AEOD TECHNICAL REVIEW REPORT*

UNIT: Limerick 1
DOCKET NO: 50-352
LICENSEE: Philadelphia Electric Company
NSSS/AE: General Electric Company/ Bechtel Corporation

TR REPORT NO: AEOD/T601
DATE: January 27, 1986
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SUBJECT: PRESSURE SENSITIVE TEMPERATURE SWITCH RESULTS IN SPURIOUS ACTUATION OF FIRE SUPPRESSION SYSTEM

EVENT DATE: April 10, 1985

REFERENCES: LERs 85-044-00 and 85-044-01

SUMMARY

This study investigates a systems interaction event at the Limerick nuclear plant which resulted in a spurious actuation of the plant's fire suppression system. The event was initiated by a trip of an auxiliary equipment room fan caused by radio transmissions from a hand held transmitter/receiver. When the standby fan started, as designed, the Halon fire protection system actuated injecting Halon into the auxiliary equipment room. The cause of the Halon system actuation was traced to a rate-of-temperature-rise thermal fire detector which was also sensitive to ambient pressure changes. The event had no significant safety consequence or generic implications because: (1) no other unwanted actions of this thermal fire detector have been reported; (2) selection of this detector was inappropriate for this location; and (3) use of the detector involved was found to be unique to the Limerick plant.

DISCUSSION

On April 10, 1985, with Unit 1 of the Limerick Generating Station operating at 3.4 percent power in the startup mode, the auxiliary equipment room 'A' ventilation system supply fan tripped during radio transmissions from a portable hand held transmitter/receiver located in the room. After a brief time delay, the 'B' (standby) auxiliary equipment room supply fan started automatically as designed. When the 'B' fan started, the Halon fire protection system actuated and injected Halon into the auxiliary equipment room. At the time, actuation of the Halon system caused personnel to suspect a fire in the auxiliary equipment room. Accordingly, the 'B' supply fan was manually shutdown by plant personnel to prevent feeding the suspected fire with additional air. A high toxic chemical concentration alarm was subsequently received and the main control room ventilation system was manually isolated by the control room operators according to procedure. It was subsequently determined that a fire had not occurred in the auxiliary equipment room.

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In order to substantiate the suspected causes for the various events, the licensee conducted special tests and investigations in an attempt to determine the precise initiators of the event sequence. From the tests and investigations, it was found that:

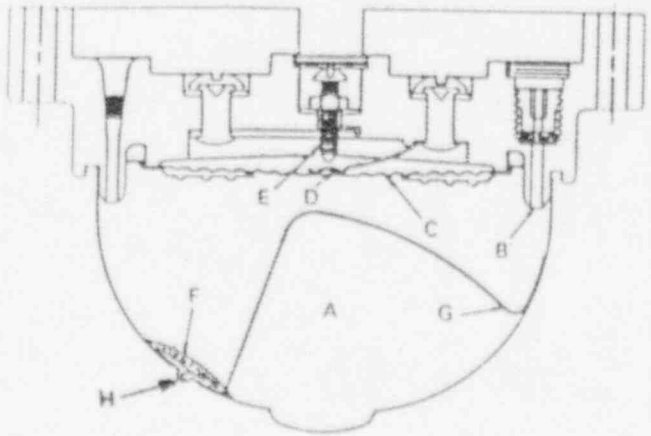
1. The operating auxiliary equipment room supply fan would trip when radio transmissions were made by a hand held transmitter/receiver if it was in the immediate proximity of the fan controller (within the cabinet). No trips occurred when radio transmission signals were generated outside the electrical cabinet.

2. When the supply fan tripped, it was found that barometric pressure in the auxiliary equipment room decreased due to the suction effect of the operating auxiliary equipment room return fan. When the standby supply fan automatically started, pressure in the room increased rapidly again.

3. The pressure increase actuated a Chemetron rate-of-temperature-rise switch installed in the fire suppression system actuation system. Actuation of the temperature switch initiated the Halon fire suppression system.

4. The control building ventilation system at Limerick is such that air leaving the auxiliary equipment room is directed to the control room ventilation duct intake plenum. Accordingly, when the Halon system actuated, Halon gas was exhausted from the auxiliary equipment room by the operating return fan and forced into the control room intake plenum. The toxic gas analyzers, which sample the air in the control room intake plenum, identified the Halon as a toxic gas and activated the toxic chemical high concentration alarm in the control room.

The design and operation of the Chemetron rate-of-temperature-rise switch was investigated by the licensee to determine the cause for the spurious switch actuation when the supply fan tripped. It was found that the switch uses two independent methods for detecting a fire: (1) the rate-of-temperature-rise element; and (2) a fixed temperature element. The rate-of-rise element is an anticipatory feature that detects fires that grow rapidly in intensity by quickly responding to abnormally fast temperature increases. The fixed temperature element detects smoldering fires which grow at a slow rate by actuating at a specific temperature setting. The Chemetron Model EPB 501 dual action thermal fire detector involved in the Limerick event is shown in Figure 1. The rate-of-rise element shown in the figure consists of an air chamber, flexible metal diaphragm and a restricted orifice vent that is accurately calibrated to control the air flow rate in and out of the chamber. The air chamber (A) expands and contracts with ambient room temperature variations. During normal temperature fluctuations, the unit "breathes" through the calibrated vent (B). For rapidly increasing temperature, the air in the chamber expands faster than it can be vented and builds up enough pressure to move the thin metal diaphragm (C) until the flexible silver contact (D) closes an electrical circuit with the stationary contact (E). If the source of heat is subsequently removed, pressure in the chamber is relieved through the vent and the contact resets to the untripped condition. The fixed temperature element is independent of the rate-of-rise heat detection feature. The fixed temperature element has a phosphor-bronze spring (G) that is held under tension by a spot of fusible



SYMBOL IDENTIFICATION

A - AIR CHAMBER
B - CALIBRATED VENT
C - MOVEABLE METAL DIAPHRAGM
D - MOVEABLE ELECTRICAL CONTACT
E - STATIONARY CONTACT
F - FUSIBLE EUTECTIC ALLOY
G - SPRING
H - INSPECTION HOLE

FIGURE 1. CROSS SECTION OF CHEMETRON FIRE SYSTEMS, INC. RATE-OF-RISE TEMPERATURE SWITCH

alloy (F). When heated to its rated temperature (either 136°F or 190°F), the alloy melts releasing the spring and closing the electrical contacts. If the fixed temperature element operates, the spring is released and opens an easily visible hole (H) on the shell to signal for detector replacement.

The rate-of-temperature-rise function in the thermal fire detector which causes an air chamber to expand and contract with temperature also makes the device sensitive to ambient pressure changes. The sensitivity is controlled by the rate of air flow into and out of the chamber which is controlled by a calibrated vent. Thus, the switch was sufficiently sensitive to ambient pressure increases to cause it to actuate when the standby supply fan was started.

The corrective actions taken by the licensee to prevent recurrence of the event included:

1. Disabling the automatic injection feature of the Halon fire protection system in the auxiliary equipment room. The detectors were rewired to only operate the control room alarms.

2. Replacing the Chemetron fire detector with a Fenwall brand fixed temperature fusible link thermal detector. The Fenwall detector does not have the rate-of-rise anticipatory feature.

3. Restricting the use of portable transmitter/receivers within certain plant areas.

A representative for Chemetron noted that most of the company literature include cautions which state that a rate-of-rise fire detector should not be used in an environment where temperature or pressure changes normally are expected to occur. The representative indicated, however, that the licensee may have purchased the fire detector from a general sales catalog that may not have included this precaution. The rate-of-rise feature is designed to actuate with temperature increases of greater than 18°F/minute.

A search of the LER data base was conducted to find other similar events involving Chemetron temperature switches applications. The search did not find any other events involving Chemetron Fire Systems equipment applications or malfunctions. A Nuclear Plant Reliability Data System (NPRDS) search also did not identify any component applications or failures for this manufacturer.

FINDINGS

1. The Limerick Halon system actuation event was caused by a pressure sensitive temperature detector which spuriously actuated when the standby ventilation supply fan started.

2. A survey of operating information found that Limerick-1 is the only plant to report the failure of a Chemetron thermal fire detector.

3. The selection of a rate-of-temperature-rise detector in the auxiliary equipment room, or a confined area with fan cooling, was a misapplication of the intent and design of the instrument.

4. The safety significance of the event was minimal because Halon gas rather than water was released into the electrical equipment area.

5. Electromagnetic field energy or radio interference from portable radios can cause unplanned actuations when operated near electrical switchgear.

CONCLUSIONS

The Limerick Halon system actuation event was initiated by a spurious electromagnetic transmission from a portable transmitter/receiver which led to the unwanted actuation of the fire protection system. The fire system actuated because a rate-of-temperature-rise thermal fire detector was inappropriately selected for the intended service location. The event had little safety consequences or generic implication because of the plant-unique application involved. The licensee's corrective actions to preclude operation of portable transmitters/receivers in areas near sensitive equipment and the replacement of the thermal fire detector with a model not sensitive to ambient pressure changes is considered adequate.