OAK RIDGE NATIONAL LABORATORY
OPERATED BY
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NUCLEAR DIVISION

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June 19, 1972

U.S. Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee 37830

Attention: Mr. J. A. Lenhard

Subject: Trip Report

At the request of Mr. J. P. O'Reilly, J. N. Robinson of ORNL, with Glen Madsen, Bill Hayward and Bob Glasscock of USAEC Region I Regulatory Operations, visited the Westinghouse Nuclear Fuel Division at Monroeville and at Cheswick, Pa. The purpose of this visit was to discuss the design, quality assurance, and fabrication of the fuel rod clusters and associated guide thimbles supplied by Westinghouse for the Indian Point Unit No. 2 of Consolidated Edison. This report summarizes the findings of this visit.

One of the control rod clusters had failed to properly insert during preoperational testing. This failure was due to a foreign piece of metal which had jammed the mechanism and had broken the rod cluster. In looking at other rod clusters that had failed to insert freely during testing, scored and/or galled areas were noted on several individual rods. It is to the cause and evaluation of these areas that this inquiry is directed.

The discussions considered five areas of interest: 1) the design of the control rod - thimble combination, 2) the nature and influence of manufacturing operations, 3) the adequacy of quality assurance actions, 4) post failure actions and 5) a general philosophical review of the problem. Thought was centered on the ramifications of this problem with respect to other reactors to determine whether the circumstances are general or unique to Indian Point.

The investigation is not complete and all evidence is not yet available, so statements made here, and particularly opinions expressed, are tentative and not necessarily correct. To make our contribution most useful, we have taken the liberty of being candid, even when supporting evidence is not definitive.

Review of Design: The thimble has a large diameter section in which the falling rod accelerates and a reduced diameter dash pot section in which it decelerates. The following Table summarizes the nominal and minimum clearances in the dash pot area, both for Indian Point No. 2 and for Rochester (the fabrication of Rochester fuel overlapped and followed the fabrication of Indian Point fuel):

	Indian Point			Rochester		
	Thimble	Rod	Minimum Clearance	Thimble	Rod	Minimum Clearance
Nominal Diameter	0.453	0.443*	0.010	0.4445	0.435	0.0095
Purchase Dimension	0.4525	--	0.0095			
Manufacturing Gages	0.451	0.443	0.008	0.442	0.4355	0.0065
Check Gages (on-site)	0.452	0.4435	0.0085			

*At tip, 0.440 elsewhere

Some rework (expanding of thimbles and filing of rod welds) was performed at the site as result of the on-site gaging. This is not surprising because the on-site thimble gage was larger than was the corresponding manufacturing gage. There is not evidence that the dimensions of the rods and thimbles deviated significantly from their proper values, so the clearances apparently were about what they were supposed to be.

If loss of clearance or insufficient clearance is the cause of the problem, it would appear that Rochester is even more vulnerable than is Indian Point, because Rochester has a smaller minimum manufacturing clearance.

Nature and Influence of Manufacturing Operations: The thimble tubes are produced by Superior Tube and are source inspected. Each of these tubes is inserted into the fuel assembly and is spot welded to four tabs on each grid, two opposed welds at the top of each grid being oriented 90° from the bottom two. Each

pair of welds is made using a Mallory 100 copper chill, nominally 0.451+0.001,-0.000 diameter, which is actually modified in the shop to permit easy post-weld removal. The welder exerts a 45-55# clamping force. The welds can have a push-through of 0.028 if the chill is omitted, and from a barely perceptible indentation to perhaps 0.007 if a new or an undersized chill is used. The bores were checked by manufacturing with a 0.451 plug gage and, if necessary, expanded and/or rerounded using an expanding mandrel. On completion of manufacture, Quality Assurance typically checked three of the twenty thimble bores, using the same plug gages used by manufacturing. Thus, while not likely, there is no assurance that an undersized dash pot could not have gone completely undetected through to the finished assembly.

The control rods are assembled, the tip is welded in (no filler metal is added in the weld), and are checked with a 0.443 ring gage, 100% by Quality Assurance.

After manufacturing, each fuel assembly is subjected to a drag test, using a rod cluster which is not necessarily either a standard one or the one it will be mated to in the reactor. This test measures the force required, over the dead weight of the cluster (∿175#), necessary to remove the cluster from the assembly. Values of 15-30# are usually measured, although some assemblies run as low as 5#.

At the site, and before operation, the rod clusters are subjected to a drop test with their mated fuel assemblies. It was during this testing that difficulties were encountered at Indian Point. These tests consist of a free drop of the rod cluster in water, and the recording of the velocity on a strip chart. It appears, looking at the data after the fact, that clusters that had difficulty later did show longer drop times during earlier tests.

Adequacy of Quality Assurance: This fabrication was performed in 1968, and the quality assurance was good for that time. In general (and in retrospect) the quality assurance actions taken then do not come up to current standards and even then, weren't always consistent. The quality assurance area was investigated by Mr. Hayward and Mr. Glasscock. Two specific deficiencies should be noted:

a. When sampling inspections were performed, the identity of items sampled was not recorded, so it is impossible to correlate these inspections with subsequent events.

b. If rod-dash pot clearance was considered critical, it should have been specifically and formally verified for each assembly (in fact, Q.A. only checked three thimbles out of twenty).

Post Failure Actions: Westinghouse has not proposed a specific program for investigation of the problem. It was strongly suggested they do so.

The control rod clusters have been inspected at the site and subjected to rework (filing or emery paper polishing) when appropriate. One cluster returned to the manufacturing plant was visually examined at Cheswick. There was no preferential orientation of the damaged area on individual rods to correlate with the orientation of the spot welds. One of the higher galled spots projected about 0.006 from the rod surface. The damage to the rod at Cheswick appeared to be uniformly around the rod (only one in the cluster was significantly damaged) and most of the gouging/galling appeared to have taken place as the rod was being withdrawn.

It is intended that the thimbles in the fuel assemblies will be subjected to a borescopic examination. Results from this are not yet available.

The water in the reactor is being removed and filtered to determine if foreign materials are present.

General Review: From the above discussion, the cause of control rod sticking is not evident. The borescopic examination of the thimbles might provide new clues. We suggested that Westinghouse review their procurement files for the thimbles and control rod components to see if any variations can be detected between this material and that used in other fuel loadings. Possible meaningful differences might be detected in chemistry, strength, hardness, or heat treatment of the material. If any dimensional measurements were recorded during manufacture, these should be reviewed.

It is possible that some information can be drawn from a study of the traces recorded in the drop tests. Comparing a very fast with a very slow trace might show where deviant action was initiated.

Reflecting on the evidence at hand, there were no data to indicate that dimensional interference was the sole source of the problem. I feel the cause lies in something unusual

such as the properties of the material, in the way the rod impacted on the conical transition surface in the thimble or the presence of foreign material, but I have no evidence to support this intuition. The borescopic examination at the site may shed some light on the variable or variables involved.

Sincerely yours,

J. N. Robinson

JNR:gs

cc: J. R. McGuffey
M. E. Ramsey
D. B. Trauger

RO INQUIRY REPORT NO. 50-247/72-14

Subject: Consolidated Edison Company

License No.: DPR-26

Facility: Indian Point 2 - PWR

Title: Equipment Failure - Control Rod Malfunctions

Prepared By: G L Madsen 6/9/72
G. L. Madsen, Reactor Inspector Date

A. Date and Manner AEC was Informed:

On June 2, 1972 G. L. Madsen, RO:I, L. Beratan, RO:HQ and R. Lofy, Parameters, Inc. were at the IP-2 site for the purpose of evaluating repair programs for the control rod and fuel assemblies as a result of control rod malfunction encountered during preoperation rod drop testing. (Inquiry Report No. 50-247/72-13 and Blue Sheet No. 57)

B. Description of Particular Event or Circumstance:

Three control rods failed to insert freely during preoperational rod drop testing. The reactor vessel head was removed and initial inspections revealed that the control rod malfunctions were apparently a result of two conditions,namely:

1. A metal object in the upper internals guide assembly for rod H-10.
2. A dimensional problem in the fuel assemblies, at the second grid from the bottom, in the rod guide thimble dashpots.

As a result of these findings, Westinghouse and Con Ed concluded that an inspection of all fuel assemblies was appropriate.

C. Action by Licensee:

1. The fuel assemblies were removed from the reactor vessel to the Fuel Storage Building for inspection and necessary repairs.
2. An inspection and repair program for all control rod assembly rodlets has been initiated.
3. A fuel assembly repair procedure was written and qualified by Westinghouse. The repair program consists of checking for internal diameter, burnishing the surface, and expanding the dashpot tubing as necessary. Sixty assemblies had been subjected to this repair by June 2, 1972.
4. Repair of the control rod and fuel assemblies is scheduled to be completed by June 9, 1972.

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