AEOD ENGINEERING EVALUATION REPORT*

UNIT: Calvert Cliffs Units 1 & 2
DOCKET NO.: 50-317 & 318
LICENSEE: Baltimore Gas & Electric Co.
NSSS/AE: Combustion Engineering, Inc./Bechtel Corp.

EE REPORT NO. AEOD/E304
DATE: March 11, 1983
EVALUATOR/CONTACT: Theodore C. Cintula

SUBJECT: INVESTIGATION OF BACKFLOW PROTECTION IN COMMON EQUIPMENT AND FLOOR DRAIN SYSTEMS TO PREVENT FLOODING OF VITAL EQUIPMENT IN SAFETY-RELATED COMPARTMENTS

EVENT DATE: November 5, 1981

SUMMARY

On November 5, 1981, Bechtel Corporation, the architect-engineer, notified the licensee for Calvert Cliffs Unit 1 and 2 that the watertight integrity of the service water pump rooms at both units could be impaired because check valves had not been installed in the floor drain system which drains by gravity to the turbine condenser pit in the turbine building. Without these check valves, the operability of the service water pumps for both units could not be assured in the event of a circulating water conduit break in the turbine building (a nonsafety area). As a temporary corrective measure, the licensee sealed some of the floor drains with inflatable plugs and modified the remaining drain lines by installing check valves to prevent potential backflow.

As part of the evaluation, we investigated the NRC requirements on the protection of safety-related equipment from possible backflow in the floor drainage system. We concluded that this topic is not being addressed as a safety issue for older operating plants.

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

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DISCUSSION

On November 11, 1981, the DAILY REPORT-REGION I carried a "prompt report" from Calvert Cliffs Units 1 and 2 indicating the licensee had been notified that the watertight integrity of the service water pump rooms in both units could be impaired because check valves had not been installed in the floor drain system which drains by gravity to the turbine condenser pit in the turbine building. Without these check valves, the operability of the service water pumps for both units could not be assured in the event of a circulating water conduit break in the turbine building of that unit.

This event was subsequently reported as LERs 81-79 and 81-47 for Units 1 and 2 respectively. The LERs state that Bechtel Corporation, the architect-engineer, notified the licensee that they consider the system design basis used to establish the watertight integrity of the service water pump room to be invalid since the service water pump room floor drains are connected without isolation to the turbine condenser pit.

Although the elevation of the service water pump room floor is twelve feet above the turbine condenser pit floor, the water level in the turbine building following the breaking of a circulating water conduit would have resulted in backflow through the floor drains and simultaneous flooding of the service water pump rooms in both Units 1 & 2 to a depth of 15 feet. Although the increase in water level would have been detected and annunciated by nonsafety grade instrumentation in the turbine pit and safety grade instrumentation in the service water pump room, there would not have been any way to stop the inflow of water into the service water pump room following a design basis flood. As a temporary corrective measure to resume power operation, the utility sealed some of the floor drains with inflatable plugs (which are still in place) and the remaining drain lines were modified by installing check valves to prevent potential backflow into the safety-related rooms. A review of other drain lines within the plants did not reveal a similar situation.

The LERs for Calvert Cliffs were submitted in accordance with technical specification 3.7.10., titled "WATERTIGHT DOORS". The licensee considered the violation of watertight integrity for the service water pump room due to improper drain line design to be comparable to the inoperability of the watertight doors to this room.

FINDINGS

The service water system at Calvert Cliffs Units 1 and 2 each have three pumps and serve both safety (the containment cooling units and the emergency diesel generator heat exchangers) and nonsafety equipment. The three service water pumps for each unit are located in a single room and Unit 1 and 2 service water systems can be cross-connected by spool pieces to allow the Unit 1 system to backup Unit 2 and vice-versa. However, Unit 1 and 2 share a common turbine building, so both of the service water pump rooms would be simultaneously affected by a circulating conduit break in the turbine building if backflow protection was not provided.

A loss of service water flow would affect the four containment air coolers for each unit, and assuming both service water pump rooms are flooded, all of the three emergency diesel generators at the site (the emergency diesel generator heat exchangers are cooled by the service water system). If containment

cooling is lost, heat removal from the containment following a LOCA can be accomplished with the containment spray system which uses the refueling water tank as a coolant source. However, if the failure of the circulating water conduit occurred as a result of a seismic event which simultaneously resulted in a loss of offsite power, then both units would have experienced a total loss of AC (plant blackout) since cooling for the emergency diesels would be lost. The impact of such a failure on safe shutdown was not discussed in the LERs by the licensee.

The design flood level of the turbine building is +18 feet. The finished grade of the plant site is +45 feet, high enough so outside flooding interactions with the turbine building were not considered in the Final Safety Analysis Reports (FSAR). The service water pump room floor is at an elevation of +3 feet (with the service water pump platform at +6 feet). Therefore, the design flood could have resulted in 15 feet of water in the service water pump rooms. There are redundant high level switches in each service water pump room; these switches are waterproof, testable, seismic class 1, and actuate an alarm in the control room.

Since the technical specifications at Calvert Cliffs did not address the equipment and floor drainage systems, an LER search was undertaken to see if, and how, licensees had reported similar defects within these systems. A fairly generalized cut set was used for the search and it obtained over 1000 reports. There were no reports similar to Calvert Cliffs, that is, no LERs on missing or faulty drainage system backflow protection devices or of backflow through drainage systems that resulted in a loss of safety-related equipment.

An examination of the FSARs of other Combustion Engineering (CE) plants indicated that potentially radioactive drainage is required to be isolated from nonradioactive drainage systems; however, the potential interactions within nonradioactive drainage systems were not specifically addressed. The exception was the FSAR for San Onofre 2 and 3, which are newer vintage plants; it states in Section 9.3.3.1 that drainage from engineered safety feature equipment rooms is configured to prevent flooding of engineered safety features equipment by drainage piping backflow. In their piping and instrumentation diagram, a check valve and butterfly valve, installed in series, are shown in the drain line between the auxiliary building (the location of the service water pump room) sump and the Unit 2/3 turbine building sump.

In view of the inconsistency in the FSARs for the older and the newer vintage designs, we decided to survey some other sources to see whether the topic of backflow protection in the floor drainage system for safety-related equipment was considered in the design of older plants.

The guidance provided in the Standard Review Plan (SRP), Section 9.3.3. "Equipment and Floor Drainage Systems" (EFDS), is quite clear in expressing the need for protection for safety-related equipment from possible backflow of the floor drainage system. One of several examples states:

> System capability to prevent drain or flood water from backing up in the drainage system into areas housing safety-related equipment has been incorporated. Statements in the SAR that this capability is provided are acceptable.

The SRP, however, applies only to the newer vintage of plant designs.

The Systematic Evaluation Program (SEP) lists the safety-related topics under review for eleven of the older light water reactors that do not have technical specifications commensurate with the Standard Technical Specifications. The basic purpose of the SEP, begun in 1978, is to reconfirm the safety of older nuclear power plants. The review compares the as-built plant with current licensing criteria and determines whether there is need for change between current technical positions on safety issues and those that existed when a particular plant was licensed. Although the SEP addresses compartment flooding, it does not include a topic pertaining to backflow protection of drain lines in safety-related rooms; therefore, in this regard, these systems are not being studied (and possibly upgraded) in accordance with SRP section 9.3.3.

In reviewing other sources of information to see if the potential interaction of compartment drain lines was previously considered in plant designs, we found that flooding of critical equipment was considered in 1972 because of an operational event at Quad Cities. At that time, Unit 1 experienced a rupture of an expansion bellow in the circulating water system (a low energy nonsafety system) and the resultant flooding caused some degradation to engineered safety feature equipment. As a result of this event, a generic review titled "Flood of Equipment Important to Safety" was initiated. This issue was tracked as topic 3-18 in the REGULATORY LICENSING - STATUS SUMMARY REPORT (the "Pink" Book) and was applicable to all operating plants as of 03/01/74. Calvert Cliffs 1 and 2, holders of construction permits at this time, were not included with the 39 operating units as a recipient of the generic letter. Calvert Cliffs, and other plants being evaluated for construction permits or operating licenses, were to have this problem evaluated as part of their safety evaluation for the license.

Topic 3-18 was phased out before all plants could be evaluated and licensees who did not respond with sufficient information to prepare an adequate Safety Evaluation Report (SER) for topic 3-18 were assigned to NRR Generic Technical Issue B-11, SUBCOMPARTMENT STANDARD PROBLEMS. The SERs issued under B-11 to complete the topic 3-18 program were titled SUSCEPTIBILITY OF SAFETY-RELATED SYSTEMS TO FLOODING FROM FAILURE OF NON-CATEGORY 1 SYSTEMS. These reports which were issued for San Onofre 1, Yankee Rowe, Indian Pt. 2 and Surry 1 and 2, and were to consider all sources of potential flooding that might adversely affect the performance of safety-related equipment required for safe shutdown. However, examination of several of these later SERs did not indicate any directed attention to drain line problems or of backflow protection. No SER was issued for Calvert Cliffs since it was not part of the topic 3-18.

The successor to the "Pink" Book is the "Aqua" Book; it is titled UNRESOLVED SAFETY ISSUES. Its most relevant subject to drain line backflow protection is topic A-17 SYSTEMS INTERACTIONS IN NUCLEAR POWER PLANTS. According to the task manager for topic A-17, backflow protection of drain lines will not be covered as part of this program or as part of the other generic issues of this publication. Additional work in topic A-17 is now being performed under TMI Action Plan, Item II-4 SYSTEMS INTERACTION. The systems interaction program is directed toward identifying hidden deficiencies in properly designed systems that may create a safety hazard, rather than identifying improperly designed systems. Thus, the design adequacy of equipment and floor drainage systems would remain the responsibility of the chartered technical branches; presumably, this is a reference to SRP, Section 9.3.3, which, by our observation, has not been implemented for the older plants.

In May, 1978, IE issued Circular No. 78-06, titled POTENTIAL COMMON MODE FLOODING OF ECCS EQUIPMENT ROOMS AT BWR FACILITIES. This circular resulted from a design review at Hatch 1, where the equipment drain system did not have isolation valves within the piping between the corner rooms. With this design, in the event of a postulated pipe break of sufficient size to flood the sump pumps in any one room, the other ECCS corner rooms would also be subject to flooding via the equipment drain system. One of the recommendations of this circular was:

> The specific design and installation for floor and equipment drains should be reviewed to verify that a flood in any one room or location would not result in flooding equipment in other ECCS equipment rooms or in areas at a lower elevation.

The circular was issued to all holders of reactor operating licenses and construction permits. No written response to this circular was necessary, so, it is not clear what action, if any, was taken by Calvert Cliffs at this time.

CONCLUSIONS

From our study, we are led to the conclusion that the subject of potential damage to redundant safety equipment as a result of backflow through the equipment and floor drain system has not been addressed for the older operating plants, i.e., units not designed to standards of SRP section 9.3.3. Both completed and existing safety improvement programs, as shown by an LER search, reviews of the SEP, SERs, and various generic topics, do not seem to address updating this subject to current licensing criteria. IE Circular No. 78-06, was too specialized to be relevant to the problem discovered at Calvert Cliffs. It covered ECCS equipment rooms in lieu of the more generalized topic of safety-related compartments and flooding of areas at a lower elevation instead of backflow protection.
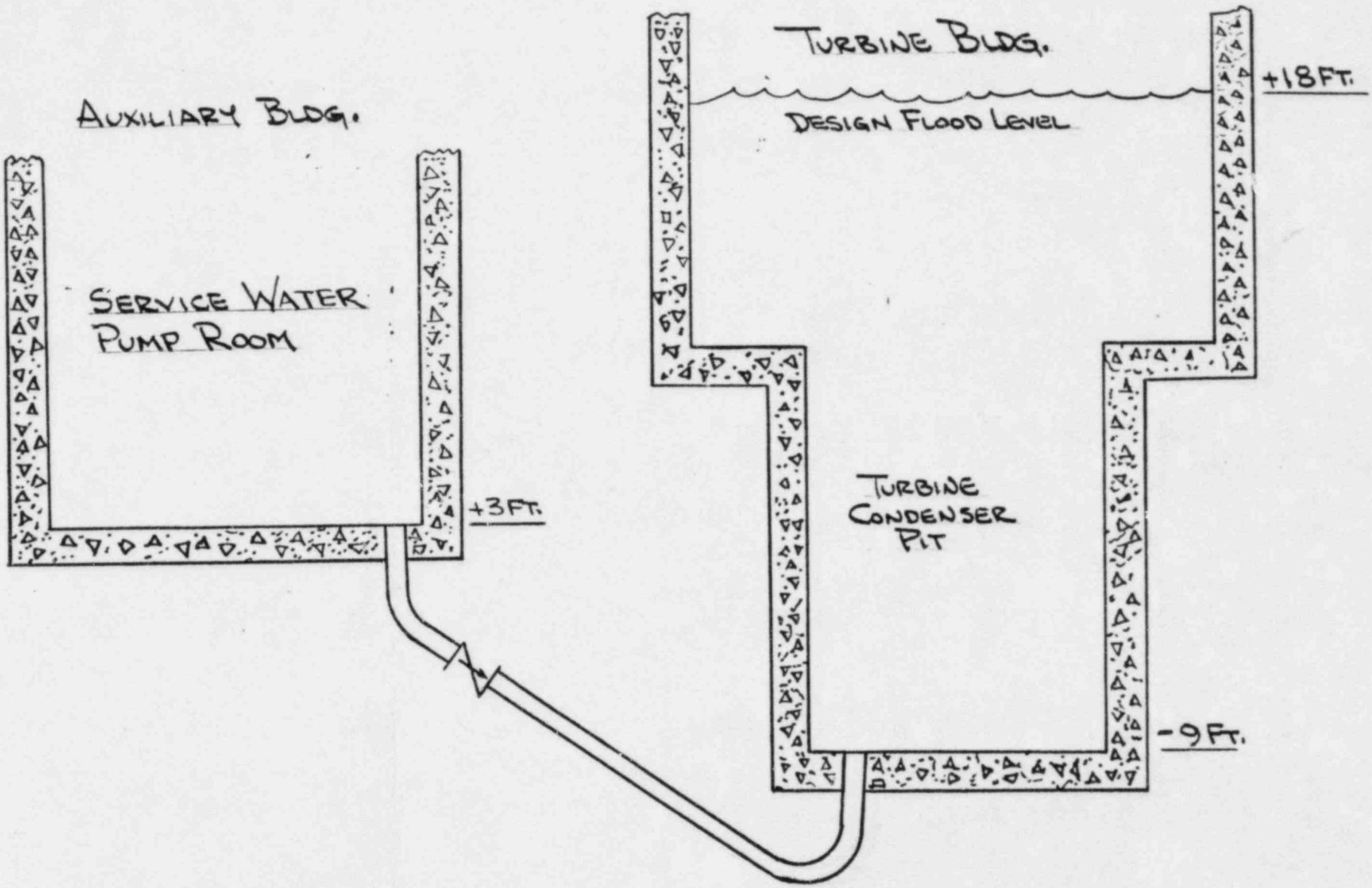
FIGURE 1. ELEVATIONS IN TURBINE BLDG. AND SERVICE WATER PUMP ROOM