ENCLOSURE 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

DRAFT

DEC 06 1976

MEMORANDUM FOR: R. E. Heineman, Director, Division of Systems Safety, NRR

FROM: V. Stello, Jr., Director, Division of Operating Reactors, NRR

SUBJECT: OPERATING EXPERIENCE MEMORANDUM NO.
FLOODING OF BASEMENT FLOOR IN TURBINE BUILDINGS

PROBLEM

Partial flooding of the Oconee Nuclear Station's turbine building basement resulted in a water level of two feet in the center of the basement floor and approximately 16 inches at the basement walls.

PRESUMED CAUSE

Oconee, Unit 3 was shutdown for refueling and maintenance. The Unit 3 turbine condenser was isolated, for inspection, by closure of the six 78-inch manually operated inlet valves and the six 78-inch air piston operated butterfly outlet valves. Three-inch jackscrews (strongback) were installed on each of the six butterfly valves to prevent inadvertent opening or drift. Three manways had been removed from the condenser so that an inspection of the condenser tubes could be performed. A loss of AC power to the air controllers for the six butterfly valves resulted in the introduction of service air to the actuator cylinders tending to open these valves. One of the six strongbacks failed to prevent the opening of one of the six condenser outlet valves, resulting in the backflow of water from Lake Keowee to

the condenser through the failed 78-inch outlet butterfly valve. Flooding of the turbine building, through the open condenser manways, continued for a period of 32 minutes until the plant personnel were able to restore AC power and close the failed valve. Approximately 200,000 cubic feet of water had entered the turbine building during the 32 minute interval. This corresponds to a depth of 16 to 21 inches of water in the turbine building, depending on the location. An electrically driven oil pump for one of the three emergency feedwater pumps and a hotwell pump became inoperable as a result of the flooding.

It is important to note that the turbine building basement floor is at elevation 775 feet (MSL) and the full pond water level in Lake Keowee is 800 feet (MSL). This configuration is considered unique to the Oconee Station since in most plant layouts the turbine building basement would be at an elevation higher than the source of circulating water thus precluding this flooding mode.

This occurrence was caused by a number of errors. First, a procedural inadequacy was responsible in that the procedures did not require the closing of the air supply valve to the butterfly valves air actuators which would have prevented valve motion. Secondly, the design of the butterfly valves is such that they will fail open upon loss of power to the four-way solenoid control valve. Thirdly, the jackscrews were not designed to withstand the forces developed by the valve air actuators.

DRAFT

DEC 0 6 1976

SAFETY SIGNIFICANCE

The turbine building, which is 790 feet long, is common to all three units of the Oconee Station. The auxiliary building, which is also common to all three units, is connected to the turbine building via six doors at the lowest elevation. A 21-inch high curb around these doors was provided to afford some protection against flooding of the auxiliary building. The LPI, HPCI, and auxiliary service water pumps are located in the auxiliary building. As mentioned previously, loss of one electrically driven oil pump for one of the three emergency feedwater pumps and one hotwell pump had occurred as a result of the flooding. If failure of two or more hotwell pumps, on any unit were to occur, it would result in the tripping of the booster and main feedwater pumps i.e., loss of all feedwater to the affected unit, with the exception of the emergency feedwater pumps which are located at a low elevation on the turbine building basement floor and one auxiliary service water pump also located in the auxiliary building. Since the emergency feedwater pumps are steam driven, it is difficult to determine at what flooding level would have become inoperative.

Since all the hotwell, booster, and main feedwater pumps are located on the turbine building basement floor, it appears that the simultaneous loss of feedwater to all three units could have occurred if the flooding of the turbine building had not been terminated. If the water level reached 21 inches at the walls, water then would have

flowed into the auxiliary building which would have eventually rendered the high pressure coolant injection and the auxiliary service water pumps inoperative. These are the only sources of water to the reactor vessel and the steam generator, respectively. Loss of the above cited pumps would have removed the only provisions for heat removal from the reactor coolant system. Portions of the condenser circulating water system piping are not seismically qualified. Consequently, even if all condenser isolation valves were to function as required during a seismic event, a single passive failure of any one of the six 78-inch pipes immediately downstream of the condenser outlet valves could cause unacceptable flooding for all three Oconee units.

While this issue was reviewed in the past, it appears that the review was limited primarily to evaluating the consequences of failure of the expansion joints in the condenser cooling water system near the condenser waterbox inlet and outlet nozzles without the consideration of a coincident failure of one of the non-seismic category I condenser circulating water isolation valves.

REPAIR

The pumps which were rendered inoperative were disassembled, cleaned and tested satisfactorily. No other equipment or component damage was experienced. In order to preclude recurrence of this incident Duke Power states that the following actions will be taken:

DRAFT
DEC 06 1976

1. The present pilot solenoids on the condenser discharge valves will be replaced with dual-coil, mechanically latched types. This will increase reliability because:
   a) Latched solenoids do not change state on loss of control power. They require electrical power only when actually changing states.
   b) Condenser discharge valves controlled by latching solenoids will therefore fail "as-is". Power failure will not initiate spurious operation of the discharge valves.
   c) Latched solenoids avoid continuous coil energization which should increase operating life.
   d) Administrative "blocks" of condenser discharge valve operation can be implemented by the tagging out of control power.
2. The power source for condenser circulating water (CCW) controls will be changed to an ICS power panelboard. This will increase reliability because:
   a) Normal power is still derived from a battery backed static inverter.
   b) Automatic transfer to a backup power source (regulated power) is made on failure of the normal source. The transfer is made without interruption of power to the load and without operator action.
3. Position indicating lights will be added in the control room for the condenser discharge valves. This will help the operator monitor system operating status because:

DRAFT

DEC 0 6 1976

a) The lights will provide additional system status information to the existing board displays.

b) Position status of all discharge valves can be determined at once without referring to a printout.

c) The lights will serve as a backup to the computer documentation of valve status.

4. The local control stations for the condenser discharge valves will be relocated further from the condenser and on the protected side of a column.

5. The physical layout of electrical cabling and pneumatic tubing in the vicinity of the condensers will be reviewed to ensure adequate protection from damage by water force.

6. A review will be conducted to determine the feasibility of raising the instrumentation lube oil pump and cooling water pump for the emergency feedwater pump.

7. The procedures for opening the CCW system inside the Turbine Building are being reviewed and revised as necessary to require that:

a) Inlet and outlet CCW pipes are vented if all CCW pumps are shutdown.

b) Manually operated valves at condenser CCW inlet are closed, tagged and mechanically locked.

c) Air to pneumatic piston valves be manually blocked and the piston be vented.

DEC 0 6 1976

DRAFT

d) Screw jacks be in place at the CCW discharge valves to prevent valves from drifting open.

e) The emergency condenser discharge valve be locked closed to the gravity drain system.

8. A design review of the station for susceptability to similar type flooding incidents and possible means of providing additional assurance of the operability of equipment important to safety is in progress.

- DOR finds these precautionary measures acceptable on an interim basis contingent on prompt implementation of the above cited actions.

DOR ACTION

DOR has had a meeting with the Duke Power Company to discuss this occurrence and the proposed correction action. The licensee has formed a task force which is actively reviewing this occurrence and other potential flooding modes to determine what modifications are necessary to preclude unacceptable flooding levels, regardless of the source of flooding. The task force is expected to complete its review and to submit a design proposal, within the next four months, for DOR review. DOR will be reviewing all operating facilities to determine if similar occurrences could arise.

RECOMMENDATIONS

DOR recommends that all applications for construction permits and operating licensees be reviewed to preclude this problem.

Principal DOR Personnel

Reviewer: B. C. Buckley, F. Clemenson

Project Manager: D. Elliott

Victor Stello, Jr., Director
Division of Operating Reactors
Office of Nuclear Reactor Regulation

Contact:
B. Buckley, DOR
492-8077