Tennessee Valley Authority
Browns Ferry Nuclear Plant

Safety Evaluation
Diesel Generators Not Seismic

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Safety Evaluation
Diesel Generators Not Seismic

On September 24, 1985, the battery racks for the 125v diesel control power for all diesel generators were found to be unqualified for earthquake loadings. This is due to unqualified material being used as bolting studs which hold the racks onto an embedded steel baseplate. Each diesel generator has its own 125v battery. It is unlikely that all eight diesel generator batteries would fail upon a seismic event. The probability of an earthquake is 4×10^{-6} per day for a mild operating basis earthquake, and therefore the probability of loss of all AC power after an earthquake is less than 4×10^{-6} per day.

The consequenses of total loss of AC power are mild for the present plant configuration and the sequence of events is slow moving. The worst case scenario is described in the following section.

Scenario for Secondary Containment

Upon loss of all AC power, secondary containment integrity would be lost due to loss of Standby Gas Treatment System. Secondary Containment function would not be required, however, as long as fuel cooling can be maintained as per the fuel cooling scenario and fuel movement is not taking place thus eliminating the chance of fuel damage.

Scenario for RCS Integrity

The RCS integrity is not directly affected by loss of AC power. All connections capable of draining the RCS or a fuel pool are seismically qualified, and the potential for LOCA is generally considered negligible for a Class I system that is not under pressure. Therefore, the ability of the fuel pool and reactor vessel/cavity systems to contain fuel cooling water is not of concern.

Scenario for Reactivity Control

Reactivity control for all units is by full-in control rods or fuel rack configuration. None are affected by a seismic event or a loss of AC power as they are seismically qualified and do not depend on electric power.

Scenario for Primary Containment

Primary containment is open on units 1 and 2 and closed on unit 3. Because the reactor vessels cannot pressurize on units 1 and 2, primary containment is not needed to contain energy released during a LOCA. On unit 3, the potential exists, upon loss of all AC power, for the vessel to pressurize. Therefore, the primary containment may serve some purpose on unit 3 and should remain closed.

Scenario for Fuel Cooling

Initial Assumptions

All eight diesel generators fail after a seismic event at T = 0

All non-seismic equipment fails at T = 0

Unit 1 is in refueling mode with core partially unloaded and pool gates open, cavity flooded.

Unit 2 is in refueling mode with core completely unloaded and pool gates closed, cavity flooded.

Unit 3 is in cold shutdown with the vessel in tact and the primary containment established.

Evaluation

In this condition, it is assumed that in the worst case, no AC power would be available after a postulated earthquake. Each unit is assumed to be left with no makeup and no conventional decay heat removal. Cooling of fuel would be through heatup and later boil off of existing water inventories.

Unit 1

The decay heat load of unit 1 is approximately 2MW divided between the fuel pool and the reactor. Since the pool gates are open, the combination of pool and reactor cavity will be treated as one volume.

The fuel pool contains 51,340 ft^3 of water and is initially about 100^oF. Conservatively, 51,340 ft^2 = 3.2 X 10^6 lbm. For an initial temprature of 112^oF, 3.2 X 10^8 BTU is required to reach boiling.

3.2 X 10^8 BTU = 93.8 MW - hrs.

With a heat load of 2 MW, about 47 hours are required to reach boiling. No credit is taken for reactor cavity water heatup during this phase.

The fuel pool water would begin to boil off after reaching 212^oF. With h_{fg} = 970 btu/lbm, 7037 lbm/hr will boil off. This is equal to 14 gpm.

The fuel pool contains 10,470 gal/ft alone which results in a maximum pool level drop rate of less than 2 ft/day after the initial 47 hours. The cavity and equipment pit water would cut this rate by approximately 1/2.

Scenario for Fuel Cooling
(Continued)

Unit 2

The case for unit 2 is similar to unit 1 analysis but has about 1/2 the heat load (1.1 mw) and is not connected to the reactor cavity. Using the same assumptions, unit 2 would be bounded by the unit 1 case with 45% margin.

Time to boil = 85 hours
Boil off rate = 7.7 gpm
Drop rate = 1.1 ft/day

Unit 3

Unit 3 pool is similar to the unit 2 case but has less decay heat load. (.34 MW)

Time to boil = 276 hours
Boil off rate = 2.38 gpm
Drop rate = .34 ft/day

Unit 3 Core

Unit 3 reactor is closed and assumed to be in cold shutdown at 180°F. The vessel level is assumed to be normal. At t = 0, decay heat removal would stop and the containment would isolate. The reactor vessel and coolant would heat up to boiling.

Decay heat = 0.6646 MWt
Time to boil = 17.8 hrs.

After reaching boiling, heat would be transferred to the suppression pool by steaming through relief valves. Air for relief valves would come from the six ADS accumulators, which would eventually be emptied. Subsequently, the reactor vessel would be allowed to pressurize to 1105 psig and then continue to relieve. At boil off phase, 137 hours would be required to boil down to TAF. A total of 154 hrs. is available to establish some makeup.

Conclusions and Recommendations

1. The amount of time available for recovery of some AC power for open vessels and fuel pools for the most limiting case is on the order of 12 days. This is ample time to re-establish some sort of AC power or makeup water.

2. The amount of time available for recovery for the closed unit 3 vessel is on the order of 150 hrs. After this time, some vessel makeup water would be required. HPCI, which is seismically qualified and independent of AC power, could be run for short periods of time by allowing the vessel pressure to increase when water is needed. In order to accomplish this, the HPCI inboarded steam isolation valve, which is AC powered, would have to be opened initially. It is recommended that this lineup be considered as a compensatory measure.

3. The probability of adverse effects on public health and safety due to the condition of the diesel battery racks is acceptable for the existing plant configuration and the short time for which the condition will exist.

4. The low probability of occurrence of an earthquake during the short time that the condition is expected to exist and the time and paths available for recovery do not warrant special procedures or equipment for recovery at this time.