AEOD ENGINEERING EVALUATION REPORT*

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NSSS/AE:	General Electric/Bechtel	
SUBJECT:	LOSS OR ACTUATION OF VARIOUS SAFETY RELATED EQUIPMENT DUE TO REMOVAL OF FUSES OR OPENING OF CIRCUIT BREAKERS	
EVENT DATE:	July 9, 1984	
AFFERENCE.	Deservice Deven & Light Company 150 04 010	

REFERENCE: Pennsylvania Power & Light Company, LER 84-012 Docket No. 50-388, dated August 9, 1984.

SUMMARY

This engineering evaluation report provides information concerning operational events which involved the practice of removing fuses for personnel protection during maintenance and/or plant modification activities. The safety concern is that this practice has resulted in unknowingly disabling safety systems and has caused inadvertent actuation of these systems with attendant plant transients.

The referenced licensee event report (LER) and five additional LERs were used as the sources of information for this report.

The report concludes that the practice of removing fuses or opening circuit breakers during maintenance and/or plant modification activities should be eliminated where practical, even if the frequency of such activity is low. Where this practice is unavoidable in order to provide plant personnel with the necessary protection during these activities, the report suggests that adequate review and analysis of the circuits involved should be performed. Independent verification of such review and analysis should be conducted to ensure that all effects on plant equipment are known. Training of involved plant personnel should be conducted to alert them to the possible undesirable results of fuse removal or breaker operation. These actions are suggested to be performed prior to removal of fuses or opening of circuit breakers. Finally, the report suggests that the Office of Inspection and Enforcement consider issuing an IE Information Notice which addresses the identified events and stresses the importance of adequate analysis, planning and training required prior to conducting maintenance and/or plant modification activities involving removal of fuses or opening of circuit breakers.

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

DISCUSSION

The referenced licensee event report provides a description of an event which occurred at the Susquehanna Unit Number 2 Plant on July 9, 1984. At the time of this event, the unit was operating at twenty percent of full power. As described in the referenced report, a Plant Modification Request (PMR) required the Core Spray Isolation Logic to be modified. To implement this modification, a Construction Work Order (CWO) was written and provided to a work group. Also, an Equipment Release Form (ERF) which tracks equipment taken out of service for such modifications was issued. At approximately 10:00 a.m. on July 9, 1984, two control power fuses associated with the Division I core spray logic for Unit Number 2 were removed by electricians. These fuses were mentioned in the CWO but not in the ERF as a possible blocking point for personnel protection while the modification was being completed. The CWO also identified other suitable blocking. However, the involved electricians apparently believed that these fuses were a local blocking point and as such they were removed. The removal of these two fuses affected the following items as identified.

- Division I of the Core Spray System for Unit Number 2 was affected in that the A loop of this system would not be provided with an initiation signal to start the A and C core spray pumps and to properly position the A loop injection valves.
- The 'A' Diesel Generator was affected in that it would not have received an initiation signal to start from the Division I Core Spray Logic provided for a LOCA condition associated with Unit Number 2.
- 3. The A and C instrumentation channels for reactor vessel low level and pressure were made inoperable. This affected Division I of the residual heat removal system for Unit Number 2 in that this system would not have actuated from these channels.
- 4. In addition to the A and C instrumentation channels for reactor vessel low level, these channels for high drywell pressure were also made inoperable. This affected the high pressure coolant injection system for Unit Number 2 in that this system would not have actuated from these channels.
- 5. The A and C 4160 volt essential buses associated with Unit Number 1 and Unit Number 2 were affected in that these buses would not receive a signal to change the load shed initiation time if a LOCA condition was present. That is, these buses are required to load shed with a ten plus or minus one second time delay with a LOCA signal present. However, due to the inoperable core spray logic this time delay would have been five minutes.

- 6. Division I of the drywell cooling fans for Unit Number 2 were affected in that these fans would not trip in the event of a LOCA.
- 7. A half drywell cooling isolation signal for Unit Number 2 was generated.
- 8. A reset signal to the start timer associated with the A emergency service water pump would not be provided. This being the case, a potential would exist for residual heat removal pump A and emergency service water pump A to start simultaneously during a LOOP/LOCA condition associated with Unit Number 2.
- The instrument air compressors for Unit Number 2 would not receive a trip signal if a LOCA condition existed for Unit Number 2.
- The containment instrument gas compressor for Unit Number 1 would not receive a trip signal if a LOCA condition existed at Unit Number 2.

Limiting conditions for operations were entered for item 1 based upon the ERF which was submitted for the PMR work. However, no such operating restrictions were entered for items 2 thru 5 prior to work commencing as these were unknowingly caused by the pulled fuses. When the fuses were pulled, operations personnel observed an alarm indicating a half drywell isolation condition was present. They immediately contacted unit coordination to determine if any work had been released which could have caused this condition. Unit coordination and operations personnel began an immediate investigation of the work involved with the PMR. By the time the workers were located, the physical work had been completed. The fuses were reinstalled at approximately 2:30 p.m. on July 9, 1984. This action cleared the half isolation signal and restored all other systems.

Another item involved in this event was the core spray out-of-service switch. When the ERF was submitted to operations for the PMR work, it was determined that the work would cause Division I of the core spray system for Unit Number 2 to be inoperable. In accordance with operating procedures, the core spray out-of-service switch was placed in the inoperable position which indicated the inoperable status of core spray. However, this same switch causes the loss of core spray logic power status indicating light to become energized. Thus, when the fuses were pulled (which also causes this light to energize), this status indicating light was already energized and as such masked the loss of the core spray logic. This masking may have contributed to the length of time (approximately four and one-half hours) the identified items were affected. As a result of this event, the following corrective actions were taken:

- a. All plant modifications involving electrical work were stopped.
- b. Training sessions were held with utility electrical construction and outside vendor personnel which emphasized that operation of circuit breakers, pulling of fuses and opening of links was not to be done.
- c. A training session was held with engineers from the installation engineering group which instructed them not to direct operation of breakers and other devices as recommended blocking.
- d. A review was conducted of open CWO's to ensure none specified blocking as part of the work plans. In addition to the above short term corrective actions, a human factor analysis will be performed on the Core Spray Status Switch with resulting design and/or procedural changes made as considered necessary.

In view of the safety implications of the above event (that is, disabling and/or improper actuation of safety related equipment due to removal of fuses), a search of the Sequence Coding and Search System was performed with the objective of identifying other similar events that occurred during the period from 1981 to 1984. The result of this search was that five additional Licensee Event Reports (LER's) were identified. These five LERs are identified on the attached reference sheet.

Reference 1 provides a description of an event which occurred at the Surry Station in September of 1981. With the unit shutdown, the battery for the smoke detector system was noted not to be accepting a charge. The electrician who was sent to remove the battery did not wish to leave energized wiring exposed and therefore he removed the line fuse not realizing that this disabled the smoke detector panel. The fire detection system ensures that adequate warning capability is available to promptly detect and locate fires in their early stages and thereby reduces the potential for damage of safety related equipment.

The cause of this event was attributed to personnel error in that the electrician did not realize that removing the line fuse would disable the smoke detector panel. Corrective action taken to prevent recurrence of this event was to revise the labeling for the smoke detector battery chargers and feeder circuits.

Reference 2 describes an event which occurred at the Oyster Creek Nuclear Generating Station on December 3, 1981. While performing maintenance

activities to repair a faulty pressure switch associated with the 'A' electromatic relief valve (EMRV), direct current power fuses 16F301A, 16F302A, 16F303A and 16F304A were removed. The effect of the removal of these fuses was the disabling of the 'A' EMRV, the loss of the pressure relief function associated with the faulty pressure switch and the defeating of one of the redundant automatic depressurization trip systems. However, it was not discovered until February 10, 1982 that one of the automatic depressurization trip systems had been rendered inoperable by removal of the direct current power fuses. Corrective action taken to prevent recurrence was to incorporate this event into the required reading program for shift operations supervision and instrument department personnel. Also, the subject fuses in the circuits for the A and B electromatic relief valves which defeat the redundancy of the automatic depressurization system were physically labeled with a caution notice which provided consequences for their removal.

Reference 3 provides a description of an event which occurred at the Sequoyah Nuclear Station on September 16, 1982. As described in this reference, during modifications on Train B of the Solid State Protection System (SSPS), the power fuses were removed to allow work on the associated output relays. The removal of these fuses caused one of the two suction valves associated with the residual heat removal (RHR) system to close thus rendering this system inoperable. Immediate operator action was initiated upon the closing of the RHR suction valve. This action included shutting off the RHR pump and switching the power source for the valve to an auxiliary power supply. Following these actions, the valve was opened and with flow re-established, the pump was restarted and the system returned to normal operation.

A review of the electrical schematics for the SSPS revealed that the 120 volt alternating current power supply for the output relays in the SSPS also supplied power to a relay circuit associated with the valve that closed. When energized, this relay circuit is activated by a pressure switch which senses reactor coolant system pressure and permits the valve to be opened if system pressure is less than a predetermined setpoint. When power was lost to this relay circuit as a result of the removal of the fuses, the associated valve automatically closed. Corrective action taken was to change the workplan covering the SSPS modifications to inform operators that removal of power fuses isolates the associated train of the RHR suction. Also, for future reference, work caution signs were placed near the location of the fuses in the SSPS cabinets.

Reference 4 describes an event which occurred at Diablo Canyon on May 18, 1983. As described in this reference, when control and instrument fuses were removed to allow construction personnel to work inside the cabinet for Radiation Monitors 28A and 28B, the air sample pumps which are common to Radiation Monitors 14A, 14B, 28A and 28B lost power. An investigation for this occurrence showed that the air sample pumps which are common to these Radiation Monitors are supplied via control and instrument fuses for Radiation Monitors 28A and 28B. Thus, when these fuses were removed to allow construction work, the power source for the common air supply pumps was also removed. Subsequently, power was restored and the system returned to its normal condition. To prevent recurrence, operations personnel involved in processing clearances have been instructed to ensure that all effects on plant equipment are known and recognized prior to approving clearances for work activity.

Reference 5 provides a description of an event which occurred at Susquehanna on April 15, 1984. In accordance with an approved personnel protection procedure, operation personnel removed two fuses associated with the primary containment isolation logic for Unit Number 2 because of work being done to incorporate an approved modification for the logic circuitry. Due to a bypass jumper which had been incorrectly installed ty construction personnel, removal of the fuses caused a false high drywell pressure signal. This resulted in actuation of the common Control Room Emergency Outside Air Supply and Standby Gas Treatment Systems. The fuses were reinstalled and equipment returned to its normal status. Subsequently, the jumper was installed properly and the modification completed. To prevent a recurrence of this event, the subject work activity and associated error were reviewed in detail with the work crew involved. During this review, the need to accurately identify and verify termination points when performing work in electrical panels was discussed in detail.

The six events described above illustrate how the practice of removing fuses may result in actuations and/or unknowingly disabling of safety related electrical equipment during any mode of plant operation. At the time the fuses were removed, the involved plant personnel were unaware of the resulting actuations and/or inoperabilities. Similar situations could occur when electrical circuits are de-energized for personnel protection by operating circuit breakers. Since the practice of removing fuses or opening circuit breakers for personnel protection during maintenance and/or plant modifications is a standard one used by utilities, it is reasonable to conclude that the six identified events are not a complete list of such events which occurred during the years 1981, 1982, 1983 and 1984. Nonetheless, these six events illustrate a potentially significant safety problem in that this practice may result in unknowingly disabling or improper actuation of safety related electrical equipment. In view of these potential undesirable consequences, it appears appropriate to suggest eliminating the use of this practice during maintenance and/or plant modification activities involving electrical equipment : even if the frequency of such activities is low. However, where such practices are considered unavoidable, in order to provide plant personnel with appropriate protection, all effects on plant equipment should be clearly identified and independently verified prior to the fuses or circuit breakers being removed or opened.

FINDINGS

As a result of the information contained in the discussion section of this report and the analysis for the referenced reports, the following findings are provided:

- 1. The events described above illustrate how the practice of removing fuses or opening circuit breakers during maintenance and/or plant modification activities can potentially cause a significant safety problem in that this practice could result in the disabling of safety related electrical equipment without plant personnel being aware that such equipment is inoperable. Such a situation may result in a station being operated outside of its limiting conditions for operation as specified in the technical specifications for the station.
- 2. The described events illustrate the importance of adequate planning and training of plant personnel for maintenance and/or plant modification activities prior to actually performing these activities. For most of the described events, it is clear that the involved plant personnel who were actually performing the work activities used inadequate procedures which did not clearly identify all of the specific steps necessary to complete such activities acceptably.
- 3. Since the practice of removing fuses or opening circuit breakers for personnel protection during maintenance and/or plant modification activities is a standard one used by utilities, it is reasonable to suggest that the six events identified are not a complete list of such events which occurred for the years 1981, 1982, 1983 and 1984.

CONCLUSION

In view of the potential number and safety consequences for events involving the practice of removing fuses or opening circuit breakers, we believe that it is appropriate to suggest, where practical, elimination of this practice during maintenance and/or plant modification activities, even at plants where the frequency of such activities may be low. Where such practices are necessary to provide appropriate personnel protection for maintenance or modification activities, adequate review and analysis of the circuits involved should be performed. Independent verification of such review and analysis should be conducted to ensure that all effects on plant equipment are known. Training of involved plant personnel should be conducted to alert them to the possible undesirable results of fuse removal or breaker operation. These suggested actions should be performed prior to removal of fuses or opening of circuit breakers.

SUGGESTED ACTION

Based on the information contained in the above sections, it is suggested that the Office of Inspection and Enforcement consider issuing an IE Information Notice which addresses the identified events. In addition, where the practice of removing fuses or opening circuit breakers is considered unavoidable during maintenance and/or plant modification activities, we believe that such a notice should stress the importance of adequate review of the circuits involved and analyses, planning, and training of plant personnel such that all effects on plant equipment are known. Also, such a notice should clearly indicate that these items should be performed and independently verified prior to actual removal of fuses or operation of circuit breakers.

Peference Sheet

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- Virginia Electric and Power Company, LER 81-058 Docket No. 50-281, dated September 22, 1981.
- General Public Utilities, LER 82-006 Docket No. 50-219, dated February 26, 1982.
- Tennessee Valley Authority, LER 82-116 Docket No. 50-327, dated October 14, 1982.
- Pacific Gas and Electric Company, LER 83-013 Docket No. 50-275, dated June 17, 1982.
- Pennsylvania Power and Light Company, LER 84-019 Docket No. 50-387, dated May 15, 1984.