Commonwealth Edison
One First National Plaza, Chicago, Illinois
Address Reply to: Post Office Box 767
Chicago, Illinois 60690

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WPW Ltr.#511-73

Dresden Nuclear Power Station
R. R. #1
Morris, Illinois 60450
July 17, 1973

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

SUBJECT: LICENSE DPR-19, DRESDEN NUCLEAR POWER STATION, UNIT 2, FINAL CONTROL ROD DRIVE ANOMALY REPORT.

References: 1) Letter of March 13, 1973 to Mr. Giambusso from W. P. Worden.

2) Letter of May 8, 1973 to Mr. Giambusso from W. P. Worden.

3) Jamrus and Gallagher, "Engineering Evaluation of Control Rod Drive Inner Filter 117C4609", NEDE-10279, Dec. 1970.

Dear Mr. Giambusso:

On February 19, 1973, three control rod drives gave indication of an apparent uncoupled condition when they were withdrawn during a startup. Preliminary information was submitted in reference (1). Since then a meeting was held on April 30, 1973 at General Electric, San Jose at the request of D. L. Pomeroy (USAEC-RO) to acquaint the AEC with the phenomenon that had occurred at Dresden, the investigations that had been conducted, and the planned follow-up action. This letter summarizes the initial events, subsequent investigations, and conclusions.

During the startup of Dresden 2 on February 19, 1973 three control rod drives that were withdrawn to position 48 gave an overtravel alarm annunciation when the overtravel check was performed. The red back lighting and position indication were lost on the main display and the four rod display, giving an indication of an apparent uncoupled condition. The drives were successfully recoupled on the first attempt and uncoupling was never experienced again even though numerous uncoupling checks were performed until the end of March, 1973 when these drives were removed during an outage.

As part of the investigation of the three control rod drive (CRD) uncoupling alarms received at Dresden Unit 2, G.E. representatives were present at the site for the CRD removal and initial examination. The initial inspection consisted mainly of measuring the overall length dimension (i.e., flange to end of fully seated uncoupling rod) and examining the inner filter assembly for damage and correct installation.

The assembly data sheets had been previously checked on the three CRD's (B-6, K-8, and L-11) and the overall length dimension of 173.406±.031 as specified on the assembly drawing, was within tolerance for each unit. The three CRD's in question were removed from the drywell and hoisted up to the CRD maintenance room for inspection.

The outer filter on each of the CRD's was removed and discarded and the overall length of the CRD (flange to uncoupling rod), was measured. In addition, the inner filter was removed and inspected. The following observations were made for each unit.

1. CRD K-8 (Flange No. 656C)

   This CRD had a measured overall length of 174 1/8 inches with the inner filter installed and 173 3/8 inches without the filter. Adding the incremental length to account for a properly seated filter to the latter measurement results in a corrected overall length of approximately 173 7/16 inches which is within the allowable tolerance range for this measurement when the filter is properly seated. The filter removal tool was engaged in the filter. Prior to any removal attempt, the filter was determined to have approximately 1/2 to 3/4 inch axial movement. In addition, when removal was attempted by 90° rotation of the tool, no spring tension was felt against the stop piston connector flats as it should have been. Removal was then achieved by simply withdrawing the filter removal tool until the filter was removed. Close visual examination (use of the eye piece) of the filter assembly was not possible due to the level of activity, therefore all observation of the filter was performed at a distance of one foot through a plexiglass shield. The retainer spring at the base of the filter was distorted. The spring surfaces which mate with the flats on the stop piston connector were deflected up and out into the filter. This filter is considered to have been disconnected from the stop piston connector prior to removal identified above.

   The damaged spring indicates that the filter could have been improperly installed prior to installation in the reactor.

2. CRD B-6 (Flange No. 20)

   The second CRD inspected had an overall measured length of 173-3/4 inches, which also exceeds the specified dimension identified above.* However, this filter was tight (approximately 1/8 inch axial movement) and considered firmly attached to the stop piston connector. The filter was rotated 90° and removed from the index tube. Observation of this filter also revealed a slightly bent retainer spring. Although it was concluded that this filter was properly attached at the time of its removal, the damaged spring indicates that the filter could have been improperly installed prior to installation in the reactor.

* The measurement was teken under conditions that did not allow accurate measurement (i.e., the reading should be ± 1/8").

3. CRD L-11 (Flange No. 91)

The third CRD inspected had an overall measured length of 173-1/2 inches which is within print allowable. The filter was tight (approximately 1/8 inch axial movement) and firmly attached. The filter was rotated 90° and removed from the index tube. The filter retainer spring was not damaged on this CRD.

Review of the engineering evaluation of the new CRD inner filter design (Ref. 3) reveals that damage occurred to a retainer spring similar to that observed on the subject CRD's. This damage during test occurred when the filter was installed without utilizing a rotating technique simultaneously with inserting the filter. This motion centers the spring on the connector and prevents flush contact of the spring and flat top of the connector. In addition, it should be noted that personnel at the Dresden site did not have the proper assembly instructions explaining this technique at the time modification was performed on these CRD's. As a result of the above, it is conceivable that damage to the retainer springs could have occurred during installation of the filter assembly following CRD modification.

The conclusions from the initial inspection are summarized as follows:

1. Two (2) CRD's contained inner filters with damaged retainer springs possibly caused by improper installation.

2. The inner filter of CRD Flange No. 656C was determined by measurement and orientation not to be coupled to the stop piston connector.

3. The uncoupled condition of Flange No. 656C could be a result of failure to lock the filter on the connector following installation.

4. A drive in the condition in which 656C was discovered (i.e., detached filter with bent spring preventing engagement of filter to connector) effectively had a "long" uncoupling rod setting. This could produce an actual uncoupling incident as the drive withdrew to position "48". If so, it is hard to explain the proper engagement of the filter the next time the coupling test was repeated as the bent spring would continue to interfere.

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5. It may be surmised, based on the coupling spring damage only, that drive 20 could have experienced a similar sequence. This is believed very unlikely, however, as some mechanism must be postulated to cause rotation of the filter to a locked position following the first uncouple alarm.

6. Drive 91 gave no evidence that the filter had ever been detached, and there was no evidence in the drive to indicate an uncoupling event ever occurred.

The following is the sequence of events which would have had to occur in order to have an uncoupling. This postulated sequence is based, mainly, on finding one filter disconnected from the stop piston in the above CRD inspection.

1. Filter seated on stop-piston but not rotated and locked.

2. Friction or filter Δ p pulls filter off the stop-piston connector.

3. As CRD approaches position 48 the filter jams on top of the stop-piston connector.

4. The uncoupling rod lifts the coupling lock plug, uncoupling the CRD. The alarm sounds.

5. On the second withdraw, the filter re-seats on the stop-piston correctly.

6. The filter either remains in place on the stop piston or, if it comes off, it never jams again.

7. Two of the filters return to the locked position and one filter comes off again (during the drive removal operation).

This unlikely sequence of events had to occur only once on three separate drives during one startup. The following paragraphs discuss the above sequence.

1. The filters could have been unlocked since, as it was pointed out in section B, above, the correct assembly instructions were not in use during the modification of these drives.

2. It is possible that friction or Δp forces could have detached the filters that were not locked into position properly. A correctly installed and properly locked filter cannot become detached without damage.

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3. The filter can jam on top of the stop-piston connector when the filter locking spring catches on the top ledge of the connector. The locking spring floats with restricted freedom inside of the base of the filter body.

4. The uncoupling rod is seated in the CRD uncoupling spud and travels with it. The stop-piston/filter assembly is stationary. As the CRD is retracted, the uncoupling rod moves down toward the stop-piston. The uncoupling rod is - 1/16 inch nominal away from the stop-piston/filter when the CRD is retracted to position 48.

5. If the filter jams on top of the stop-piston connector, this adds an additional - 3/4 inch. This additional length in the stop-piston/filter and uncoupling rod train is enough to cause the CRD to uncouple. This can only happen when the CRD is fully retracted to position 48.

6. The filter can be re-seated on the stop-piston. Reference 1 indicates that 85 lbs force is required to seat the filter. However, this is for a new filter. Reference 1 also indicates that this force can "vary widely and could conceivably drop below the 35 to 50 pounds of force exerted by the spring-loaded control rod coupling plug." Subsequent measurement at San Jose of a "used" stop-piston/filter assembly indicated a value less than 30 pounds force is required.

7. It would be extremely difficult to explain why this would happen only once on these three drives. There is no indication of a common mode failure. Once the CRD's were recoupled, they never came uncoupled again in over 25 tries.

8. Drive 656C, whose filter was found in the detached position, required the normal lift of the uncoupling rod in order to disengage from the control rod during removal. Yet the filter spring prevented the filter from re-engaging when an attempt was made to seat it before taking the 173.406 measurement. This may have been because the drive was in the horizontal position, which would shift the spring to its extreme limit of movement.

9. The other two drives, whose filters were found in the locked position, must be presumed to have properly re-engaged at step 5 and never had the filter come off again. This requires a rotation of the filter after step 2.

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Complete disassembly and inspection of the three control rod drives was accomplished on May 7, through May 10, 1973.

The uncoupling rod assembly, spud, stop piston, cylinder tube and flange, drive piston assembly, index tube, and collet and piston assembly of the three drives in question were found to be in good condition and showed normal wear. A few stop piston seals were broken, but this is normal for their length of service. The only abnormalities were the bent springs on the inner filter found in the initial CRD inspection as stated earlier in this letter.

A test was performed to determine the force required to put an old and a new inner filter on a stop piston. The two old inner filters with bent springs required approximately 22 lbs. while the undamaged old inner filter required about 25¼ lbs. A new filter required about 36¼ lbs.

The control rod drives have been rebuilt and are not available as spares.

The electrical circuits were checked for potential sneak paths which might give a false indication of uncoupling, but none were found.

Based on our analysis, we can postulate a sequence of events which could result in a possible uncoupling. This sequence of events has been stated above. The postulated sequence of events is primarily based on finding one inner filter disconnected from the stop piston in the initial CRD inspection.

From our analysis at the time of the uncoupling indication and our continued investigation, it is our conclusion that although unlikely, the most likely explanation was that a rod uncoupling did occur. The postulated control rod uncoupling cannot occur at any position other than the full out position, i.e., position 48, because interference between the drive uncoupling rod and the dislocated inner filter can only occur at the full out position. Any insertion of the crd recouples the drive and control blade, thus we cannot see a significant increase in the likelihood of our operating with an unknown uncoupled control rod. Consequently, we conclude that there are no safety implications as a result of this occurrence.

If this uncoupling phenomenon happens again, the drives which exhibit this phenomenon will be removed during a scheduled outage, disassembled and inspected. Additionally, when any drive is removed for scheduled maintenance, we will insure that the inner filter is properly installed by following the correct procedures.

Sincerely,

Fred S. Morris

for W. P. Worden
Superintendent

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