TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE
37401

July 10, 1974

Mr. A. Giambusso
Deputy Director for Reactor Projects
Directorate of Licensing
Office of Regulation
U.S. Atomic Energy Commission
Washington, DC 20545

Dear Mr. Giambusso:

In the Matter of the) Docket Nos. 50-260
Tennessee Valley Authority)

Your letter dated June 21, 1974, requested a final report on the missing steamline plug parts from unit 2 of the Browns Ferry Nuclear Plant. Five copies of that report, which contains the information presented in our June 10, 1974, report as well as that requested during our June 13, 1974, meeting, are enclosed.

Very truly yours,

J. E. Gilleland
Assistant to the Manager of Power

Enclosure (5)
CC: Mr. R. R. Barris
General Electric Company
832 Georgia Avenue
Chattanooga, Tennessee 37402

Mr. K. L. Sessions
General Electric Company
9040 Executive Park Drive
Knoxville, Tennessee 37919

Mr. R. B. Beers
TVA Projects
General Electric Company
Atomic Power Equipment Department
San Jose, California 95125

6405

COPY SENT REGION 2

TENNESSEE VALLEY AUTHORITY

BROWNS FERRY NUCLEAR PLANT UNIT 2

OPERATION WITH UNRECOVERED STEAMLINE PARTS

Description of the Event

During surveillance testing of the RCIC system, auxiliary boiler steam (150 psig) was inadvertently introduced into the main steamline. The MSIV's were closed and the GE-supplied steamline plugs (ref 731E860) were installed in the RPV steamlines. The inflatable seal on the plug was pressurized to 40 psig with instrument air. The "C" steamline plug blew out and struck the vessel wall a glancing blow, at the same time hitting the vent line on steamline plug "A" 3 inches above the plug. The plug then fell back into the vessel and sank, coming to rest near the center of the reactor on top of the blade guide handles. The vessel was at normal operating level, which is 15 feet above the top guide. None of the handles on the blade guides on the top guide was damaged.

The guard flange (158B775A-P6) was stripped off of the steamline plug as it left nozzle "C". The 3/4-inch ϕ nylon rope (which was secured around the refueling bellows lifting clip and the handle in the plug vent line) was sheared 18 inches from the vent line handle. The steamline plug rotated 180 degrees before striking steamline plug "A". The guard flange struck the vessel wall at 350 degrees azimuth below nozzle "A". Steamline plug "C" vent line was turned down as it hit steamline plug "A" knocking off four 1/4-inch SS bolts, five 1/4-inch SS washers, and two pieces of safety wire. From steamline plug "C" eleven 1/4-inch SS bolts, one 1/4-inch bolt head, twelve 1/4-inch washers, six pieces of SS safety wire, one 3/16-inch allen head SS screw, and one 3/16-inch SS flat washer was knocked off and scattered over a wide area in the vessel and outside the vessel flange.

A careful search of the reactor and surrounding area resulted in the recovery of all parts <u>except</u> one 1/4-inch SS bolt 1 inch long, three 1/4-inch SS washers, one 3/16-inch SS allen head screw, and one SS piece of safety wire.

Description of the Event (continued)

The search was conducted by a written procedure on around-the-clock basis for 6 days with an average of six persons participating continually expending approximately 864 man-hours. The control rod blade guides and fuel support castings were removed, the manway in the shroud support was ground out to permit access below the core plate, and the vessel was searched thoroughly short of removing the control rods. Thirty-seven missing parts were located, as indicated below.

3 washers and 1 bolt on and around top guide

4 bolts, 4 washers, and 2 safety wires in main steam header "A"

1 bolt, 1 washer, and 1 safety wire on core plate

1 bolt, 2 washers, and 1 safety wire in the jet pump area

2 bolts and 1 safety wire at fuel support casting location 46-23

2 bolts and 1 safety wire at fuel support casting location 50-43

1 bolt and 1 washer at fuel support casting location 46-27

1 washer at fuel support casting location 54-39

1 washer under the core plate around the stub tubes

1 bolt and 1 washer on the feedwater spargers and core spray headers

2 bolts, 1 safety wire, and 1 washer in reactor well on bulkhead plate outside the RPV

At this point, it was concluded that the missing parts had most likely been ejected from the reactor pressure vessel and had been swept up and discarded by the floor sweepers before it was realized that some of the parts might be outside the vessel. The only location within the reactor pressure vessel where parts might be was in the control rod guide tubes under the velocity limiters. This possibility was considered and is evaluated in Safety Evaluation, item B.

Following a meeting with representatives of AEC, at the request of AEC, TVA again drained the reactor pressure vessel; removed all control rod blade guides, fuel support castings, and control rod blades, and inspected the area of the control rod

Description of the Event (continued)

guide tubes under the control rod velocity limiters. The effort to remove control rods and castings and expose guide tubes required 3 days and expended approximately 600 man-hours. One additional washer was found in the guide tube at location 50-27.

All control rod blade guides were reinstalled, and the vessel was filled and made ready to receive the operational sources.

Safety Evaluation

A. The reactor pressure vessel cladding was visually examined (10X) where the steamline plug and the guard plate made contact. There was no evidence of indentations or upset metal. Based on this information, the structural integrity of the reactor pressure vessel is not considered to be affected by this incident.

B. If a part found its way into a guide tube, the part could migrate into the control rod drive and be captured by the drive filter. This would not affect the drive's scram capabilities. Although it is extremely unlikely, it could lodge between the control rod guide tube base and the index tube of the drive. This could result in preventing blade withdrawal but not insertion.

Although the above-mentioned situation could create an operational problem, it poses no safety problem.

C. The obvious concern associated with the lost parts is that associated with the potential for fuel bundle flow blockage and subsequent fuel damage. A detailed study of flow blockage in a BWR has been made in a GE Topical Report (1). As stated in that report, based on analyses of high power density fuel operating at 18.5 KW/ft.:

(a) It could take more than a 90-percent inlet area blockage to cause a MCHFR less than 1.0; therefore, no fuel rod damage would occur unless more than a 90-percent blockage occurs.

Safety Evaluation (continued)

(b) If the blockage were more than 90 percent, clad melt and fuel crumbling would occur. This would lead to high radiation sensed by the main steamline radiation monitors which would scram and isolate the reactor. Offsite doses remain less than 10CRF20 limits.

Based on the information concerning the size of the lost parts, the following conclusions are drawn:

1. If the parts found their way into the lower plenum, the fluid velocities would be high enough to sweep them up toward the fuel bundles only if the parts maintained a horizontal position. In the vertical position, the velocities are not high enough to lift the parts. Also, if the parts were lying on the bottom head where the fluid velocities are low, it is considered unlikely that they could get swept up off of the vessel surface. Therefore, even though it is possible for the washers to get lifted up toward the fuel, its occurrence is considered unlikely.

2. Because the fuel bundle orifice diameters are considerably larger than the lost parts (center bundles 2.211 inches, peripheral bundles 1.469 and 1.244 inches, low enriched bundles 1.800 inches), it is not possible for the inlet orifices to become blocked.

3. If the parts were swept up toward the orifice region, they would most likely pass through the orifice and become trapped against the lower tie plate. The cross-sectional area of the individual parts is so small that the flow area reduction would be minimal.

4. If the parts become fragmented into small pieces, these pieces could become lodged in the fuel bundle spacers, which would probably cause local boiling transition and over-heating with subsequent cladding damage

Safety Evaluation (continued)

due to fretting. However, this should only be limited to a small number of rods in the core because of the limited amount of material.

D. It is virtually impossible for a part to have found its way into the recirculation pump suction piping because the pumps were not operating at the time of the incident, and their suction is approximately 30 inches above the bottom of the annulus. However, the effect of foreign parts on a recirculation pump has been considered and has been judged to cause no significant adverse effect if one should get into a pump. The parts are small and would most likely pass through the large openings in the recirculation pump impeller with no effect whatsoever. If a part did get caught in an area of close clearance, it could become distorted or mar a pump component slightly. Any of these effects would be small and inconsequential in such a large pump. General Electric has experienced several 1/2-inch diameter, 10- to 20-inch-long, stainless-steel rods passing through a recirculation pump at a foreign facility with no pump damage.

Therefore, it can be concluded that the lost parts will not pose a safety problem.

This has been considered by both the Plant Operations Review Committee and the Nuclear Safety Review Board, and they conclude that the plant can be operated safely.

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1. Consequences of a Postulated Flow Blockage Incident in a Boiling Water Reactor - NEDO-10174.