UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA ST., N.W., SUITE 3100
ATLANTA, GEORGIA 30303

Report Nos. 50-259/82-23, 50-260/82-23 and 50-296/82-23

Licensee: Tennessee Valley Authority
500A Chestnut Street
Chattanooga, TN 37401

Facility Name: Browns Ferry Nuclear Plant

Docket Nos. 50-259, 50-260 and 50-296

License Nos. DPR-33, DPR-52 and DPR-68

Inspection at Browns Ferry site near Athens, Alabama

Inspectors: [signature] for 8/24/82
J. W. Chase — Date Signed

[signature] for 8/24/82
G. L. Paulk — Date Signed

Approved by: [signature] for 8/24/82
F. S. Cantrell, Section Chief, Division of Projects and Resident Programs — Date Signed

SUMMARY

Inspection on July 30, 1982 to August 10, 1982

Areas Inspected

This routine inspection involved 81 resident inspector-hours in the area of operational safety.

Results

In the one area inspected, one violation was identified; violation of 10 CFR 50, Appendix B, Criterion V as implemented by TVA's QA Topical Report, TBA-TR75-1. (Units 1/2/3).

DETAILS

1. Persons Contacted

   G. T. Jones, Power Plant Superintendent
   J. R. Bynum, Assistant Power Plant Superintendent
   J. R. Pittman, Assistant Power Plant Superintendent
   L. W. Jones, Quality Assurance Supervisor
   W. C. Thomison, Engineering Section Supervisor
   A. L. Clement, Chemical Unit Supervisor
   D. C. Mims, Engineering and Test Unit Supervisor
   A. L. Burnette, Operations Supervisor
   R. Hunkapillar, Operations Section Supervisor
   T. L. Chinn, Plant Compliance Supervisor
   M. W. Haney, Mechanical Maintenance Section Supervisor
   T. D. Cosby, Electrical Maintenance Section Supervisor
   R. E. Burns, Instrument Maintenance Section Supervisor
   J. E. Swindell, Field Services Supervisor
   A. W. Sorrell, Supervisor, Radiation Control Unit
   R. E. Jackson, Chief Public Safety
   R. Cole, QA Site Representative, Office of Power

   Other licensee employees contacted included licensed reactor operators and senior reactor operators, auxiliary operators, craftsmen, technicians, public safety officers, quality assurance, quality control and engineering personnel.

2. Management Interviews

   On August 6, 1982, a management interview was conducted with the Power Plant Superintendent and other members of his staff. The licensee was informed of one violation identified during this report period.

3. Licensee Action on Previous Inspection Findings

   Not inspected.

4. Unresolved Items

   None.

5. LOSS OF SECONDARY CONTAINMENT EVENT

   Unit 2 was shutdown for a refueling outage on July 30, 1982. Technical Specification 4.7.C requires that secondary containment integrity be demonstrated at each refueling outage prior to refueling. S.I. 4.7.C was conducted on Unit 2 and the refuel zone on July 30, 1982 with unsatisfactory results. The events that followed are listed on the table of events enclosed in this report section. The maintenance of secondary containment integrity and the response to accident signals is more complex at Browns Ferry than at other reactor facilities due to the zone concept; therefore, a summary follows that describes basic secondary containment operation at Browns Ferry.

A. SECONDARY CONTAINMENT

The Secondary Containment or Reactor Building completely encloses all three units drywell and suppression chambers which make up the individual primary containments. The primary purpose of the secondary containment is to minimize the ground-level release of airborne radioactive materials and provide for the controlled and elevated release of the building atmosphere under accident conditions.

When the primary containment is open, such as during refueling and maintenance operations, the secondary containment serves as the primary containment.

(1) System Description

The reactor building encloses the reactor and its pressure suppression primary containment. This structure, together with the reactor building heating and ventilation system and the Standby Gas Treatment System, provides secondary containment when the primary containment is in service during power operation and primary containment when the drywell is open for refueling or maintenance.

In addition to the primary containment, the reactor building houses the refueling and reactor service areas, the new and spent fuel storage facilities and other reactor auxiliary and service equipment.

The normal ventilation system provides filtered air to the reactor building and then exhausts it through an elevated release.

The ventilation system maintains the reactor building at a .25 inch negative internal pressure thereby insuring inleakage. Access to the reactor building is provided by double door air locks and an equipment access hatch.

a. Reactor Building

The reactor building substructure consists of poured-in-place reinforced concrete exterior walls that extend up to the refueling floor. The refueling room floor is also made of reinforced poured-in-place concrete. The superstructure of the reactor building above the refueling floor is a structural steel frame.

The reinforced concrete exterior walls and the structural steel for the superstructure are designed for tornado considerations and missile protection. In addition, blowout panels are installed to prevent excessive pressure differentials.

b. Relief Panels

Excessive pressure differentials due to steamline ruptures and tornadoes are prevented by venting to the atmosphere through relief panels. Three sets of relief panels and a flow limiter prevent the overpressurization of the secondary containment system. These consist of the main steam relief panels, the zone relief panels, the exterior siding panels and the HPCI flow limiter. Main steam ruptures would be vented to the turbine building through main steam relief panels location in the steam tunnel. Zone relief panels vent other steamline ruptures to the refueling floor. Zone relief panels also vent excess air to the refueling floor during tornado depressurizations. The exterior siding panels vent the refueling floor to the atmosphere.

c. Air Locks and Penetrations

All entrances and exits to and from the reactor building are through double door personnel and equipment air locks. Each pair of access doors is equipped with weather-strip type rubber construction seals and are electrically interlocked so that only one of the pair may be opened at a time.

d. Ventilation

The reactor building is heated, cooled, and ventilated during normal and shutdown operation by a circulating air system. The reactor building heating and ventilating system is shutdown and isolated when the secondary containment is isolated and connected to the Standby Gas Treatment System (SBGTS).

While the reactor building heating and ventilating system is not an engineered safeguard, certain components do perform engineered safeguard functions. The double isolation valves, the vacuum relief valves, and the equipment area cooling units serve engineered safeguard systems and are designed to engineered safeguard standards and criteria.

The ventilation system provides 100% makeup air. Outside air is filtered and then passes across hot water coils for winter heating and through evaporative coolers for summer cooling, and hence to four supply fans per unit. Two 100% capacity supply fans per unit furnish air to the refueling zone. Two

100% capacity fans supply air to each of the unit reactor zones. The filters, coils, coolers, and supply fans are located outside the reactor building.

The ventilation of air from the reactor building is ducted to exhaust fans located on the reactor building roof. One hundred percent standby exhaust fan capacity is provided. The refueling zone fans and reactor zone fans exhaust through separate fan stacks. The air from each zone is monitored before release. High activity will isolate the secondary containment. Normal ventilation air exhaust is not filtered.

(2) Secondary Containment Isolation

The reactor building is divided into four ventilation zones which may be isolated independent of each other. The refueling room which is common to all the units forms the refueling zone. The individual units below the refueling floor form the other three reactor zones. The four zone ventilation control system provides increased capability for localizing the consequences of an accident or radioactive release such that the effect will be localized in one zone while maintaining the ability to isolate the entire reactor building if necessary. With one or more zones isolated, normal operations may be continued in the unaffected zones. If the internal zone boundaries should fail the entire reactor building would still meet the requirements of secondary containment by assuring filtered elevated release. The zone system is not an engineered safeguard and the failure of the zone system would not in any way prevent isolation or reduce the capacity of the secondary containment system.

A reactor zone is isolated upon isolation of the primary containment in the particular zone, by high radiation level in the ventilation exhaust duct leaving that particular zone or by manual operation. The refueling zone is always isolated when any reactor zone is isolated. The refueling zone only is isolated by a manual signal or by high radiation signal from any of the six radiation monitors located on the refueling floor that serve the refueling zone. Upon isolation all of the ventilation systems serving the isolated zone or zones are shut down, the ducts are isolated, and the Standby Gas Treatment System is started and begins exhausting from the isolated zone or zones.

3. Standby Gas Treatment System

The Standby Gas Treatment System provides a means for minimizing the release of radioactive material from the containment to the environs by filtering and exhausting the atmosphere from any or all zones of the reactor building during containment isolation conditions.

An elevated release is provided by exhausting to the plant stack. The Standby Gas Treatment System is classified as an Engineered Safety System.

a. System Description

This basic system consists of a suction duct system, three filter trains and blowers and a discharge vent. Also a vacuum relief system is provided for each ventilation zone. The suction duct system exhausts from the normal ventilation discharge of each of the three reactor zones ahead of the isolation valves and from the refueling zone independent of the normal ventilation system. Each of the filter trains contains a moisture separator and a heater to provide humidity control, banks of particulate and charcoal filters to remove particulates and halogens and a blower.

The three filter trains and blowers are arranged in parallel and are located in the Standby Gas Treatment building. All three trains share a common suction manifold. In this way each of the three trains is connected to all three reactor zones and the refueling zone. The design operating mode for the SBGTS is at least two of the three trains. The three Standby Gas Treatment blowers discharge to the atmosphere through a single underground pipe to the 600-foot-high plant stack. A vacuum relief system is provided to prevent high differential pressure in the secondary containment system in the event the inleakage is considerably below the design flow of the standby gas treatment system.

b. System Features

During normal plant operation, the SBGTS is in a standby mode and can be started automatically or manually. The SBGTS is capable of processing air flow from the following areas:

1. Refueling zone
2. Reactor zone
3. Drywell
4. Suppression pool
5. High Pressure Coolant Injection gland exhaust blower.

All three SBGTS share a common inlet or suction header. Filter trains A and B are cross-connected downstream of the second HEPA filter. This permits cross-connecting filter trains and blower for the A and B systems. Although the C system shares a common inlet, it does not have the cross-connect capabilities.

c. Automatic Initiation

Control logic for the SBGTS automatically and concurrently starts all three filter trains upon receipt of an accident signal. All three trains then run for the duration of the accident. Should one train fail, the two operating trains will continue to provide the design flow.

The SBGTS will automatically start if any of the following conditions exist:

1. Reactor zone high radiation
2. Refuel zone high radiation
3. Low reactor water level
4. High drywell pressure

The reactor zone and refueling zone ventilation systems automatically shutdown upon receipt of a SBGTS initiation and all air flow is processed through the filter trains.

d. Vacuum Relief

Using the Standby Gas Treatment System to exhaust less than four zones will result in an exhaust rate greater than the infiltration rate. The secondary containment wall area for an individually isolated zone is less than that of the total 3-unit building containment which results in proportionally smaller leakage rates. Consequently, negative pressure within any zone during a single-zone isolation operation would be much greater than 0.25 inch of water minimum. The standby gas treatment vacuum relief system will bleed outside air into each zone of the reactor building to prevent outside pressure exceeding the pressure inside the building by more than ½-inch water gauge. Each reactor zone is provided with a separate independent vacuum relief unit. The refueling zone is provided with two separate vacuum relief units. The vacuum relief units are located on the air supply duct downstream of the isolation valves. A vacuum relief unit consists of two electrically operated, low leakage dampers mounted in series. One of the dampers is two-position while the other is the modulating type. Upon zone isolation the two-position damper is automatically opened. The other damper modulates automatically to regulate the pressure difference between the reactor building and the outside to between ¼- and ½-inch water gauge. The two-position damper may be operated manually from the main control room, and the modulating damper activates when the two-position damper energizes.

e. Inspection and Testing

The reactor building inleakage rate is determined by isolating the reactor building ventilation and operating the SBGTS. The SBGTS flow is adjusted to 12000 SCFM, and the secondary containment is verified to have a pressure $\geq$.25 inch water gauge below pressure outside the building. Technical Specifications require this test to prove secondary containment integrity. S. I. 4.7.C is used to verify secondary containment each refuel outage.

The Standby Gas Treatment System filtration trains and blowers are arranged such that one redundant train and its associated blower may be serviced or tested while the other two trains are ready to operate. In the event of a signal to isolate secondary containment and start the SBGTS the train on test will shut down and isolate and the other two trains will start automatically. Two out of three standby gas treatment blowers are adequate to keep all three reactor buildings zones and the refueling zone at a pressure of ¼-inch water gauge below atmospheric.

B. Evaluation and Testing Phase of Loss of Secondary Containment Event

During the evaluation and testing phase, the licensee identified numerous cross-ventilation paths between zones. Additionally, some areas of secondary containment integrity degradation were observed. A summary of the significant secondary containment deficiencies found during licensee testing follows. In all, about 300 trouble reports were filed to repair various conditions to improve secondary containment and zone integrity.

(1) Unit 3 "A" reactor zone fans would not control at 0.25 inch H_2O. The building runs at 0 pressure or positive pressure.

(2) Static pressure controllers (dampers 64-15, 6-146) were not operating properly on any unit. These controllers modulate to maintain zone vacuum at ¼- to ½-inch water gauge.

(3) SBGTS flow indicators FI 65-50, 65-71 would not properly read low flows.

(4) Several reactor building dampers were leaking.

(5) Several leaks found in:

   a. fire protection pipe penetrations
   b. EECW and electrical conduit penetrations
   c. electrical penetrations

(6) Manual damper on "A" SBGTS would not control.

(7) Check damper and isolation dampers on "B" SBGT leaked allowing the "B" SBGTS fan to run backward when idle.

8. Dampers to SBGTS (3-64-40, 41) would not properly open.

(9) Manometers and traverses were installed to read ventilation and SBGTS flows for better accuracy, since normal flow instruments were erratic.

(10) Several areas where unit 3 could crosstie to other areas (Recirculation MG set drains, shutdown board rooms, valves to drywell head areas, door on RWCU backwash receiver tank room) were blocked before successful SI completion.

(11) The most significant secondary containment boundary violation found was a dislodged Unit 1 steam tunnel differential pressure relief panel. The dislodged panel allowed a 5 square feet opening to exist between the Unit 1 reactor building and the turbine building. The closing of this opening allowed a significant improvement in the ability to maintain a negative pressure in the reactor zones and refueling zones of all units. This fact gives credence to the apparent interdependence of one zone with the remaining zones. The relief panels are designed to relieve at 50 psf steam tunnel pressure in case of a steam line rupture. Each panel is mounted with explosive bolts that release (break) when the set differential pressure is reached. The dislodged panel was last determined installed in June 1981 in accordance with Mechanical Maintenance Instruction 14 requirements. (The licensee is investigating the failure mechanism for this panel) (Open item 259/82-23-01).

(12) Unit 3 supply fan dampers would not fully close on securing due to misalignments.

(13) Numerous ventilation damper indicator lights indicated open and closed position at same time.

(14) Some dampers failed to close on an isolation signal.

(15) Numerous dampers required linkage adjustments to assure proper operation.

(16) Numerous leaks from electrical board rooms into the reactor building.

(17) Unit 2 supply fan damper was warped.

(18) Rubber boot seals around main steam line in the steam tunnel leaked from the reactor building to the turbine building.

(19) Controls between fan operation and dampers failed in some cases.

(20) A normal ventilation duct between Unit 1 and the refuel floor was found ruptured.

(21) The rubber boot expansion joint around the steel superstructure of the refuel floor between Units 2 and 3 was noted as being deteriorated in several locations. One section open to atmosphere was 3 inches by 12 inches in size.

Due to the number of deficiencies noted followup inspection by the inspector in this area will be required. The licensee committed to review the preventative maintenance program in this area. The inspector will leave this item as an open item until a preventative maintenance program is established to assure proper secondary containment isolation when required, fan and damper maintenance, and instrumentation and controls maintenance. (Open Item 259, 260, 296/82-23-02).

C. Surveillance Instruction 4.7.C

Surveillance Instruction 4.7.C. is required to be performed each refueling outage prior to refueling to verify secondary containment in accordance with technical specifications. A summary of the procedural steps used to conduct this surveillance follows.

(1) During preoperational testing for Unit 3, specific baseline data was taken on each ventilation zone that documented the current inleakage rates. The total of the inleakage rates was below the technical specification requirements of 12,000 CFM. Since each zone inleakage rate was slightly different, as would be expected, a formula was used to ratio the documented inleakage rate to the technical specification requirements. This formularized percentage was then used to specify the maximum allowable inleakage rate for each zone. The entire secondary containment test, using only the SBGTS fans, had not been conducted since preoperational testing of Unit 3. Only zone testing had been conducted.

(2) The surveillance instruction allowed the operation of adjacent zone ventilation systems during the tests. During the evaluation phase the licensee noted that the adjacent zone ventilation directly affected the value obtained during S.I.4.7.C. due to the cross ventilation paths between the ventilation zones. The ventilation system supplies 50,000 ft^3/min. of air per unit to the refueling zone and 100,000 ft^3/min. of air per unit to each reactor zone. The

individual zones are maintained at 1/4 in. water gauge negative internal pressure by their separate ventilation systems. During the secondary containment testing by zone, the Standby Gas Treatment Fans pull only a percentage of the 12,000 ft^3/min. to verify the 1/4 in water gauge requirements. The SBGTS fans are rated at only 9,000 CFM each. It can be seen that any excess leakage into the reactor zone could be masked by the cross-leakage between units and the large volumetric flow rates of the normal ventilation systems. During a loss of offsite power and unit power the normal ventilation systems would not be operating since they are fed power from the non-vital reactor ventilation boards. The SBGTS fans are supplied from the vital diesel auxiliary boards which remain operational during accident events. (LOCA and Loss of Offsite Power). The secondary containment test conducted on Unit 2 on July 30, 1982 failed apparently because the normal negative internal pressure maintained in Unit 3 during the testing was not present since the Unit Reactor zone fans were not properly controlling. Unit 3 was at zero pounds or slightly positive pressure. Thus, cross leakage between Unit 3 zone and Unit 2 zone affected the Unit 2 testing causing the test to fail. During testing on various zone combinations erratic results were obtained. This was due to several noted deficiencies including; flow instruments not properly recording at low flows, dampers not operating properly during isolation functions, indicators not working properly so that it could not be easily determined the correct position of dampers, SBGTS dampers leaking by or not controlling, and failure to immediately realize the interdependence of ventilation flow and SBGTS flow between adjacent zones.

(3) The primary cause of the secondary containment test failure was apparently due to the dislodged pressure relief panel in the Unit 1 steam vault. The dislodged panel allowed a 5 square foot area to be open from the turbine building to the reactor building. The panel was last verified installed in accordance with relief panel inspection, called out in Mechanical Maintenance Instruction 14, conducted May 22, 1981. There were many secondary causes that have been found during the licensee evaluation and testing program including; boot seals leaking in the steam tunnels, deterioation of the rubber expansion joint connecting the steel structure around the Unit 2/3 refuel floor areas, inleakage from various penetrations on piping and electrical conduits, and supply dampers leaking to the reactor building from the environs.

The inspectors reviewed the surveillance instruction for adequacy in meeting regulatory requirements. The review included several observations of the surveillance in progress, review of previous surveillance records, and discussions with plant personnel. The inspectors and the licensee noted that the procedure did not adequately determine secondary containment integrity by zone if the normal ventilation system in adjacent zones was left operating. By leaving normal ventilation on, the negative pressure aided the creation of the desired negative pressure in the zone under test because of the cross leakage. The inspector informed the Plant Superintendent at the exit meeting on August 6, 1982 that failure to have a procedure to accurately determine secondary containment integrity was a violation of Technical Specification 6.3.A. (259, 260, 296/82-23-03).

Sequence of Significant Events
During Loss of Containment

Date	Time	Event	Results
July 30, 1982	2000	Secondary Containment Integrity SI 4.7.C. conducted on Unit 2	Failed
July 31, 1982	0353	Secondary Containment Integrity SI 4.7.C. conducted on Unit 2	Failed
July 31, 1982	2000	SI 4.7.C conducted on all zones (Reactor and Refuel).	Unit 3 Reactor zone failed (would not maintain 0.25 in. water gauge). All other zones passed test. Flow 11, 500 CFM.
July 31, 1982	2025	Unit 3 was shutdown due to failure to verify secondary containment integrity on SI 4.7.C.	
August 1, 1982		Recalibrated flow instruments	
August 1, 1982	1200	Conducted SI 4.7.C on Unit 3.	Passed easily.
		Broke primary containment on Unit 2 for refuel outage.	
August 2, 1982	1200	Conducted SI 4.7.C. on Unit 1.	Passed easily.

August 2, 1982	1800	Licensee decided to conduct SI 4.7.C. on all zones due to questionable validity of tests and erratic results.	
August 3, 1982	0047	Conduct of SI 4.7.C. complete on all zones	All zones failed tests. Flow · 12,000 cfm
August 3, 1982	0156	Unit 1 shutdown. Commenced reestablishment of primary containment on Unit 2.	
August 4, 1982	------	Established Technical Support Center as command post for secondary containment testing and evaluation.	
August 5, 1982	0600	U-2 primary containment established.	

D. Summary of Loss of Secondary Containment Event

The review of this event by the inspectors led to the following conclusions.

1. The secondary containment at Browns Ferry has been undergoing a gradual deterioration since preoperational testing. This deterioration has been masked by the performance of zone testing exclusively since the preoperational testing on Unit 3. During zone testing the normal ventilation system has been kept running in the adjacent non-tested zones. The adjacent zone ventilation system thus compensated for any excess leakage by assisting in maintaining the required 1/4 in. water gauge pressure. This assistance was proven during the licensee testing phase after the event; primarily due to the cross-leakage between zones.

2. Zone testing of the secondary containment cannot be adquately performed unless all reactor building ventilation is secured or pressure measurements taken in the non-tested zones with the tested zone pressure being reduced to 0.25" water gauge plus X" water gauge measured in the non-tested zone.

3. The exact period in which secondary containment could not be maintained could not be determined. The containment integrity was significantly reduced due to the dislodged panel in the Unit 1 steam vault. The inspectors did verify

through record verification that the Unit 1 steam relief panels had been inspected for proper installation in May, 1981. When the steam relief panel was reinstalled, all zones were able to be maintained at 0.25" water gauge pressure with 15,000 CFM (greater than technical specifications allow, but well within the capability of two standby gas treatment trains). When flow was reduced to the Technical Specification limit of 12,000 CFM, all zones met requirements except Unit 3. However, it should be noted that after the relief panel was repaired, there were periods in the testing phase in which secondary containment could not be maintained because of the non-repeatability of the normal ventilation isolation dampers to return to their fully isolated position.

Based on this event, the licensee has established secondary containment in all zones by performing the secondary containment test on the entire reactor building and refueling zone. At this time individual zone isolation has not been proven. The inspectors will continue to follow the licensee's progress towards zone isolation. (Open Item 259, 260, 296/82-23-04). It should be noted that zone isolation is not an operating licensee requirement. The only license requirement is to be able to prove and maintain secondary containment in the reactor building. Zone isolation aids in separating the three units for operational considerations only. Since the licensee has not demonstrated zone isolation, a loss of secondary containment in one zone would necessitate the placement of all four zones in a condition in which secondary containment is not required. If zone isolation is proven, then the licensee could isolate an affected zone and demonstrate secondary containment in the non-affected zones and continue normal operation in the non-affected zones.