AEOD/E508

ENGINEERING EVALUATION REPORT

NUCLEAR PLANT OPERATING EXPERIENCE INVOLVING SAFETY SYSTEM DISTURBANCES CAUSED BY BUMPED ELECTRO-MECHANICAL COMPONENTS

May 1985

Prepared by: Stuart Rubin

NOTE: This report documents the results of a study completed by the Office for Analysis and Evaluation of Operational Data regarding specific nuclear operating experiences. The findings and conclusions contained in this report are provided in support of ongoing NRC activities. Since the activities are ongoing, the report is not necessarily final, and the findings and conclusions provided for consideration do not represent the positions or requirements of the responsible program offices of the Nuclear Regulatory Commission.

TABLE OF CONTENTS

AEOD ENGINEERING EVALUATION REPORT*

UNIT: Multiple LWRs
DOCKET: Multiple LWRs
LICENSEE: ultiple
NSSS/AE: Multiple

EE REPORT NO. AEOD/E
DATE:
EVALUATOR/CONTACT: S. Rubin

SUBJECT: NUCLEAR PLANT OPERATING EXPERIENCE INVOLVING SAFETY SYSTEM DISTURBANCES CAUSED BY BUMPED ELECTRO-MECHANICAL COMPONENTS

EVENT DATE: Multiple

SUMMARY

A study was performed to evaluate nuclear plant operating experiences involving safety system disturbances caused by bumped electro-mechanical components. The study found that enclosed switches, relays, transmitters and possibly relays in circuit breakers are among the most sensitive electro-mechanical devices in a nuclear plant. Physical disturbance will frequently change the output state of these components. Bumped components have resulted in reactor scrams, safety system isolations, trips and initiations, and loss of power to safety systems. A reactor scram, caused by bumped reactor protection system enclosed switches, was found to be among the most common occurrences for BWRs. The data indicates that enclosed switches, relays, transmitters and possibly relays in circuit breakers would be among the most sensitive components in a plant during a seismic disturbance. It is suggested that these classes of components, and their potential for causing unacceptable system transients or conditions, be considered for NRC staff review during Phase II of the proposed resolution of USI A-46, "Seismic Qualification of Equipment in Operating Plants."

*This document supports ongoing AEOD and NRC activities and does not represent the position or requirements of the responsible program office.

1.0 INTRODUCTION

Events occasionally are found during the screening of nuclear power plant operational data, involving a system perturbation or plant transient initiated because an electro-mechanical device in the plant had been physically disturbed or jostled. These incidents typically are caused when a member of the plant operating or maintenance staff bumps into or jostles a sensitive electrical device or its support structure. The equipment involved in these "bumping" incidents include components such as enclosed switches (e.g., pressure switches, level switches, flow switches), transmitters, circuit breakers and relays. The plant system perturbations initiated by these bumping incidents have included occurrences such as reactor scrams, system trips, system initiations and system isolations.

The system perturbation typically occurs because the physically disturbed electrical component experiences a change of state. For example, the contact(s) of an enclosed switch bounces open or closed interrupting or establishing continuity in a circuit; the contacts of a relay bounce open or closed energizing or deenergizing the relay or; the armature in a transmitter is jarred (displaced) increasing or decreasing the output signal amplitude. The change of state then causes a control or protective action to be initiated, resulting in the plant disturbance.

Bumping events would appear to be useful indicators of a component's sensitivity to mechanical shock or vibration and the kinds of plant transients or system disturbances that can occur when sensitive components are jostled or vibrated. A major seismic disturbance at a nuclear plant site could also physically agitate a wide range of electro-mechanical devices in the facility. Accordingly, bumped component operating experiences might also provide several important insights into: (1) which classes of electrical components might be most sensitive to a seismic disturbance and; (2) the kinds of plant system perturbations or transients which might occur during a major seismic event. Because of these potential uses, a study was initiated to collect, sort, analyze and evaluate the bumped component incidents which have been reported. The purpose of this study was to determine if there were one or more specific components and/or specific system transients which might be of potential importance to system reliability or plant risk. In cases where an adverse system response was involved (e.g., a trip of a safety system) an attempt was made to investigate the seismic qualification of the component involved in the bumping incident.

To perform this study several data bases were searched. These included: licensee event reports (LERs), NRC Daily and Morning Reports and Nuclear Power Experience reports. The events collected from these searches are summarized in Appendix A. The summary information for each event includes the plant name, the event date, the system and component involved and a brief description of the event. The event description includes the event cause and the key plant system transient response (consequences) involved.

The results of this study are provided in the following sections of this report. Section 2.1 contains a general discussion of the quantity and kinds of events which were found, including the cause, components, and the system consequences. Section 2.2 provides an evaluation of the significant component/consequence pairs which were found from the data analysis.

Section 2.3 provides a discussion of the potential safety implications of the events collected. Section 3.0 contains a discussion of the significant study findings. Section 4.0 summarizes the conclusions obtained from the study, while Section 5.0 provides a suggestion for follow-up consideration by others.

2.0 DISCUSSION

2.1 Analysis of Components and Consequences

Over 50 operating occurrences involving bumped electro-mechanical devices were found, investigated and evaluated for this study. Most of these events occurred relatively recently, spanning the years 1980 to 1984. Only relatively recent events were found, even though the LER searches included LERs as far back as the late 1960's. The fact that no events were found for the earlier years of commercial nuclear plant operation (i.e., the late 1960's and 1970's) can likely be attributed to the lack of reporting and reporting requirements which existed in these earlier years. Records of these earlier events would likely exist in individual plant operating experience files (e.g., plant logs). However, no attempt was made to obtain and review the records of individual plants in order to capture this "missing" data. Thus the recent data was taken to be representative of earlier (missing) data rather than a trend involving increasing frequency of events over time.

The data collected involved electrical components which could be assigned to one of six different cause/component categories. These categories are: enclosed switches, handswitches, relays, circuit breakers, transmitters and miscellaneous. The safety system disturbances (consequences) generally could be sorted into one or more of the following six categories: (1) reactor scram, (2) safety system isolation, (3) safety system trip, (4) safety system initiation (excluding reactor scrams), (5) loss of power to a safety system and, (6) other. Appendix A provides a description of the events found and evaluated for this study.

Enclosed switch and circuit breaker events accounted for most of the occurrences found. The former category included pressure, flow, level and temperature switches, while the latter category often involved bumped external handles on the motor control units for safety-related pumps or valves. The events involving enclosed switches generally were caused when the device or its support structure was jostled by a member of the operating staff or impacted by a physical object. The circuit breaker events typically involved a member of the operating staff inadvertently brushing past the circuit breaker handle changing its position.

The handswitch events also involved causes similar to the circuit breaker events. Since transmitters and relays are both enclosed or protected electro-mechanical devices, the events involving these equipment reflected causes similar to the enclosed switch events. That is, the disturbance was transmitted through the rigid body of the component, to an otherwise protected moving part.

The most frequent system consequences resulting from bumped electrical components are reactor scrams and losses of electrical power to safety system equipment. A total of 16 events led to reactor scrams. All of these events except two were caused when an enclosed switch associated with the reactor or turbine

protection system or the primary containment isolation system was disturbed. The remaining two events involved a bumped relay and a breaker. All of the events involving a loss of electrical power to a safety-related system or component were caused when a circuit breaker or a handswitch was inadvertently disturbed by station personnel working in the plant. The safety system trip and safety system initiations categories accounted for five and twelve events respectively. No individual cause component was found to dominate either of these two consequence categories, although enclosed switches comprised almost half the events involving safety system trips. The last significant consequence category - safety system isolations - included just five events. However, no component cause pattern was evident for the five events in this consequence category.

2.2 Evaluation of Significant Component/Consequence Pairs

2.2.1 Loss of Power - Circuit Breakers

The most common cause-consequence pair found involved a loss of electrical power caused by a disturbed circuit breaker. The event at Surry 1 (see pg. A-9) is a typical example of this kind of occurrence. At Surry the circuit breaker for a motor operated valve in the containment sump suction line for a low head safety injection pump was found open during a routine control board walkdown. The open circuit breaker resulted in a loss of motive power to the valve motor operator. Extensive equipment modifications were being performed in the area of the breaker, and it was believed that the breaker's handle was accidentally bumped by a worker. The suction valve is manually actuated and must be remotely opened by the control room operator following a postulated loss of coolant accident. Thus the open breaker effectively disabled one of the low pressure emergency core cooling system trains. The manner in which the open breaker was discovered is also representative of this kind of occurrence. The control room operator observed that the valve open/close indicating lights were not illuminated during a routine control board walkdown. Accordingly, it would not be expected that a breaker-induced inoperability problem would remain undetected for very long.

The bumped circuit breaker events often involve some physical contact with the breaker handle which protrudes from the switchgear or motor control center front panel. However, this may not have been the cause in all cases. In some cases impact with or vibration of the entire breaker module could also have caused the breaker to open inadvertently. In such cases it would have been likely that a disturbed internal component, such as a relay, could have been the cause for the breaker opening.

The bumped handswitch events are similar in character to many of the bumped circuit breaker events. The handswitch events, however, always involve physical contact with a switch lever or a knob which protrudes above the plane of the panel board on which the switch is mounted. For handswitch events, it should not be expected that jarring the entire panel mounting board would cause the switch mechanism to change position. For this reason handswitch events would not appear to raise an equipment inoperability concern during a seismic occurrence.

About one half of the external switch events resulted in a loss of electrical power to a safety system. Thus the consequences of these events were often

similar to the circuit breaker events. Finally an examination of the plants reporting bumped circuit breaker or handswitch events reveals that no plant had more than two such events during the period spanned by the data base. This would appear to suggest that inoperability of safety systems during normal operations (non-seismic), caused by bumped circuit breakers or handswitches, is not a significant safety concern.

2.2.2 Reactor Scrams - Enclosed Switches

The second most frequent cause-consequence pair found was a bumped enclosed switch that resulted in a reactor scram. A total of fourteen (14) events were found in this category. Almost all of the events found (12 out of 14) occurred at a BWR facility. Most of the events involved reactor protection system (RPS) switches of an instrument channel sensor. The occurrences which involved RPS switches resulted in a direct reactor scram. The other scrams occurred when a turbine protection system or the containment isolation system switch actuated. These occurrences resulted in an indirect reactor scram which followed the turbine trip or containment isolation.

The greater number of BWR scrams caused by bumped enclosed switches likely can be traced to key differences between the design and location of PWR and BWR RPS sensors. BWRs typically utilize enclosed switches (pressure, level, flow, etc.) for RPS sensors while PWRs do not. PWR reactor protection systems typically utilize transmitters for sensing plant conditions. Therefore, PWRs have far fewer potential RPS switch "targets" which could initiate a reactor scram. Secondly, the instruments used in BWR reactor protection, primary containment isolation and turbine protection systems generally are mounted on racks outside the drywell (primary containment) structure but inside the reactor building (secondary containment) structure. This location is significant because the secondary containment of a BWR station frequently is occupied by plant personnel and/or contractor personnel during normal plant operation. Plant personnel must work in the reactor building to perform routine maintenance, testing, repair and inspection activities. Thus the enclosed switches involved in the BWR events are generally accessible for bumping by plant personnel. In contrast to these arrangements, the instrument sensors (transmitters) utilized in a typical PWR facility are usually mounted inside the reactor building containment making them less accessible to plant personnel during normal plant operation. In summary, the relative inaccessibility and lack of use of enclosed switches in most PWR facilities would appear to explain the general absence of bumped instrument caused reactor scrams for PWRs.

Several late generation BWRs (e.g., Hope Creek, Limerick, and Nine Mile Point 2) and a few older operating BWRs (e.g., Peach Bottom, Monticello, Brunswick 2 and Vermont Yankee) have plans to install or have already backfitted, respectively, transmitter-type sensors similar to those used by the PWR RPS design (Refs. 1 and 2). The transmitters, which are to be seismically qualified, are still to be located on racks outside primary containment. The use of qualified transmitters instead of the more sensitive switches should make the RPS, PCIS, etc., sensors installed in these BWR plants less susceptible to reactor scrams caused by bumped instruments. A review of the data indicates that none of the operating BWRs with qualified transmitters installed have reported a reactor scram caused by a bumped RPS instrument. The operating data would appear to suggest then that: (1) plants which use transmitters in the RPS generally are not susceptible to reactor scrams caused by bumping incidents, and (2) plants which

use enclosed switches in the RPS can be susceptible to reactor scrams caused by bumping incidents.

Reactor scrams at BWR facilities likely could be reduced by upgrading the administrative and/or the physical controls associated with the sensitive instruments. BWR plants could tighten the control over the access to areas near the sensors providing inputs to the reactor protection, containment isolation and turbine protection systems. This would reduce the opportunity for bumping incidents. Alternatively, plants could install physical barriers around the instrument racks as a means of protecting the instruments. The fence-type enclosures installed around BWR scram discharge volume level switches is a good example of such barriers. Finally, it would appear that the potential for reactor scrams could be reduced if susceptible plants were to backfit transmitter-type sensors (analog trip system) as replacements for the enclosed switch-type sensors. As mentioned above, several BWRs have already made the change over to the analog trip system on a voluntary basis.

2.2.3 Loss of a Safety System Function

A third category of potential significance is safety system trips or isolations caused by bumped enclosed switches, relays, transmitters or components other than handswitches or breakers. Such events potentially could be significant because: (1) the consequence involves a partial or complete loss of a safety system function and (2) a similar response of the electrical component during a major seismic occurrence at the site might be brought into question. That is, it might be suggested by the operating experience that the same safety system could (at least temporarily) be similarly disabled during a severe seismic disturbance. This might occur even though it is intended that the equipment remain functional during an earthquake.

Six events involved a trip or an isolation of a safety system for one of the causes cited above. Of these only the auxiliary feedwater system trips caused by bumped overspeed trip devices at the Prairie Island and Palisades plants involved more than one event. The remaining four events involved single isolated occurrences. The four other occurrences consisted of: (1) a reactor core isolation cooling system trip (and isolation) caused by a bumped relay, (2) a control room emergency outside air supply system (CREOASS) charcoal bed deluge system actuation (loss of CREOASS) caused by a bumped temperature switch at Susquehanna 1, (3) an emergency diesel generator trip caused by a bumped barring gear limit switch at Brunswick-2, and (4) a control rod drive pump (high pressure make-up) trip caused by a bumped enclosed pressure switch at Oyster Creek. Because of the diversity of these events and their causes, they were evaluated separately.

A limited review of the design of the auxiliary feedwater pump turbine overspeed trip device was made to assess its potential sensitivity to trips induced by seismic disturbances. The review found the turbine overspeed trip design to be rugged and sturdy. It did not appear that its design would be sensitive to trips caused by seismic disturbances. Operating experience also appears to support this conclusion. Since these trip devices are mounted directly on the turbine casing, they would be subject to high frequency vibrations while the turbine is running. However, no overspeed trip events were found which were caused by turbine vibration. Similar steam turbines and overspeed trip devices

have been widely used on naval and civilian surface ships for many years. Many of these ships likely experienced severe equipment jarring motions at some time or another without incident. This experience appears to provide additional evidence that overspeed devices are rugged and are not very sensitive to physical disturbances. Accordingly, it was concluded that even though AFW turbines have tripped because of bumping incidents, auxiliary feedwater pump turbine overspeed trip devices should not be expected to trip during seismic events.

The reactor core isolation cooling system (RCIC) trip and isolation event at Duane Arnold on May 7, 1984 was initiated when a relay in the RCIC steam leak detection circuit was inadvertently jarred. The relay assembly was jarred while a plant technician was removing the relay cover as part of the RCIC steam leak detection test procedure. The jarring action indirectly transmitted a vibration through the deenergized relay module. No direct displacement of the relay contact moving arm occurred, however. The relay energized causing a spurious RCIC isolation. The relay involved was a type HGA relay with model number 12HGA11A52F.

Vendor representatives for the component (i.e., General Electric) were contacted to discuss the seismic qualification of the relay. The GE representative indicated that the HGA relay at Duane Arnold was designed consistent with good industry practice in effect at the time the plant was being built. This would have involved either a shake test or a dynamic analysis based on an appropriate seismic g-load. With respect to more recent (i.e., IEEE-344) qualification standards, the GE representative indicated that HGA-type relays were likely included in the seismic qualification reviews for protection equipment now backfitted at BWR plants to resolve the ATWS issue.

At Susquehanna, on October 18, 1982 the "A" train of the CREOASS deluge system spuriously actuated, dousing the system's charcoal beds. The deluge system actuated when a fire system thermo-switch was accidentally bumped by maintenance personnel. The thermo-switch is manufactured by the Fenwal Corporation, model number 27120-0.

Representatives of the Fenwal Corporation were contacted to obtain information on the seismic qualification of the switch. The Fenwal staff engineer contacted stated that a "sister" temperature switch (Model No. 27121) was successfully tested in accordance with the seismic qualification testing procedures described in IEEE-344 (Ref. 3). The difference in the two switches, according to the representative, is that the temperature switch involved in the Susquehanna event opens on a rise in temperature while the seismically tested switch closes on a temperature rise. From the information collected it was concluded that the switch was likely qualified to operate during a seismic disturbance.

On January 18, 1983, with the "A" control rod drive (CRD) pump at the Oyster Creek plant out of service for maintenance, the "B" control rod drive pump tripped on a spurious low suction pressure signal. The "B" CRD pump tripped when the low suction pressure switch was inadvertently disturbed by a mechanic who was servicing the "A" CRD pump. The mechanic accidentally jostled the pressure switch while attempting to quickly move away from the "A" CRD pump vent line that began to discharge water. The control room operators observed the "B" CRD trip condition annunciated in the control room and immediately restarted the pump.

The CRD pumps at Oyster Creek are used to provide make-up to the reactor vessel for small line breaks in the reactor coolant system up to 0.002 ft^2. For breaks this size or less, a single CRD pump is capable of preventing the core from uncovering. This avoids the need to actuate the automatic depressurization system. For this reason, at the Oyster Creek plant, operability requirements for the CRD pumps are addressed in the plant Technical Specifications.

The device involved in the incident is a Mercoid pressure switch with model number DAW-43. A vendor representative was contacted to discuss the seismic qualification of the subject pressure switch. The representative stated that the switch involved in the incident was fairly sensitive to mechanical disturbances. It was not of a type that was qualified to not change state during a major earthquake. Furthermore, because of the sensitivity of the mercury wetted switch, it would be difficult to show by testing that it would not change state when subject to the jarring associated with a seismic event. Even so, the Oyster Creek experience indicates that the bumped switch did not prevent the CRD pump from being restarted after the jarred switch motion had ceased. Therefore, although the jarred switch resulted in a spurious shutdown of the CRD pump, the effect was only a temporary inoperability of the CRD system train.

2.2.4 Loss of Pressure Boundary Integrity

Two events were significant because the bumped component resulted in a temporary loss of reactor coolant system integrity. On January 29, 1980 and again on July 16, 1981 the same pressurizer pressure transmitter was jarred at the Calvert Cliffs plant by a technician who was working inside the reactor containment building. The jarred transmitter put out a spurious high pressure signal causing a pressurizer power operated relief valve to open. In one instance the transmitter was jarred while the transmitter's cover was being removed. In the second event the same transmitter was inadvertently bumped during equipment movement in the area. The transmitter involved was a Fischer and Porter Company (F-P) model 50EP1041BC balanced force motor-type pressure transmitter. The subject transmitter is part of the low temperature overpressure protection circuitry for the plant. The transmitter involved in these events is disabled during normal power operations. Accordingly, the specific transmitter involved in the two events would not be capable of initiating a similar adverse plant system response during a postulated major seismic event if the plant were operating at power. However, similar make and model transmitters are used in other plant protection systems at Calvert Cliffs. Fischer and Porter transmitters are also used to sense steam generator and pressurizer pressure during normal plant operations. These transmitters might be capable of initiating an adverse plant response (similar to that described above) during a major seismic occurrence.

A review of the NRC staff's Safety Evaluation Report for the Calvert Cliffs equipment qualification program (Ref. 4) indicates that the Fischer and Porter (F-P) model 50EP1000 series pressure transmitters, which could be subject to a harsh environment during an accident, are to be removed and replaced. The F-P transmitters inside containment will be replaced with Barton transmitters while the F-P transmitters outside containment that are potentially subject to a harsh environment will be replaced with Rosemount transmitters. These changes are being made to replace the non-seismically qualified/non-environmentally qualified F-P transmitters with qualified units. However, this replacement program

may not affect F-P transmitters located in mild environments of the plant. Accordingly, when the replacement program is completed, sensitive model 50EP1000 series F-P transmitters that might spuriously affect plant safety systems during a seismic event may still be installed in the plant.

2.3 Potential Safety Implications

A review of plant operating experiences involving bumped electro-mechanical devices indicates that enclosed switches, relays, transmitters and possibly (relays within) circuit breakers are among the more physically sensitive classes of electrical components in a nuclear power plant. The experiences indicate that when such components are physically jostled or vibrated, a spurious change of their state (output) can result. The operating plant data also reveals that a wide range of safety system disturbances can be initiated when one or more components of these types change state. Many of the spurious automatic system responses can be classified as involving a successful but unwanted safety system action. Other responses have involved a (temporary) disabling or degrading of a safety system or system important to plant safety. Reported events of the first type include reactor scrams, containment isolations and diesel-generator starts. Reported events of the second type include a spurious isolation of an emergency high pressure pump turbine, a spurious trip of an operating high pressure make-up pump and a spurious opening of a power operated relief valve.

Because of the sensitivity to physical disturbance exhibited by these classes of components, it could be reasoned that they would also be among the kinds of devices that could experience an undesirable or adverse change of state as a result of the equipment shaking which would accompany a major seismic event. However, a lack of seismic qualification (which might be suggested by these jostling events) cannot be concluded directly because neither the amplitude nor the frequency of the jostling (forces) actually involved in the events is known. Nevertheless, a detailed evaluation of several of the events which involved a degraded or disabled safety system (or system important to safety) revealed that the devices involved in the incidents were not explicitly seismically qualified. If, in fact, one or more of these types of devices in the plant were not seismically qualified, their spurious changes of state during a major seismic event might have a significant effect on plant system behavior.

To illustrate this point, the potential adverse effects of enclosed switches used in a typical BWR/3 or BWR/4 can be considered. Typically BWRs utilize enclosed switches for the reactor protection system sensors (e.g., reactor high pressure trip), the main steam line isolation trip circuitry sensors (e.g., high steam flow) and the HPCI and RCIC steam supply line isolation circuitry (e.g., high turbine exhaust diaphragm pressure, high steam flow). A major seismic disturbance, accompanied by a loss of off-site power, could result in the following plant/operator response scenario: The loss of off-site power would result in a generator trip followed by a reactor trip (assuming the jostled reactor high pressure switches did not cause a direct spurious reactor trip). The loss of off-site power would also result in a loss of feedwater and the main condenser (vacuum) caused by the loss of power to the feedwater and circulating water pumps, respectively. Effectively the vessel would be isolated from the main condenser heat sink. With the vessel isolated and no feedwater available, the HPCI and RCIC systems would initially be relied upon to provide emergency high pressure make-up. However, both high pressure systems might

themselves isolate because of jostled switches (e.g., the HPCI and RCIC steam supply line isolation valves might close on a spurious turbine exhaust line diaphragm high pressure signal). Were this to occur, the operator would likely quickly take steps to reopen the closed HPCI and/or RCIC isolation valves needed to reestablish operability of the RCIC and/or HPCI systems. Once open another seismic shock (i.e., an after shock) might cause the previous close/open sequence of the HPCI/RCIC steam supply line isolation valves to be repeated. However, repetitive cycling of motor-operated isolation valves, especially in a short time period (e.g., within five minutes), could exceed the design duty cycle for the motor operator. This could result in the winding failure of the motor. Such valve motor operator failures have been reported where repetitive valve cycling has occurred over a short period of time (Refs. 5, 6 and 7). The unavailability of high pressure make-up caused by valve motor operator burnout, would place reliance for safe shutdown on the low pressure systems after RCS depressurization. However, proper operation of a BWR's low pressure core cooling systems also involves proper operation of the same kinds of enclosed switches including pressure and level switches. Spurious operation of these switches might also cause unintended valve cycling which could lead to undesirable behavior of the low pressure core cooling systems similar to that described for the HPCI and RCIC systems. The potential for switches to adversely affect any of the low pressure ECC systems would depend on their sensitivity to seismic shaking (i.e. with respect to contact bounce) and the effects of a spurious change of state of the device on overall system behavior. The seismic qualification of enclosed switches, including the potential effects of contact bounce on system behavior, would require a review beyond the scope of this study. The additional effects of spurious changes of state of relays, transmitters and possibly circuit breakers would likely be similar to those for enclosed switches.

3.0 FINDINGS

3.1 Enclosed switches, relays, transmitters and possibly circuit breakers, appear to be sensitive to physical jostling or vibration and may change state (output) when bumped.

3.2 Enclosed switch-type sensing elements, generally used in most operating BWR protection and primary containment isolation systems, have resulted in a significant number of bumped instrument initiated reactor scrams for these plants. In contrast, the transmitter-type sensing elements mounted inside containment, that are generally used in most operating PWR protection systems, have resulted in relatively few bumped instrument initiated reactor scrams for PWR plants.

3.3 Events involving bumped circuit breakers often result in a loss of power to a safety system (component). While most of these incidents appear to have resulted from a bumped (displaced) breaker handle, several of these events may have been caused by a jostled component internal to the breaker (e.g., a relay).

3.4 In addition to reactor scram and losses of power supply events, the incidents involving bumped electro-mechanical devices have resulted in safety system isolations, trips and actuations.

4.0 CONCLUSIONS

A study of plant disturbances caused by bumped electro-mechanical components reveals that certain classes of equipment such as enclosed switches, relays, transmitters and circuit breakers can be susceptible to a change of state (e.g., energize or deenergize) when jostled. The study also shows that the consequences of bumped component events can include reactor scrams as well as safety system trips, isolations and actuations.

Specifically, the data shows that BWR plants have sustained a significant number of reactor scrams initiated by bumped enclosed switches. In contrast, PWR plants rarely have experienced reactor scrams initiated by bumped electrical devices. The relative absence of bumped electrical device initiated reactor scrams at PWRs can be attributed to the use of transmitter-type sensing elements which are mounted inside containment. In this location an RPS or control system instrument would not generally be vulnerable to jostling. At the same time the newest BWR plants and several of the operating BWR plants which utilize seismically qualified transmitters instead of switches for the sensing elements in the RPS, PCIS, and certain control systems, have not reported plant disturbances caused by bumped instruments.

Bumped circuit breakers accounted for a significant number of the events found. These events generally involved a loss of electrical power to a system or component important to safety. Although many of the circuit breaker events were thought to have been caused by a disturbed (displaced) breaker handle, several may have been caused by a jostled internal component, such as a relay.

Bumped electro-mechanical devices have also demonstrated the potential to degrade or disable systems important to plant safety. Included among these was an event at Oyster Creek (caused by a bumped Mercoid pressure switch) that resulted in a trip of a control rod drive pump. Additionally, two events at Calvert Cliffs (caused by a jostled F-P transmitter) resulted in a temporary degradation of the primary system pressure boundary when a power operated relief valve spuriously opened.

To date, none of the bumping incidents has involved a serious plant transient or system disturbance which has resulted in a significant challenge to the plant safety systems or the operating staff. However, had the plant operating status been different it is possible that some of these incidents could have led to a more serious event.

Phase II of the NRC staff's proposed resolution plan for Unresolved Safety Issue A-46, "Seismic Qualification of Equipment in Operating Plants," (Ref. 8) calls for a plant-specific equipment qualification review of certain classes of electro-mechanical equipment beyond the specific classes already defined in Phase I. Included in Phase I are: Low-voltage switchgear, unit substation transformers, motor operated valves, air operated valves, and vertical (and horizontal) pumps and motors. The specific classes of equipment which may be included in Phase II have not yet been determined. There was insufficient data to quantify either the amplitude or the frequency of the jostling forces involved in any of the events studied. However, the operating experiences collected for this study would appear to be of value in providing qualitative generic insights into the classes of electro-mechanical devices which are sensitive to physical disturbances and therefore, might be susceptible to spuriously

change state during the jostling that would accompany a major seismic disturbance at a nuclear plant. Such a view would suggest that enclosed switches, relays, transmitters and circuit breakers could be among the more seismically sensitive classes of electro-mechanical devices in the plant. That is, these classes of electrical equipment would appear to be among the more likely components to undergo an undesirable or adverse change of state (output) during a major seismic event (e.g., a safe shutdown earthquake). For this reason it would appear appropriate that special consideration be given to these classes of components for Phase II of the proposed plant-specific equipment qualification reviews.

5.0 SUGGESTION

Because of the relatively high sensitivity to mechanical shock and vibration exhibited by enclosed switches, relays, transmitters and possibly (relays in) circuit breakers, it is suggested that these types of components be included in Phase II of the planned resolution program for Unresolved Safety Issue A-46, "Seismic Qualification of Equipment in Operating Plants."

6.0 REFERENCES

1. "Analog Transmitter/Trip Unit System for Engineered Safeguard Sensor Trip Inputs," R. Strong, L. Youngborg, NEDO-21617, April 1977.

2. "Analog Transmitter/Trip Unit System for Engineered Safeguard Sensor Trip Inputs (Amendment No. 1)," R. Strong, L. Youngborg, NEDO-21671-1, January 1978.

3. "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Generating Stations," IEEE Std 344-1975.

4. "Technical Evaluation Report Review of Licensees' Resolution of Outstanding Issues From NRC Equipment Environmental Qualification Safety Evaluation Reports, Calvert Cliffs Nuclear Power Plant Unit 2," Franklin Research Center, October 13, 1982.

5. Georgia Power Company, Docket No. 50-266, Licensee Event Report No. 80-101, July 29, 1980.

6. Georgia Power Company, Docket No. 50-366, Licensee Event Report No. 80-109, August 26, 1980.

7. Georgia Power Company, Docket No. 50-366, Licensee Event Report No. 81-088, October 6, 1981.

8. Memorandum from Denton (ONRR) to Stello (CRGR), "CRGR Review of Proposed Requirements Resulting From Resolution of USI A-46, 'Seismic Qualification of Equipment in Operating Plants'," October 31, 1984.

APPENDIX A
PLANT OPERATING EXPERIENCES

Plant Name: HATCH 1

Report No.	Event Date	System/Component	Event Description
(1) LER 83-035	830628	600V Essential AC MCC/Circuit Breaker	The normal power supply to a 600V Essential MCC tripped. The cause of the event was traced to construction personnel who inadvertently bumped the breaker trip switch and control power toggle switch while moving equipment by the breaker. The control power toggle switch was turned to the on position and the breaker was reclosed.
(2) PNO-II-82-76 LER 82-60	820703	RPS/Reactor Pressure Switch	While operating at 100% power, a spurious reactor high pressure signal occurred and resulted in a reactor scram and vessel isolation. Eleven safety/relief valves failed to open at the set opening pressure during the transient which followed the scram. It was believed that a maintenance worker had inadvertently bumped into the reactor high pressure instrument rack, causing the high pressure signal to occur.

Plant Name: HATCH 2

Report No.	Event Date	System/Component	Event Description
(3) 81-57	810623	Plant Service Water Valve/Control Switch	During normal operation the Division II Normal Plant Service Water Supply Valve to Reactor Building Division I was found closed when it should have been open. It was believed that the local control switch for the valve was accidentally bumped by personnel working in the area causing the valve to close. The valve was reopened and a protective cover for the switch was installed to prevent recurrence.

Plant Name: POINT BEACH 1

Report No.	Event Date	System/Component	Event Description
(4) NRC Daily Report	830308	Main Turbine Protection System/ Relay	The plant scrammed due to a spurious main turbine trip. An investigation by the licensee revealed that the turbine trip was caused when a turbine stop valve relay was accidentally bumped by contractor personnel who were working on nearby fire protection equipment.

Plant Name: CALVERT CLIFFS 1

Report No.	Event Date	System/Component	Event Description
(5) NRC Daily Report	821110	DC Power Supply/ Circuit Breaker	With the plant operating at power, the reactor tripped on low level in the #1 steam generator. This occurred following a loss of 120VAC power to the main feed regulating valves. The 120VAC power was lost when a breaker supplying DC power to the inverter opened. It was believed that the breaker opened when it was accidentally bumped by personnel working in the cable spreading room.
(6) LER 80-07	800129	Power Operated Relief Valve/Pressure Transmitter	With the plant shutdown and reactor pressure at 258 psig one of the two Power Operated Relief Valves (PORVs) spuriously opened decreasing pressure to 169 in 4 minutes. The operator shut the PORV by going to override. The PORV opened when an erroneous high signal occurred as a result of personnel jostling the pressure transmitter. The pressure transmitter was disturbed when a technician, conducting a review of instruments installed in the containment building removed the transmitter cover to visually examine the internal components.
(7) LER 81-56	810716	Power Operated Relief Valve/Pressure Transmitter	During Mode 5 operations and 250 psig reactor pressure, one of the two Power Operated Relief Valves (PORVs) opened unexpectedly. The control room operator immediately shut the PORV isolation valve. The PORV opened when an erroneous high reactor pressure signal occurred as a result of personnel bumping the pressure transmitter. A mechanical stop was to be installed to protect the transmitter.

Plant Name: PRAIRIE ISLAND 2

Report No.	Event Date	System/Component	Event Description
(8) LER 83-02	830216	Heat Tracing/ Control Switches	Control switches for the heat trace circuits of the safety injection pump suction line from the boric acid tank, were found in the "off" position. It was believed that personnel working in the area had unknowingly bumped the control switches to the off position.

Plant Name: CRYSTAL RIVER 3

Report No.	Event Date	System/Component	Event Description
(9) LER 81-06	810123	Control Bldg. Emerg. Ventilation System Fan Motor/ Circuit Breaker	The circuit breaker for the control building emergency filtration fan was observed open. The cause was traced to an inadvertent bumping of the breaker.

Plant Name: PRAIRIE ISLAND 1

Report No.	Event Date	System/Component	Event Description
(10) LER 81-01	810112	Auxiliary Feedwater Pump/Overspeed Trip Device	While performing piping modification work in the area of the No. 11 auxiliary feedwater pump, a workman accidentally bumped the overspeed trip mechanism, tripping the steam admission valve closed.

Plant Name: SURRY 2

Report No.	Event Date	System/Component	Event Description
(11) LER 81-47	810721	Service Water Supply Valve/Circuit Breaker	The service water supply valve to the component cooling water heat exchangers was found open with its associated circuit breaker open. Since the breaker is located in an area where extensive maintenance was being undertaken it was believed that the breaker was accidentally bumped by maintenance personnel, causing it to open. The breaker was reclosed and the valve cycled to verify operability.
(12) LER 81-57	810827	Boron Injection Tank Inlet Valve/ Circuit Breaker	A routine control board walkdown revealed that the circuit breaker for the boron injection tank inlet valve was open. Since the breaker is located in an area where extensive modifications were being undertaken it was believed that the breaker was accidentally bumped by construction personnel causing it to open. The breaker was reclosed and valve position indication verified.

Plant Name: SURRY 1

Report No.	Event Date	System/Component	Event Description
(13) LER 81-38	810827	Containment Sump Suction Valve/ Circuit Breaker	A routine control board walkdown revealed that the circuit breaker for the motor operator of a containment sump suction valve was open. It was believed that the breaker was accidentally bumped by construction personnel working in the switchgear room causing it to open.

Plant Name: PEACH BOTTOM 2

Report No.	Event Date	System/Component	Event Description
(14) LER 82-44	821229	Torus Water Level/ Transmitter	With the plant operating at full power a torus water level recorder went off scale and annunciated a low level alarm. The problem was traced to a torus level transmitter which was accidentally bumped by a laborer who was performing an equipment modification in the area.

Plant Name: FITZPATRICK

Report No.	Event Date	System/Component	Event Description
(15) NRC Daily Report LER 84-18	840918	Reactor Protection System/Scram Volume Level Switches	With the reactor in cold shutdown a spurious high water level signal for the discharge volume occurred, which initiated a reactor scram. The event was caused by a worker who inadvertently bumped the level switch on the scram discharge instrument volume.

Plant Name: VERMONT YANKEE

Report No.	Event Date	System/Component	Event Description
(16) LER 83-19	830816	RHR Torus Spray Valve/ Circuit Breaker	During normal review of the control room panels control room personnel discovered a loss of indication for an RHR torus spray valve. The associated breaker was found to be in the open position. Workers in the area of the breaker were instructed to use caution when working around electrical panels.

Plant Name: PALISADES

Report No.	Event Date	System/Component	Event Description
(17) LER 81-007	810122	Auxiliary Feedwater Pump/Overspeed Trip Device	The overspeed trip device for the turbine driven auxiliary feedwater pump was discovered to be tripped. A contractor worker, working in the pump room, apparently accidentally bumped the overspeed trip unit.

Plant Name: DRESDEN 3

Report No.	Event Date	System/Component	Event Description
(18) NRC Daily Report	830219	Reactor Protection System and PCIS/Main Steam Line High Flow Switches	With the reactor operating at 100% power the main steam line isolation valves closed spuriously isolating the vessel and initiating a reactor scram. The event was caused by a spurious high steam flow signal. The high flow signal was caused by a contractor drilling on a concrete wall near the instrument rack which caused the rack to vibrate. Vibration of the rack caused the flow switches to actuate.

Plant Name: MILLSTONE 1

Report No.	Event Date	System/Component	Event Description
(19) NRC Daily Report	821119	Reactor Protection System/Pressure Switch	With the plant in hot standby the reactor scrammed on low condenser vacuum. The scram was caused when a worker accidentally bumped the instrument rack containing the RPS condenser low vacuum instrumentation.

Plant Name: R.E.GINNA

Report No.	Event Date	System/Component	Event Description
(20) LER 83-244	830311	DC Battery Charger/ Circuit Breaker	While operating at 100% power, the control room annunciator "Battery Charger Failure" alarmed. An immediate investigation revealed that a circuit breaker to a 150 Amp battery charger was open. The cause was traced to a QC inspector, who accidentally bumped the breaker while climbing a ladder in the area.

Plant Name: MILLSTONE 2

Report No.	Event Date	System/Component	Event Description
(21) LER 82-48	821210	Vital 120 VAC Bus/ Control Panel Switch	During normal plant operation power was lost to a Vital 120 Volt AC bus. The event was caused when when a worker accidentally bumped a switch handle causing the supply to be switched from the alternate supply to the normal supply. The normal supply had previously been tagged out for maintenance. Covers were installed to prevent recurrence.

Plant Name: YANKEE ROWE

Report No.	Event Date	System/Component	Event Description
(22) LER 82-033	821009	Nuclear Instrumentation/Circuit Breaker	During a refueling outage the nuclear instrumentation channels were inadvertently de-energized for approximately 10 minutes. The de-energization was traced to an open circuit breaker. The breaker was inadvertently bumped by station personnel installing new equipment in the area. The breaker was immediately reclosed.

Plant Name: BRUNSWICK 2

Report No.	Event Date	System/Component	Event Description
(23) LER 82-43	820323	Diesel Generator/ Barring Gear Limit Switch	The control room annuciator indicated that an abnormal condition existed in Diesel Generator No. 3. A check of the local control panel indicated that a lockout condition existed which prevented automatic or manual starting of the diesel generator. The diesel barring gear limit switch was accidentally bumped during housekeeping activities causing it to actuate. The lockout was reset.
(24) LER 82-142	821218	Primary Containment Isolation System/Flow Switch	The containment isolation valve for a sensing line serving a reactor vessel pressure switch closed unexpectedly during normal plant operation. The isolation occurred when construction personnel inadvertently bumped the valve and/or its associated instrument piping. This caused the excess flow switch to actuate, shutting the valve.

Plant Name: BRUNSWICK 1

Report No.	Event Date	System/Component	Event Description
(25) LER 83-24	830206	Core Spray System Valve Motor Operator/Circuit Breaker	The "B" Core Spray System inboard injection valve position indication light was found unlit. A check revealed that the circuit breaker had been turned off. Plant personnel had inadvertently bumped the breaker handle with a chair, switching it to the "off" position. The breaker was immediately reset to restore power to the valve motor operator.

Plant Name: DUANE ARNOLD

Report No.	Event Date	System/Component	Event Description
(26) LER 83-19	830524	Reactor Water Cleanup System Valve Motor Operator/ Circuit Breaker	The position indicator for the outboard isolation valve of the RWCU system was lost during normal plant operations. An investigation revealed that the circuit breaker supplying power for the motor operator and the valve position indication circuitry was open. It was believed that personnel had accidentally bumped the breaker. The breaker was immediately restored to operable status. Methods for physically protecting the switchgear were also to be reviewed since the height of the breaker handle (knee level) was such that carts could easily contact the breaker handle.
(27) LER 83-30	830812	Diesel Generator Control/Panel Switch	During normal plant operation an individual performing general housekeeping accidentally bumped a DG Unit/Parallel switch on the DG control panel. This caused a control room alarm and the DG to align in parallel rather than unit control mode. The event was caused by contract personnel contacting the switch handle while walking by the switch with a plastic bag in hand. The switch was reset by an operator.

Plant Name: DUANE ARNOLD

Report No.	Event Date	System/Component	Event Description
(28) LER 84-27	840712	RPS/Reactor Pressure Switches	With the plant at 99% power a spurious reactor high pressure signal occurred which caused a reactor scram. The spurious high pressure signal was caused by a 6' piece of scaffolding pipe falling against an instrument rack support. This in turn jarred the reactor high pressure scram switches.
(29) LER 84-18	840607	RCIC PCIS Steam Leak Detection Differential Pressure/Relay	While operating at 72% power, with monthly surveillance testing being performed on the RCIC Steam Line High Differential Pressure System, a spurious RCIC isolation and RCIC turbine trip occurred. The trip and isolation occurred when a relay in the PCIS Steam Leak Detection System was inadvertently jarred, energizing the relay. The relay was jarred when the relay cover was being removed as part of the monthly surveillance test on the leak detection system. A review of plant records revealed no other instances of an RCIC turbine isolation or another spurious HGA type relay actuations that were caused by jarring or vibrating of the relays.

Plant Name: NORTH ANNA 2

Report No.	Event Date	System/Component	Event Description
(30) LER 82-65	821007	Containment Spray Pump Casing Cooling Water Pump/Circuit Breaker	The control power for the "A" Casing Cooling System pump was found de-energized. The circuit breaker for the pump was found open. The breaker was reclosed and control power was verified. Workers in the area had moved a ladder about one hour earlier in the area and may have bumped the breaker handle.
(31) LER 82-71	821027	Containment Spray Pump Casing Cooling Water Pump/Circuit Breaker	The control power for the "B" Casing Cooling System pump was found de-energized. The circuit breaker for the pump was found open. The breaker was reclosed. It was believed that the breaker may have been unintentionally disturbed by workers in the area.

Plant Name: DAVIS BESSE-1

Report No.	Event Date	System/Component	Event Description
(32) LER 81-52	810904	Essential 4.16KV Bus/ Circuit Breaker	The essential 4.16KV Bus C1 underwent an undervoltage condition unexpectedly automatically starting DG 1-1. The electrical distribution system responded normally during the occurrence to pick up the vital electrical loads. Cleaning personnel working in the immediate area of the DG control panel had inadvertently bumped the control switch on breaker AC1110, de-energizing the C1 bus. The C1 bus was restored to its normal line-up.
(33) LER 81-73	811111	Auxiliary Feedwater System Valves/Circuit Breaker	The reactor operator noticed that the position indicating lights for several valves in the auxiliary feedwater system were lit. An investigation revealed that the supply breaker to the attendant MCC was open. The cause was suspected to be a construction worker accidentally bumping the switch. The breaker was reclosed restoring power to the affected equipment.
(34) NRC Daily Report	840911	Main Turbine Protection System/ Level Switch	With the plant operating at 70% power a turbine trip followed by a reactor trip occurred. The turbine trip occurred due to a moisture separator high water level signal. It was believed that a level switch on the turbine deck had been accidentally bumped by a member of the operating crew.

Plant Name: SUSQUEHANNA 1

Report No.	Event Date	System/Component	Event Description
(35) LER 82-40	821018	CREOASS Deluge System Heat Tracing/ Temperature Switch	The CREOASS charcoal bed deluge system initiated unexpectedly. A construction worker accidentally bumped a fire suppression system thermo-switch on the charcoal beds. The charcoal was changed out and the preventive maintenance procedures have been modified to valve out the deluge system during maintenance.
(36) LER 83-60	830411	Electrical AC Power/ Supply Breaker	With the plant in cold shutdown power to a 480 volt essential bus was interrupted causing an RPS actuation signal and isolation of Division II of residual heat removal shutdown cooling. The event was caused when an electrician inadvertently bumped the power supply 50, a 480 volt essential Motor Control Center.

Plant Name: MAINE YANKEE

Report No.	Event Date	System/Component	Event Description
(37) NRC Morning Report	840719	Main Steam Dump System/Hand Switch	While operating at full power the steam dump valves spuriously opened. An investigation determined that a wheel of an I&C maintenance mechanic's pushcart had bumped into one of two temperature controllers, moving it from automatic to manual.

Plant Name: MONTICELLO

Report No.	Event Date	System/Component	Event Description
(38) NRC Daily Report	840912	Transformer/Relay	The 110 transformer bank inadvertently isolated causing both EDG's to start automatically when power was lost to the No. 1 auxiliary reserve transformer. Technicians in the switchyard had inadvertently bumped relays to the #10 transformer bank.

Plant Name: LASALLE-2

Report No.	Event Date	System/Component	Event Description
(39) Insp. Report No. 50-374/ LER 84-18	840606	RPS/Level Switch RCIC/Level Switch	With the plant operating at 24% power, a spurious low water level signal caused the RCIC system to initiate. The erroneous low water level signal also tripped the "B" channel of the Reactor Protection System. The main turbine tripped when the RCIC initiated. The turbine trip caused the "A" (and "B") channel of the RPS to trip which initiated a reactor scram. An instrument mechanic had been performing work on the wide range level monitor and had accidentally bumped the instrument rack. The bumped instrument racks had caused two RCIC level switches and the RPS level switches on the rack to put out an erroneous high water level signal.
(40) LER 84-14	840118	PCIS/Relay	With the plant in hot shutdown, PCIS Groups 2 and 4 actuated isolating the secondary containment and shutting down the reactor building ventilation system. The event occurred when a station construction worker inadvertently jostled a relay in the PCIS while replacing the relay cover. Had the Group 2 isolation occurred under different conditions a loss of the drywell instrument air would have been the consequence.

Plant Name: DRESDEN 2

Report No.	Event Date	System/Component	Event Description
(41) N/A	820126	RPS/Pressure Switch	A spurious reactor high pressure signal resulted in a reactor scram. The event was caused when a local instrument rack was accidentally bumped.

Plant Name: QUAD CITIES 2

Report No.	Event Date	System/Component	Event Description
(42) N/A	830111	PCS Main Steam Line High Flow/DP Switch	With the plant operating at close to full power a spurious high flow signal on one of the main steam lines occurred. This caused the associated MSIV to close which resulted in a reactor trip. The event was caused when a contract employee working near the instrument rack containing the main steam line flow instrument accidentally bumped the rack.

Plant Name: QUAD CITIES 1

Report No.	Event Date	System/Component	Event Description
(43) N/A	820127	RPS/Reactor Pressure Switch	A spurious reactor high pressure signal resulted in a reactor scram. The event was caused when a local instrument rack was accidentally bumped.
(44) NRC Daily Report	830216	RPS/ and PCIS/Main Steam Line High Flow	With the reactor operating at 100% power a reactor scram occurred after a spurious high steam flow condition caused a Group 1 (MSIV) isolation. The Group 1 isolation (closure of all MSIVs) signal was caused by personnel accidentally jostling the instrument rack containing the high steam line flow switches.

Plant Name: PILGRIM

Report No.	Event Date	System/Component	Event Description
(45) NRC Daily Report	820816	PCIS Main Steam Line High Flow/ Switches	While operating at 100% power the plant scrammed due to spurious closure of the main steam isolation valves. The event was caused when an instrument rack was bumped during the erection of staging causing a spurious high steam flow signal, which closed the MSIVs.

Plant Name: BROWNS FERRY 1

Report No.	Event Date	System/Component	Event Description
(46) N/A	820126	RPS/Reactor Pressure Switch	A spurious reactor high pressure signal resulted in a reactor scram. The event was caused when a local instrument rack was accidentally bumped.
(47) NRC Daily Report	840103	RHR/Local Control Switch	With the plant operating at 34% power the "D" RHR pump spuriously started. The event occurred when laborers cleaning the basement accidentally bumped the local control switch and started the pump.

Plant Name: BROWNS FERRY 2

Report No.	Event Date	System/Component	Event Description
(48) LER 84-06	840904	Turbine Protection System/Oil Tank Level Switch	With the plant operating at 61% power, the main turbine stop valves tripped closed on a spurious turbine oil tank low level signal. The reactor immediately scrammed on the turbine stop valve closure. The root cause of the turbine trip was attributed to an inadvertent actuation of the level switch when the switch was accidentally bumped during equipment testing.

Plant Name: OYSTER CREEK

Report No.	Event Date	System/Component	Event Description
(49) LER 83-03	830118	CRD Pump Suction Pressure/Switch	With the plant at 50% power the "B" CRD pump tripped off line on low suction pressure. The event occurred when a mechanic working in the area of the CRD hydraulic system inadvertently jostled the low suction pressure switch for the "B" CRD pump tripping the pump. The control room operators restarted the pump.

Plant Name: GRAND GULF 1

Report No.	Event Date	System/Component	Event Description
(50) LER 84-034	840719	RPS Motor Generator Set/Output Breaker	With the plant in cold shutdown both shutdown cooling loops isolated. The event was caused when a maintenance electrician inadvertently bumped a breaker handle which resulted in the "A" RPS motor-generator set output breaker tripping open.

Plant Name: WNP 2

Report No.	Event Date	System/Component	Event Description
(51) NRC Daily Report	840919	PCIS/Temperature Switch	With the plant operating at 47% power the reactor water cleanup system spuriously isolated. Only the outboard valve closed. It was believed that the isolation occurred as a result of someone bumping the temperature switch on the outlet of the non-regenerative heat exchanger.
(52) NRC Daily Report	840319	HPCS Diesel/Under voltage Relay	With the plant in cold shutdown the high pressure core spray system diesel automatically started. The diesel started when an instrument technician accidentally bumped an undervoltage relay.

Plant Name: PEACH BOTTOM 3

Report No.	Event Date	System/Component	Event Description
(53) NRC Inspection Report	830215	Reactor Protection System/Scram Discharge Volume Level Switches	With the reactor shutdown, a reactor scram occurred due to a scram discharge volume high level signal. It was believed that the level instrument had been bumped sufficiently hard to trip both RPS channels.