors noted in the events includes:

The procedures were incomplete so the technician improvised.

The independent verifier would have to change in and out of anti-contamination gear several times to perform check-off function. A suit count indicated that he didn't bother and checked off valve positions anyway.

Shift supervisor permitted impromptu change in evolution that he noted in his blackbook, but he didn't inform the rest of the CR staff who were following formal equipment control documents.

Test procedure was aborted in the middle and the equipment was never properly restored.

Independent verifier accompanied the technician who indicated the steps and equipment he was to sign-off on.

Equipment left in wrong position even though there was a sign-off by an independent verifier.

No procedure used in evolution, so the technician incorrectly improvised based on his knowledge.

Technician rotated manual valve 1-2/3 turns and felt resistance that he incorrectly interpreted as a closed valve.

Deleted valve position markers from procedures.

Technician aware that another test was to be performed with some of the equipment so he abandoned the current test procedure before the equipment was restored.

Tag-out sheet used incorrect valve names but correct valve numbers. The technician focused on the valve name, not the number.

Many valves had missing name tags, and the licensee delayed replacing them.

Duct tape was not removed from the exhaust ports of several air operated valves even though action was specified in procedures. When installed, the exhaust port was not readily visible and the tape was the same color as the valve.

All four AFW flow control valves were in wrong position for four days, 11 shift turnovers. It was surmised that everybody thought the positions were correct because they were all the same.

Freeplay in handwheel on a butterfly valve negated the use of the number of turns as a basis for maintaining correct valve throttle position.

Deficient independent verification is a concern as noted in five of the examples discussed above. At River Bend, independent verification was defeated when the technician who aligned the system prompted the "independent" verifier to sign-off a specific action. It appears that the "independent" verifiers falsely signed-off at Summer, Turkey Point, Braidwood, and Comanche Peak. At Turkey Point, the "independent" verification was performed presumably 17 minutes later by an experienced SRO after the valve was restored. The root causes of these types of human failures are usually not determined, but probably range from deliberate (we are in a hurry to get the plant started) to boredom (I have done this many times before) to lazy (I don't want to suit up to check the valve position) because the equipment are normally found in their correct positions.

Lack of control of I&C activities is another problem area as noted above. At Catawba, the I&C personnel left the root valves closed on redundant pressure instruments. Other examples can be found in the Appendix. One licensee indicated that 50 percent of the mispositioned equipment events were caused by I&C personnel, though this large fraction was not indicated by the events in the Appendix.

Events at Summer and Braidwood above involved wrong component or wrong unit. In both cases the verifier signed-off the check list. At Comanche Peak, informal approvals by the shift supervisor left the operator at the controls out of the communications loop which contributed to a mispositioned valve. At Indian Point, the operators ignored a valve stem indication and incorrectly judged resistance to manual movement to mean a closed valve. Technicians improvised in the absence of specific directions, sometimes they improvise in spite of having directions available.

The licensee corrective actions varied from soft:

Operations senior management formally established a policy for restoration of equipment to operable status; the licensee held shift briefings to stress the importance of self-checking and independent verification; disciplinary actions against personnel directly involved; more control of contractor personnel; verbatim compliance with procedures was reemphasized; management suspended all work and held meetings with all personnel stressing their expectation regarding procedural compliance. If the procedure can not be performed as written, personnel were to stop and have the procedure changed. Steps are to be performed in sequence (a change from previous policy);

to semi-soft:

The surveillance test procedure was modified to require a second verification that a component out of service is being cleared; independent verification procedure was modified to include safety related manual valves; requirement not to sign clearance tags until component is actually observed in proper position and the tags were modified to include a space for the independent verifier's signature;

to hard:

Marking rings have been installed on all emergency core cooling system (ECCS) throttle valves; developed a device to fix dampers in position and indicate if their position has changed from previous check; Enhancements have been made to local valve position indication; valves were painted purple to identify them as potential release paths; put covers over switches; added a redundant alarm independent of switch position; alarm annunciation installed.

This same range of corrective actions was identified in industry reports on mispositioned equipment.

A frequent licensee correction is to reiterate self verification or STAR - Stop, Think, Act, Review. This is an important consideration, but does not comply with regulatory expectations of "independent" verification or automatic status indication. Discussions with licensees indicate that the shift supervisor determines how verification is to be accomplished. If time is not critical, then a second individual may be sent out after completion of the equipment alignment to verify its status using check lists. If time is money, then the verifier will accompany the equipment restorer. As noted above, I&C actions do not appear to have separate "independent" verifiers as a rule.

In several instances, the licensee implemented corrective actions relevant to regulatory expectations. They installed marking rings so that correct throttle positions could be ascertained easily and they installed alarms in the CR for easy operator recognition that safety equipment is not available. A palpable action to correct mispositioned equipment deficiencies instead of a management/procedure modification was not a major resolution for most of these events.

### Safety Importance

The importance of this issue is that mispositioned equipment may leave a safety system unavailable to mitigate an accident for which it was designed. This is especially a concern if both trains are affected.

About 200 mispositioned equipment events were collected for a four year period in this study. Discussions with a licensee indicate that the actual number could be ten times larger (equivalent to 2000) because most events involve only a single train and therefore do not exceed the reporting threshold. A rough estimate of the number of opportunities to misposition equipment at all plants (100) in four years is  $4 \times 10^6$  based on an assumed 10,000 opportunities per plant-year. Thus, an estimated probability of mispositioning a single component is  $5 \times 10^{-4}$  to  $5 \times 10^{-5}$ . This estimate, even considering uncertainties, is below the estimate of human error probabilities of  $10^{-3}$  to 0.5 calculated for mispositioned equipment in Ref. 3.

Similarly, about 30 events involved multiple components. Using this number as a first approximation of common-mode failure of a system caused by mispositioned equipment,

an estimate of the probability of system loss by this mechanism is  $8 \times 10^{-6}$ . Two train system unavailabilities estimated in plant PRAs range from  $10^{-2}$  to  $10^{-3}$  and  $10^{-3}$  to  $10^{-5}$  for three train systems (Ref. 4). Thus, the estimated contribution of mispositioned equipment to system unavailability is not a major contributor on an industry wide basis.

## FINDINGS

1. Mispositioned equipment continues to occur despite NRC and industry actions. Regulatory guide 1.47 and TMI Action Plan Item I.C.6 impose specific expectations regarding means to minimize these occurrences. The industry has issued over ten reports on the topic. The NRC inspectors have cited numerous violations for mispositioned equipment.
2. The personnel errors leading to mispositioned equipment vary widely. There appears to be a breakdown in the independent verification process which is supposed to provide regulatory assurance that the safety systems are properly aligned.
3. The licensee corrective actions generally do not include tangible modifications such as status alarms and position markers, but rather, they lean toward employee discipline and counseling.
4. Mispositioned equipment appears to be a small contributor to system unavailability on an industry wide basis.

## CONCLUSIONS

No new initiatives are warranted at this time. The safety impact of mispositioned equipment is small and existing regulatory guidance addresses the issue adequately. In addition, the NRC inspectors monitor configuration control at the plants through inspection modules and are accustomed to writing citations for observed infractions.

## REFERENCES

1. J. Harbour (EGG), Trip Report of Onsite Analysis of Human Factors of Event at Catawba Unit 1 on 900320 (Overpressurization of RHR System), May 31, 1990.
2. Letter from H. Tucker (DPC) to NRC, June 15, 1990.
3. W. Vesely to A. Thadani, Swain's Human Error Probabilities for Leaving Valves in Misconfigured Positions, NRC Memorandum, March 4, 1981.
4. A. El-Bassioni et al, PRA Review Manual, NUREG/CR-3485, August 1985.



## APPENDIX

### SUMMARIES OF MISPOSITIONED EQUIPMENT EVENTS

**Catawba** - IR 413/93-34 - Mode change made with manual valves closed on turbine driven auxiliary feedwater pump (TDAFWP). Informal implementation of the removal and restoration process and a misinterpretation of the technical specifications (TS) contributed to this deficiency. Licensee cited for violation.

**Salem** - IR 311/93-23 - Two instances of improper valve restorations were noted in the IR. These incidents resulted in unexpected fluid discharges. \$50,000 fine.

**Turkey Point** - IR 250/93-26 - Five chemical and volume control (CVCS) valves were found closed after they had been independently verified to be open. The two operators involved stated that they had performed the valve alignment together rather than separately as required by the licensee procedures and training. According to the IR, the lack of independent verification did not violate NRC requirements.

**North Anna** - IR 338/93-27 - Violation for incorrectly opened diesel generator (DG) breaker after a test by putting switch in pull to lock position.

**Browns Ferry** - IR 260/93-12 - Violation for five instances with hold order tags not in place with clearances still active and two hold order tags did not correctly specify component position on the sheet.

**Millstone** - IR 336/93-28; 93-03 - Violation for incorrectly throttled high pressure safety injection (HPSI) valves.

**Zion** - LER 295/93-08 - A motor operated valve was incorrectly logged back in-service following surveillance activity. There were two previous LERs - 92-23 and 89-06 - which concerned switches that were mispositioned and not identified during control board walkdowns.

**Dresden** - IR 237/93-27 - A non-cited violation concerned inadequate restoration after a surveillance.

**Quad Cities** - LER 254/93-17 - A systems engineer initiated draining exhaust pots in high pressure coolant injection lines prior to testing and failed to have valves restored to operable positions following the test. There were two previous LERs - 92-01 and 92-24 - that were concerned with valve misposition.

**Diablo Canyon** - LER 323/93-02 - Maintenance personnel disabled a second damper in a ventilation system while performing preventive maintenance. There was one previous LER - 92-11.

**San Onofre** - LER 361/93-05 - A management walkdown discovered bolts missing or broken on tornado blowout panels on 7/15/92. Panels were restored on 9/30/92.

**Sequoiah** - LER 278/93-02 - Routine containment integrity surveillance identified five, 1/2 inch, drain valves unsecured and two open one-turn.

**Pilgrim** - LER 293/93-20 - Two ATWS pressure transmitters valved out for 3 hours. The valves were closed during a backfilling procedure which was unclear about which of the two valves in series to close. As a result, the I&C personnel left the valve closest to the instrument rack closed.

**Grand Gulf** - IR 416/93-11 - Licensee cited for operator failure to follow procedure which resulted in an individual control rod scram from the wrong position. This was the third rod mispositioning in four months.

**River Bend** - IR 458/93-20 - The licensee was cited for two examples of possible flaws in their independent verification program. There was an inappropriate communication between the performer of system restoration and the independent verifier.

**Haddam Neck** - LER 213/93-12 - I&C personnel discovered all four steam line flow transmitters isolated and an equalizer valve open while in Mode 3.

**Robinson** - LER 261/93-06 - The licensee discovered an air return damper inappropriately blocked open with a wooden wedge.

**ANO 1** - IR 313/93-06 - The licensee was cited because of a mispositioned locked throttle valve in the AFW bearing cooling return line. The licensee identified several other cases of mispositioned valves.

**Prairie Island** - IR 282/93-10 - A non-cited violation was noted for failure to perform independent verification of equipment control tags used for configuration control during maintenance activities.

**Dresden** - LER 249/93-09 - The licensee discovered an isolation valve for a pressure switch closed during a calibration test. Two previous root valve mispositionings were noted in LERs - 93-90 and 92-28.

**Quad Cities** - LER 254/93-07 - During planned bus manipulations, power was removed from the sample pump for the toxic gas analyzer and wasn't discovered for 7 hours after completion of the bus manipulations.

**Waterford** - IR 382/93-19 - During the inspection, one violation was noted regarding the failure to adequately implement a plant status control requirement for a locked valve.

**Palisades** - IR 255/93-12 - Non-cited violation was noted pertaining to the restoration of a hydrogen recombiner following maintenance. There was a failure to execute a restoration switching and tagging order.

**Wolf Creek** - IR 482/93-14 - A mispositioned valve that rendered a hydrogen analyzer inoperable resulted in a non-cited violation involving an inadequate procedure.

**Three Mile Island** - IR 289/93-13 - Valve mispositioning event discovered.

**Grand Gulf** - IR 416/93-07 - Non-cited violation involved mispositioned valves in the RHR system.

**ANO 1** - LER 368/93-01 - Original installation of reactor vessel level system probes had miswired sensors whose polarity was reversed. Correction was made at instrument panel. Subsequent sensor replacement with correct polarity did not correct polarity adjustment at instrument panel. Error undetected for 6 months.

**Limerick** - IR 352/93-09 - Mispositioned valves found during essential service water lineup verification.

**Vogtle** - LER 425/93-02 - Discovered that interlock for containment building personnel airlock door was defeated.

**Cooper** - LER 298/93-06 - Two fire barrier doors in reactor building (RB) found open and obstructed with no fire watch assigned.

**Braidwood** - LER 457/93-01/06 - Head vent inappropriately isolated during RCS draindown - resulted in holding up the water level and providing incorrect level indication. One previous related LER - 92-42.

**Peach Bottom** - LER 278/93-03 - The head vent valves closed because the instrument air supply valves were closed. The problem was attributed to the operator not fully moving instrument air switch to automatic.

**Brunswick** - LER 324/93-04 - RHR system isolated when an incorrect fuse was removed from back panel. Caused by incorrect labeling.

**Vogtle** - LER 424/93-01 - Valving error caused the opposite train to be removed from service.

**Millstone** - LER 336/93-03 - Licensee discovered mispositioned HPSI valve. Previous LER - 92-04 - had problem with the same system.

**Braidwood** - IR 456/92-25 - Violation for not implementing corrective action from LER 456/90-14 concerning deferred restoration of equipment.

**Summer** - IR 395/93-03 - A non-cited violation identified a mispositioned switch on the local control panel for the containment hydrogen analyzer.

**Crystal River** - IR 302/92-30 - A mispositioned valve was noted in the spent fuel cooling system.

**Oconee** - IR 269/93-03 - Violations: Unit 1 not maintained in accordance with refueling procedure and in Unit 3, valves not placed in "auto" after restarting main feedwater system.

**LaSalle** - LER 373/93-02 - Safety relief valve (SRV) stuck open because of duct tape over actuators air valve manifold exhaust port. Other SRVs also had tape on their exhaust ports.

**Callaway** - IR 483/92-15 - Improper tagging of valve.

**Sequoyah** - IR 327/92-36 - Violation (EN-93-020) involved inadequate procedures and failing to follow procedures which resulted in mispositioning throttle valves. \$50,000 fine.

**Peach Bottom** - LER 277/92-26 - Outside Appendix R because an emergency service water sluice gate power feed was in the "on" position.

**Zion** - LER 295/92-23 - Operator discovered that defeat switches were not returned to normal following an abnormal operating procedure action. Previous LER - 89-06 - involved the same switches.

**Wolf Creek** - IR 482/92-30 - \$50,000 fine for mispositioned locked throttle valve in essential service water system (SWS).

**Three Mile Island** - IR 28<sup>o</sup> '92-20 - Atmospheric monitor not returned to service following surveillance and diesel inoperable for 1 month because of a mispositioned cooling water valve.

**Crystal River** - IR 302/92-27 - Violation for not following procedures which resulted in misalignment of a valve.

**Calvert Cliffs** - IR 317/92-27 - Violation for the isolation of the common miniflow line for all ECCS.

**Perry** - LER 440/92-23 - Discovered mispositioned instrument isolation valve for pressure transmitter.

**Turkey Point** - LER 250/92-12 - Discovered airlock vent valve open. Caused by incorrect indication.

**San Onofre** - LER 361/92-09 - Discovered emergency seal water isolation valve closed for salt water cooling pump.

**Zion** - LER 295/92-20 - AFW discharge valve locked closed. Previous event noted in a DVR in 1990.

**Perry** - LER 440/92-19 - Valve positioning error disabled both SLCS trains.

**Quad Cities** - LER 254/92-24 - Drywell vent valve closed because air supply valve closed during scaffold construction. Occurred in spite of extensive prejob briefing of contractor personnel about air valves in the vicinity of the work area.

**Davis Besse** - LER 346/92-08 - Equalizing valve for pressure switch found open and inoperable.

**Brunswick** - LER 325/92-25 - Discovered that effluent sampling system not in service when reactor building ventilation started.

**Oconee** - LER 269/92-13 - Containment isolation valve found open.

**Diablo Canyon** - IR 275/92-22 - Identified three instances of mispositioned equipment.

**Catawba** - IR 413/92-22 - Violation for valve misalignments in CVCS, ECCS, and steam generator (SG) blowdown line. One deficiency was the operators incorrectly assumed that alignment was returned by fill and vent procedure. In another instance, the operators failed to close valves within block tag-out. These errors resulted in fluid discharge. The cause of the misalignment of the SG blowdown valves was not determined.

**Hatch** - LER 386/92-14 - Personnel error resulted in mispositioned valve.

**Millstone** - IR 423/92-16 - Increase in the number of mispositioned safety-related valves because of procedural inadequacies and personnel errors.

**St. Lucie** - IR 335/92-11 - Violation noted because of maintenance personnel not restoring peripheral services following equipment modification.

**Brunswick** - LER 325/92-22 - Main steam line drain valve open while clearance tag indicates it is closed.

**South Texas** - LER 498/92-06 - All four AFW control valves closed after recovering from reactor trip.

**Hatch** - LER 321/92-11 - Control switch found in open position rendering excessive flow check valve inoperable.

**Millstone** - LER 423/92-08 - Plant personnel discovered that eight valves not included in service water system TS valve lineup.

**Comanche Peak** - LER 445/91-10 - AFW recirculation test line had isolation valve 1/4 turn open even though independently verified after test 14 days earlier.

**Millstone** - LER 423/92-04 - CR pressurization bottles were found isolated by two manual valves.

**Millstone** - LER 326/92-04 - HPSI train header valve discovered closed while in Mode 3.

**Oconee** - LER 287/91-09 - Containment integrity valve found mispositioned during forced outage. Could have been open for 8 months.

**Comanche Peak** - LER 445/91-30 - Entered Mode 3 with two mispositioned ECCS valves.

**Perry** - LER 440/91-24 - Discovered keepfill pressure below limit because of mispositioned valve.

**Comanche Peak** - LER 445/91-29 - Handswitch positions for steam supply valves left in pull to lock after entering Mode 3 thus defeating TDAFWP.

**WNP2** - LER 397/91-34 - RHR system differential pressure switch found isolated.

**Catawba** - LER 413/91-20 - Discovered breaker open for one train of the R ventilation and chilled water system.

**McGuire** - LER 369/91-14 - Air handling unit outlet control found in the closed position.

**Millstone** - IR 336/91-28 - Weakness in the tag-out restoration process was noted in the IR.

**Palo Verde** - LER 530/91-11 - Equalizing valve on AFW flow transmitter found open. The licensee acknowledged other mispositioned valve events.

**Limerick** - LER 353/91-12 - Two floor drain plugs needed for RB integrity were removed by maintenance personnel.

**Nine Mile Point** - LER 410/91-16 - Mispositioned valves identified.

**North Anna** - IR 338/91-16 - Non-cited violation because a technician failed to close a valve after taking a sample of the demineralizer. The independent verification did not occur.

**Millstone** - LER 423/91-21 - Containment isolation valve found mispositioned.

**Browns Ferry** - IR 259/91-24 - Adjacent and different sized fuses were reinstalled in the wrong locations during an equipment restoration evolution. Procedures were not followed.

**Indian Point** - IR 286/91-14 - Violation cited because personnel failed to close a valve during a maintenance evolution and, despite its position indicator showing the valve full open, proceeded to tag it as shut.

**Sequoyah** - LER 327/91-17 - Containment radiation monitor (RM) inoperable because inlet valve closed.

**Sequoyah** - LER 328/91-03 - Breaker for operator for cold leg accumulator incorrectly locked in closed position.

**Callaway** - IR 483/91-13 and LER 483/91-03 - Violation for inadequate surveillance of position of throttle valve in the SI system.

**Vogtle** - LER 425/91-08 - SI pump tagged out for maintenance. Caused by procedure inadequacy.

**Peach Bottom** - LER 277/91-20 - Two diesels discovered inoperable because of a mispositioned fuel oil valve.

**Prairie Island** - LER 282/91-06 - RM switch in the reset position instead of the operate position.

**McGuire** - LER 370/91-02 - TDAFWP inoperable because of a mispositioned sliding link on a pressure switch. I&E error.

**Salem** - IR 272/91-09 - Violation for not releasing tag for ECCS pump and not repositioning suction valve per tagging release work sheet and work order for tagging not signed-off.

**Catawba** - Special Report 4/22/91 - Diesel didn't reach speed because of mispositioned fuel oil strainer.

**Catawba** - IR 413/91-11 - Violation because personnel failed to complete assignment of sequence numbers for restoration of generator tag-out equipment.

**Seabrook** - LER 443/91-03 - Unlocked instrument root isolation valves eventually mispositioned because of inadequate procedure.

**Surry** - LER 280/91-04 - Fuel oil transfer pump erroneously tagged-out and secured making one of the diesels inoperable.

**Catawba** - LER 413/91-02 - One train of low pressure safety injection inoperable during power escalation because of closed suction valve.

**Surry** - LER 280/90-19 - All six main feedwater flow transmitters found isolated, equalized and drained.

**Millstone** - LER 336/90-22 - Service water, cross-tie header valve found open. \$37,500 fine.

**Perry** - LER 440/90-39 - Both loops of containment spray mode of the RHR system inoperable because of a mispositioned valve. Procedure problem

**Perry** - LER 440/90-38 - CR RM isolated for more than 7 days.

**San Onofre** - EA 90-115 - \$150,000 fine for TDAFW inoperable for 55 days.

**Perry** - LER 440/90-34 - Mispositioned equalizing valve on RV water level instrumentation.

**San Onofre** - IR 361/90-37 - Violation for leaving sump valve open 4 days.

**Catawba** - IR 413/90-29 - Violation for not following a procedure that resulted in a mispositioned valve and the spray-down of a pump room.

**Fermi** - IR 341/90-13 - Violation for HPSI suction valve mispositioned for 19 hours after surveillance test.

**Prairie Island** - LER 282/90-13 - Inadvertent mispositioning of 11 heater controls.

**Hatch** - IR 321/90-15 - Violation for mispositioned valves in the core spray system.

**Harris** - IR 400/90-14 - Violation because essential chiller was inoperable due to a mispositioned valve.

**Robinson** - LER 261/90-11 - Fire damper found in the open position instead of closed. This is the only damper that must be closed to be operable.

**Maine Yankee** - LER 309/90-05 - "Summer Control Switch" in the wrong position which impacted calorimetric calculations.

**Summer** - IR 395/90-18 - Violation for two chiller system valves mispositioned and two operators failed to verify correct positions which resulted in overheating of component cooling water pump motor.

**Zion** - LER 295/90-13 - Discovered both primary and emergency water makeup lines isolated seal water tank. Procedural deficiency.

**Palo Verde** - IR 528/90-20 - Violations for not following procedures for maintaining a locked open valve for an atmospheric dump valve and incorrectly opening a valve which overpressurized the postaccident sampling system.

**Turkey Point** - IR 250/90-14 - Violation for changing modes with no reactor vessel level instrumentation system operable and one ECCS flow path unavailable. Also noted a containment isolation valve pinned open instead of closed.

**St. Lucie** - IR 389/90-09 - Violation concerning the control of plant work order tags.



**Millstone** - LER 423/90-17 - Accumulator isolated unknowingly for 4 hours because operator failed to reopen a valve following a fill operation.

**Salem** - LER 311/90-24 - Radwaste effluent line monitor left isolated by chemistry personnel.

**Peach Bottom** - LER 277/90-12 - Valves left closed after removal of blocking permit.

**Calvert Cliffs** - LER 317/89-19 - HPSI discharge header valves not locked shut per LTOP requirements.

**Harris** - LER 400/90-13 - Misaligned valve caused unplanned release from waste gas system.

**South Texas** - LER 498/90-07 - All three trains of containment ventilation isolation in test mode and incapable of actuation for 35 minutes while fuel movement occurring.

**Hatch** - LER 321/90-08 - Two RV head vent valves found closed.

**Seabrook** - LER 443/90-12 - Numerous instrumentation valves found mispositioned.

**Palisades** - LER 255/90-05 - AFW inoperable because backup nitrogen bottles isolated.

**Sequoyah** - LER 327/90-04 - Handswitch controlling steam supply to AFW pump in manual.

**Trojan** - IR 344/90-02 - Temporary modification tags still in place 5 months after closeout.

**Trojan** - LER 344/90-20 - Control switches for HPSI found in pull-to-lock position.

**Salem** - IR 272/92-01 - RCP seal return RV had an unauthorized gagging device installed.

**Catawba** - LER 414/90-09 - "Audible rate multiplier" switch found in "off" position during refueling.

**Indian Point** - IR 247/92-07 - Violation for numerous errors found during a walk-down of a diesel using licensee's check-off list. Both missing valves and mispositioned valves.

**Indian Point** - LER 286/93-17 - Three-way valve on gas sampling monitor out of position for 1 month.

**Indian Point** - LER 286/93-42 - SWS in configuration not controlled by plant procedures.

**Oconee** - LER 270/93-06 - Containment isolation valve mispositioned.

**Harris** - LER 400/92-06 - Excess flow check valves were mispositioned for 5 years.

**Perry** - LER 440/92-08 - Discovered that outboard containment isolation valve on RHR system was open and deenergized for 5 hours in Mode 5. Opened as part of a tag restoration evolution.

**Catawba** - IR 314/90-09 - Violation for leaving block valves closed 3 days on SG PORVs and leaving containment valve seal water system isolated.

**Catawba** - IR 413/90-10 - \$100,000 fine for leaving pressure instrumentation isolated (root valves) when refilling plant.

**Clinton** - LER 461/90-11 - SW was isolated to both diesels. Operators relied on counting turns on the manual valve, but freeplay in handwheel defeated action.

**Zion** - ENS 17756 - Mechanic incorrectly turns off dc power switch on diesel during walkdown in preparation for maintenance.

**Turkey Point** - IR 250/93-22 - Non-cited violation of a mispositioned fire water system valve that was not restored properly by tag-out routine even though there was independent verification.

**Nine Mile Point** - LER 220/92-05 - Gate to screenhouse forebay was inappropriately closed resulting in net positive suction head problems for SW pumps.

**Dresden** - LER 249/92-22 - Drained condensate line on isolation condenser degraded performance of system because it allowed the condenser to be bypassed.

**Quad Cities** - LER 254/93-04 - Drain plugs not installed during removal of floor drain isolation valves.

**Point Beach** - LER 266/91-07 - Fire barriers had holes without compensating fire watch.

**Limerick** - LER 352/91-16 - Changed modes with reactor core isolation cooling (RCIC) inoperable.

**Limerick** - LER 352/91-17 - Fuse was not replaced after performing maintenance on a safeguard transformer and was not discovered for 2 years.

**LaSalle** - LER 374/91-01 - Open penetration in TS related fire wall without compensating fire watch.

**Salem** - LER 311/93-01 - Underfrequency protection inoperable because of mispositioned test switch.

**Sequoyah** - IR 327/92-17 - Violation for entering Mode 4 with inoperable containment spray system.

**South Texas** - IR 498/92-08 - Violation for four circuit breakers not tagged.

**McGuire** - IR 369/92-10 - Non-cited violation regarding a containment pressure transmitter valved out because of failure to follow procedures.

**North Anna** - IR 338/92-03 - Violation for not having emergency diesel generator bypass valve opened and locked during operating procedure.

**Perry** - IR 440/92-02 - Operators failed to implement written instruction resulting in valve lineup error which caused loss of instrument air to main steam isolation valves (MSIVs).

**Oconee** - IR 269/91-35 - Violation for misconfigured valves affecting containment isolation and an inadvertent boron dilution of a storage tank over several days.

**Catawba** - IR 413/91-27 - Violation for three configuration control problems.

**Comanche Peak** - IR 445/91-62 - Two violations were noted for improper system alignments entering Mode 3.

**Braidwood** - IR 456/91-24 - Violation for the failure of an independent verifier to note that a seal injection filter was not properly isolated.

**Haddam Neck** - IR 213/91-25 - Violation for fuel movement without sufficient containment closure.

**ANO** - IR 313/91-30 - Violation for inadvertently disabling HPSI train.

**Byron** - IR 454/91-27 - Violation for entering Mode 4 with both trains of containment spray inoperable.

**Palisades** - IR 255/91-18 - Violation for having pressure switch inoperable for 2 weeks.

**Farley** - IR 348/91-19 - Violation for both air start headers inoperable on one diesel.

**Millstone** - IR 245/91-16 - Violation for charging header isolation valve to CR hydraulic unit being mispositioned.

**Wolf Creek** - IR 482/91-30 - Violation for inoperable RM in containment blowdown path.

**Millstone** - IR 423/91-16 - Violation for working outside of workscope and rendering PORV inoperable.

**Seabrook** - IR 443/91-29 - Violation for leaving demineralized water line unisolated following restoration of system.

**Farley** - IR 348/91-17 - \$25,000 fine for leaving recirculation bypass valve open on AFW train.

**Palisades** - IR 255/91-17 - Violation for failure to return containment spray pumps to service prior to criticality.

**Zion** - IR 295/91-15 - Violation for entering Mode 3 with an AFW pump inoperable for 2 days.

**South Texas** - IR 489/91-11 - Violation for finding a number of plant valves with handwheels locked.

**Oconee** - IR 287/91-09 - Violation for leaving certain valves open when start up initiated.

**River Bend** - LER 458/92-27 - RCIC not placed in standby prior to changing modes.

**Hatch** - IR 321/92-12 - Excess flow check valve inoperable and bypassed for 18 hours.

**Limerick** - LER 92-07 - Reactor enclosure isolation valves reset switches not returned to auto position.

**Turkey Point** - IR 250/92-10 - A turbine operator replaced back-up nitrogen bottles for MSIVs and failed to realign the valves properly to two MSIVs.

**Indian Point** - IR 286/91-26 - Violation for automatic voltage control being out of position on DG.

**Millstone** - LER 423/91-25 - Failed to deenergize solid state protection input relays for cold overpressure protection.

**Sequoyah** - IR 327/93-09 - Seven safety-related valves mispositioned.

**St. Lucie** - IR 389/93-05 - Safety injection tank isolation valve left open following test in Mode 5.

**Nine Mile Point** - LER 220/93-04 - Selector switch for two monitoring systems placed in a position that interrupted auxiliary systems.

**Indian Point** - LER 286/93-12 - A penetration supply line left disconnected following an integrated leak rate test.

**Wolf Creek** - LER 482/93-10 - Entered Mode 4 with switches for motor drive auxiliary feedwater pumps in pull to lock. \$50,000 fine.

**Diablo Canyon** - LER 275/92-30 - Valves not sealed open due to personnel error.

**Summer** - IR 395/90-21 - Violation for not taking adequate corrective action for mispositioned valve events.

**South Texas** - EA 90-138 - Violation for mispositioned AFW recirculation valve.

**Peach Bottom** - LER 277/93-07 - Purge valve mispositioned thus defeating RM in dry well.

**River Bend** - LER 458/92-18 - System pressurized with automatic depressurization system train isolated because of closed root valve.

**St. Lucie** - LER 389/91-03 - Mispositioned component cooling water valve disabled heat exchanger.

**Oconee** - IR 269/92-24 - Mispositioned valve in low pressure service water system on Unit 3.

**Comanche Peak** - IR 445/93-26 - All four feedwater isolation valves found open after a surveillance test and restoration signed off that they were closed.

**Comanche Peak** - IR 446/92-201 - Violation for not correcting mispositioned valve events.

**Salem** - LER 272/92-18 - Containment spray system valves found closed during plant start-up.

**Turkey Point** - IR 250/92-34 - Letdown heat exchanger vent valve open and uncapped.