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Jersey Central Power & Light Company

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May 18, 1970

Dr. Peter A. Morris, Director
Division of Reactor Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Subject: Oyster Creek Unit No. 1
Control Rod Drives

Dear Dr. Morris:

As a follow up to Mr. George Kelcec's letter of April 21, 1970, informing you of the status of Oyster Creek's control rod drives and our decision to shut down the plant and investigate drive leakage problems, the following is a summary of the findings and conclusions determined during the shutdown. These findings and conclusions have been reviewed by the Plant Operations Review Committee and the General Office Review Board and they concur.

To reiterate, some of the operational difficulties and information which led us to the conclusion that the plant should be shutdown and the control rod drive mechanisms inspected were as follows:

1. After the plant shutdown in October, 1969, when the drive inner strainers were found plugged and thus removed, the control rod drive withdraw stall flows were monitored. These stall flows, which are given on page 3-19 of Amendment No. 55 to the License Application, indicated that there was increasing seal leakage in the drive mechanisms.

2. During the period from December, 1969, to April 18, 1970, it was observed that the drives with high stall flows were requiring us to increase the drive pressure in order to withdraw these drives. Although the need to increase drive pressure does not indicate a safety problem, it could lead to the inability to restart the reactor after a scram if the leakage progressed sufficiently.

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3. The increasing leakage of the drive seals was also indicated by the decreasing time between reactor scram and the high scram discharge volume level trip which had decreased from approximately 30 seconds down to approximately 8.5 seconds just prior to the shutdown in April, 1970. Although the time had decreased to 8.5 seconds on April 7, 1970, it did not decrease further by April 14, 1970, and the control rod drive scram times remained essentially the same.

4. During a scram on April 7, 1970, three control rod drives did not latch in the "00" position but rather latched in the "02" position, six inches from full insertion. They were inserted by a normal drive-in signal by the operator after the scram. Only one of these drives latched in the "02" position on a scram on April 14, 1970. The reactivity worth of the control rod is very small between the "02" and "00" position, with the total worth of all 137 control rods between these two notches being approximately 0.50% $\Delta k/k$.

Considering all of these indications of control rod drive seal leakage, the decision was made to shut down on April 18, 1970, and inspect several of the drives.

After the shutdown on April 18-19, 1970, several drives were removed, and it was found that many of the seals were broken or damaged, and it was concluded that 136 of the 137 drives should be removed, inspected, disassembled and the seals replaced. The drive in position 30-03 was not disassembled since it cannot be returned to full operability without removing the reactor vessel head. The drive inspection consisted of the following:

1. Removal of the drive and visual inspection of external parts.

2. Leakage tests of the drive after removal were made on approximately the first twenty drives. The leakage was sufficiently large on these drives that it was concluded that the remainder of the drives should be disassembled and inspected without first leak testing them.

3. Disassembly, inspection, and reassembly of the drives was performed using the manufacturer's recommended procedure and a check-off list for each drive to assure complete inspection and replacement of all seals and other parts which might have been damaged or out of specification. This work was performed under the supervision of the General Public Utilities Quality Assurance Group. To summarize the findings of this program, 139 drive mechanisms were disassembled (including three spare drives) and the following observations made:

a. Number of drives requiring index tube replacement 77

b. Number of drives with damaged Bellville Washers 54

c. Number of drives with clogged or restricted cooling water orifices 66

d. Number of drives with one or more collet seal rings stuck or tight 27

e. Number of drives with one or more piston seals damaged 71

(184 out of 1096)

f. Number of drives with one or more stop piston seals damaged 138

(428 out of 552--one drive had complete stop piston assembly replaced)

g. Number of drives with one or more stop piston bushings damaged 27

(31 out of 276)

Note: Bushing and seals were considered damaged if they were heavily scored.

h. Number of drives with garter springs broken 67

i. During the inspection approximately 60% of the drives had 1/16" to 1/8" of dirt accumulation on the top of the stop piston and a few drives had some concentration of the dirt in the center of the stop piston of 1/4". Some dirt was found in the collet pistons. The dirt was made up of some sand, metal chips, and iron oxide. A few small pieces of teflon tape were found in cooling water orifices.

The cause of the seal damage can be attributed to air in the drives, dirt, and high pressures developed in the buffer during scram at ambient conditions. During drive overhaul or initial installation, air accumulates in the drive and must be vented. To prevent the air

problem, a better and more extensive venting procedure for the drives has been initiated for removal of air after work on a drive. Normal drive exercising during operation will effectively vent off air originating from the drive water. When a drive has been reinstalled, a friction test is performed after venting; this test provides a good indication of proper venting. If the friction test indicates air in the system, the venting procedure is repeated.

Since initial startup, dirt in the system has gradually been removed by operation of the plant condensate demineralizers, cleaning of the condenser hot wells, by the clean-up system filters, and by removal from drives when they were removed. In addition, during the drive removal on this shutdown control rod drive guide tubes were flushed. Other BWR's have experienced similar dirt problems during initial operation but after a few months of operation they no longer had dirt problems. It is felt that the system is well cleaned and with the return of the inner strainers to the drives (10 mil strainers) there should not be a dirt problem with the control rod drive seals.

During initial testing many scrams were performed on drives with the reactor at ambient conditions. These scrams cause high pressures to develop under the stop piston due to drive line inertia and the effect of the accumulator coming into play as the drive slows down in the buffer. Initially the accumulator precharge pressure was 850 to 870 psig, but in February, 1970, this precharge pressure was reduced to 565 to 585 psig. This decrease in precharge pressure reduces the transient pressure on the stop piston seals during scrams at ambient conditions from approximately 5800 psig to 4000 psig thus reducing the occurrence of seal breakage due to this factor. This same pressure condition was the cause of the index tube bulging, and consequently, this occurrence will be reduced by the decrease in precharge pressure. In addition, scram testing at ambient conditions will be minimized to further reduce the probability of seal breakage and index tube bulging and instead, scram testing will be done at pressure whenever practicable.

The testing program for the control rod drives after reassembly is as follows:

1. Each drive was leak tested for under piston and over piston leakage after reassembly and prior to installation in the vessel. Each drive has been leak tested to assure that the under piston leakage at 160 psig was less than a total of 0.45 gpm from the stop piston seals plus the drive piston external seals plus the ball check valve plus the drive piston internal seals. The maximum total leakage permitted from a similar over piston test is 0.99 gpm. These tests confirm proper reassembly of the drives.

2. Each drive was vented during 15 full stroke operations.

3. Each drive was adjusted for a speed of insertion and withdrawal of 48 ± 3 seconds for full stroke and then rechecked three times.

4. Each drive was checked for insert and withdraw stall flows.

5. Each drive was given a friction test to verify that there was no excessive friction in the drive train or the control rod in the core. Differential pressure measurements made on a storage type oscilloscope were recorded for each drive by taking pictures of the variation in pressures. During this test the maximum pressure drop permitted over the full stroke (inlet to outlet pressures) was 15 psi. If this limit was exceeded, a notch out and settle friction test was performed with a limit placed on the rod settling differential pressure of less than 30 psi. Only one drive did not meet the 15 psi limit, and this drive was within the 30 psi rod settling differential pressure requirement.

6. Each drive was scram tested once at ambient conditions and will be scram tested once at rated pressure conditions, with the reactor at hot standby prior to returning to full power.

These tests have verified the proper venting, proper operation and proper reassembly of the drives prior to taking the reactor critical.

In order to assure continued satisfactory operation of the control rod drives during operation, the scram times of twenty-six selected drives will be monitored and recorded during reactor scrams. The withdrawal stall flows of all drives will be checked once a month and any need for increased drive pressure when moving control rods for operation or during drive exercising observed and recorded. After a reactor scram, the buffer action for the twenty-six selected drives will be evaluated for erratic action and the time between reactor scram and high discharge volume trip will be monitored.

If the total (sum of 137 drives) withdrawal stall flow reaches 550 gpm, the PORC and GORB will evaluate the situation existing at the time, taking into account any new information available, to determine the appropriate action. This stall flow is less than that which existed prior to the April 18-19, 1970, shutdown.

General Electric has advised that tests have shown that with the lower accumulator precharge pressure no significant index tube bulging takes place and that experience at other BWR's show that drives work well after initial startup and operation.

It is concluded that the overhaul and testing program that has been completed will assure proper operation of the drives. In addition, the surveillance program will adequately monitor drive performance for continued proper functioning and will provide early evidence of deterioration of drive performance.

Very truly yours,

Ivan R. Finfrock, Jr.

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Manager, Nuclear Generating Stations

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