DUKE POWER COMPANY
OCONEE UNIT 3

Report No.: RO-287/76-18

Report Date: October 25, 1976

Occurrence Date: October 9, 1976

Facility: Oconee Unit 3, Seneca, South Carolina

Identification of Occurrence: Partial flooding of the Turbine Building

Conditions Prior to Occurrence: Oconee Units 1 and 2 at 100% Full Power
Unit 3 in refueling shutdown

Description of Occurrence:

On October 9, 1976 at 0013 two status alarms were received in the Oconee 3 control room: Low voltage on static inverter 3DID and blown fuse on static inverter 3DID. At approximately 0015, personnel investigating the static inverter alarms were notified of flooding in the Turbine Building basement. Investigation of the inverter problems was deferred while the flooding was investigated. The flooding was determined to be through the open manways (condenser maintenance was in progress) on condenser waterbox 3A2 although the reason for the flooding could not be determined. Various Oconee 1,2, and 3 Turbine Building sump alarms were received from 0017 to 0035. At 0045, 32 minutes after the flooding began, the 3KVID 125 volt AC panelboard was normally reenergized from the regulated AC source and the flooding was secured. The flooding was to a depth of approximately 24 inches in the center of the Turbine Building and 16 inches along the Turbine Building/ Auxiliary Building wall. No water entered the Auxiliary Building due to the curbs by the entrances to the Auxiliary Building (minimum of 21 inches). Oconee Units 1 and 2 remained at power operation although some power reductions were necessary seven hours later for inspection of secondary equipment and replacement of contaminated lubricating oils.

Designation of Apparent Cause of Occurrence:

The following pertinent conditions existed on Oconee 3 prior to the initiation of this occurrence.

1. Oconee 3 was in refueling shutdown with maintenance and inspections being performed on the condenser and condenser waterboxes during this outage.

2. All six manually-operated butterfly valves at the condenser circulating water (CCW) inlet (3 CCW-14 through 3 CCE-19) were closed and tagged (See attached Figure 1).

3. All six pneumatic piston-operated butterfly valves at CCW outlet (3 CCE-20 through 3 CCW-25) were closed and 3 inch jackscrews were in place to hold valve closed. The solenoid valves were supplied with air to close the pneumatic pistons.

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4. All Unit 3 condenser waterboxes were dewatered.

5. Manways on each of six condenser inlet and outlet pipes were open (3 manways on each discharge pipe and 2 manways on each inlet pipe).

The sequence of events which caused the flooding was initiated by the loss of the 3DID static inverter which supplies 125 volt AC power to the vital instrumentation panelboard 3KVID. Panelboard 3KVID supplies power to the CCW vacuum priming system which controls the four-way solenoid valves which direct air to the opening or closing side of the pneumatic piston-operated CCW discharge valves. Deenergization of these solenoids applied air to the opening side of the pistons for valves 3CCW-20 through 3CCW-25. In the case of 3CCW-20, this opening force was of sufficient magnitude to bend the "hold closed" jackscrew thereby allowing the valve to open. This in turn allowed water to flow back from Lake Keowee, through the CCW discharge piping, into the outlet waterbox and out five manways into the Turbine Building basement. Valves 3CCW-21 through 3CCW-25 were maintained closed by the jackscrews.

The apparent causes of this occurrence are twofold. First, a procedural inadequacy was responsible in that the air supply to these pneumatically operated valves was not isolated and thereby preventing motion. Secondly, the design of the CCW pneumatic piston-operated discharge valves is such that they are designed to fail open upon the loss of power to the four way solenoid control valve.

Analysis of Occurrence:

This incident resulted in the partial flooding of the Turbine Building basement. This occurrence has been previously considered and an analysis of the worst case is presented in FSAR Supplement 13, dated January 29, 1973. This case considers the rupture of a 4.25 inch rubber expansion joint on one 78 inch diameter inlet pipe. This is the worst case since this is considered to be the largest breach of piping, is at the lowest elevation and is directly on the discharge of the CCW pumps. The result of this analysis indicates that the break could result in flooding at a rate of 235 CFS into the 202' x 790' Turbine Building with a corresponding rate of increase of water level of 0.088 ft/min. This results in covering the Turbine Building/Auxiliary Building 1.5 foot curbs in 17 minutes. This time was considered adequate for diagnosis of the occurrence and appropriate corrective action to isolate the flooding.

The case presented in the FSAR is more limiting than the October 9, 1976 flooding incident since the FSAR case flooding rate is 2.1 times as great as in this incident. Sufficient time (32 minutes) was permitted for diagnosis of the flooding and corrective action to stop the flooding before the Auxiliary Building curbs were exceeded. The as-built curbs have a minimum height of 21 inches which would have further lengthened the time necessary for the water to enter the Auxiliary Building another ten minutes.

No safety systems in the Turbine Building or Auxiliary Building were affected with the exception of the emergency feedwater pump. The emergency feedwater pump lube oil and circulating water pumps were submerged and their operability was in question. However, the provisions of Specification 3.4 were met in that the capability to remove at least 5 percent decay heat was available from the hotwell pump, condensate booster pump and main feedwater pump string

or through a hotwell pump and a condensate booster pump as required by Technical Specification 3.4.

It is concluded that the health and safety of the public was not affected by this incident.

Corrective Action:

Following this incident, an evaluation was performed of all equipment which had become submerged. This equipment was inspected, repaired and maintained as necessary. In order to prevent a future recurrence of this incident, the following corrective action will be taken:

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 tagging out control power.

2. The power source for CCW controls will be changed to an ICS Powerpanel-board. 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 -

   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 provide 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 insure 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:

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

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

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

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

   e) Lock closed the emergency condenser discharge valve 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.