



For BWR plants, each main steam line contains two MSIVs; one inboard valve located inside the containment and one outboard located outside the containment. A MSIV is designed to fail closed on loss of pneumatic pressure to the valve operator. The valves are piloted by two solenoid operated pilot valves, which are normally designed to be powered from independent sources. For a typical BWR-6 plant, the dual solenoids are powered from different divisions of the essential AC power system. For the older BWR plants, one solenoid is powered from DC and the other powered from AC. During normal operation, both solenoids are energized. The valve pilot system is designed such that when one or both solenoids are energized, the MSIV will remain open.

However, independent power supplies to the solenoids were not provided in the case of the Perry MSIVs. When a single power source was interrupted, both solenoids were de-energized and caused the MSIVs to close. Based on the AIT report (Ref. 2), this was the result of a power source wiring error which was caused by the architect engineer (Gilbert Associated Incorporated), who failed to implement the design recommended by General Electric. The GE design required independent power sources to each solenoid: RPS A power to solenoid A and RPS B power to solenoid B. This is the design stated in the Perry FSAR. However, the actual layout was RPS A power to both solenoids A and B for the outboard MSIVs and RPS B power to both solenoids A and B for the inboard MSIVs. Because of confusing layout and labelling of the circuitry, the test engineers failed to discover the discrepancy between the design as described in the FSAR and the actual layout.

Following the event of June 17, 1987, the licensee for Perry committed (Ref. 3) to modify the power supplies to the solenoids in accordance with the GE recommendations. Based on the discussions with the NRR staff, the modifications were conducted during the July 12, 1987 outage and accepted by the staff. No further actions are required regarding this issue.

However, as indicated earlier, this technical review was initiated to evaluate generic implications of this event and potential safety concerns related to other safety systems. Results of the evaluation are discussed below:

There are four BWR-6 plants in operation in the U.S., i.e., Grand Gulf, Clinton, Perry and River Bend. The individual project managers of these plants were polled regarding this problem; none of them was aware of any evidence to suggest a wiring error of power supplies at other plants which is similar to Perry. Searches of SCSS data also indicate that no similar event of MSIV failure such as that experienced at Perry has been reported. Therefore, there is no evidence to suggest that the wiring error of power sources to the MSIV solenoids goes beyond the Perry plant.

The event raised a safety concern relating to re-opening of the outboard MSIVs when the pilot solenoids were re-energized. This scenario may have a potential to cause a failure of isolation. However, this failure mode is considered unlikely for the following reasons.

During a demand of containment isolation, the MSIVs are automatically closed by the Nuclear Steam Supply Shutoff System (NSSSS) logic. Once isolation is initiated, the MSIVs will remain closed, even if the condition that caused the isolation is restored to normal. The operator must manually operate switches

in the control room and manually reset the logic to re-open the MSIVs. Therefore, automatic re-opening of the MSIVs should not occur if the MSIVs were closed because of isolation demand. Consequently, the Perry event results in no safety significance regarding that particular concern.

Since the RPS buses supply power to the RPS trip systems, the NSSSS, the Process Radiation Monitoring System, and the Neutron Monitoring System, power failure and subsequent restoration of a bus may also affect the functions of these safety systems.

The RPS consists of two independent trip systems. Each trip system is composed of two channels. The RPS is arranged in a one-out-of-two-twice logic scheme. Loss of power to one bus would de-energize one trip system and cause a half scram. Restoration of power supply to the bus has no adverse effect.

The NSSSS provides signals to isolate the reactor vessel and various plant systems which carry radioactive fluids or gases. For the BWR-6, the NSSSS is divided into five isolation groups including the MSIVs trip channels. For isolation groups other than the MSIVs, the isolation logic is different in that a single failure can result in an isolation. Loss of a RPS bus or plant parameter signals may cause isolation valves in these other groups to close. However, the consequences of these isolations are not as significant as MSIV closure and the isolation can usually be reset without tripping the plant. If the isolation logic has been activated and an isolation signal has been generated, the operator must reset the isolation logic to prevent automatically reopening valves. Therefore, there is no potential failure of containment isolation resulting from power failure of a bus.

The Process Radiation Monitoring System and the Neutron Monitoring System are powered by redundant power sources from the Essential AC Power System. Trip of one bus has no effect on the systems.

Searches of the SCSS data result in 55 LERs relating to the loss of one RPS bus for BWR plants. Review of these LERs indicates that no unexpected effect on the safety systems had occurred after the power sources were restored.

#### FINDINGS

The findings of this technical review is summarized as follows:

1. The event occurred on June 17, 1987 at Perry was caused by a wiring error of the power supply to the MSIVs pilot valves. This problem appears to be plant specific.
2. Searches of the SCSS data show no similar occurrence.
3. Searches of the SCSS data also indicate that there were no events which resulted in adverse effects when RPS bus was re-energized.

## CONCLUSIONS

Based on the above discussions, it is concluded that the closure and re-opening of the MSIVs were caused by a wiring error. Searches of SCSS database result in no similar event. Therefore, this event is considered as plant unique. The licensee has modified the circuitry during a July 12, 1987 outage. This corrective action is adequate. With respect to other safety systems, which are powered by the same source as the MSIVs, searches of the SCSS database reveal no reported abnormal operation. When the RPS bus was re-energized, all affected systems were reportedly restored to operation as designed. The NSSSS signals were reset and the isolations were recovered.

## REFERENCES

1. Licensee Event Report Number 87-042, dated July 17, 1987.
2. Augmented Investigation Team Report Number 50-440/87014, dated July 21, 1987.
3. Letter, Murray R. Edelman (The Cleveland Electric Illuminating Company) to A. Bert Davis (NRC Regional III Administrator) dated June 20, 1987.