L. Shao

Date: SEP 29 1978

Serial No.: IE:ROI: 78-10

TRANSFER OF LEAD RESPONSIBILITY

TO: B. K. Grimes, Assistant Director for Engineering and Projects, NRR

SUBJECT: SAFE ENDS FOR RECIRCULATION NOZZLES

RESPONSIBLE ASSISTANT DIRECTOR: E. L. Jordan

DESCRIPTION OF ITEM REQUIRING RESOLUTION:

With regard to operating BWR's, GE has identified five types of safe ends which have been used to connect recirculation inlet lines to reactor vessel nozzles. Four of these types include thermal sleeves which are welded to the safe ends. The material is inconel for Type 1 safe ends and stainless steel for Types 2, 3, and 4 safe ends. The design of Types 1 and 3 safe ends includes a crevice at the thermal sleeve to safe end joint. The design of Types 2 and 4 safe ends precludes the crevice at the joint, but does include stagnant water.*

Duane Arnold has Type 1 safe ends. All of them have cracked and one crack extends thru the safe end wall. The safe ends have been removed and are being replaced with others of modified design. Metallographic examination of the cracked safe ends is in progress to determine the cause of cracking. This work is being performed by independent laboratories under contract to the licensee and IE. S.W. & B.C.

Two other units, Brunswick 1 and 2, have Type 1 safe ends. Based on preliminary metallographic results from Duane Arnold, an immediate action letter has been sent to the licensee for Brunswick specifying volumetric examination of the safe ends in the vicinity of the thermal sleeve to safe end welds.

Or thermal stress

Preliminary metallographic results obtained for Duane Arnold safe ends indicate that the cause of cracking may be stress corrosion at the tip of the crevice. Nevertheless, vibration induced fatigue originating from the jet pump riser may be a contributing factor.

Because of the presence of crevices and stagnant water in the Type 3 design, NRR and IE do have some concern for the long term integrity

*See Enclosure for identity of safe ends at each operating plant.

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49-28180

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of these safe ends. Type 4 safe ends have a more complex geometry which eliminates the crevice or locates it away from the safe end wall, but does not eliminate stagnant water.

For BWR's operating and under construction which have Type 1, 2, 3 or 4 safe ends, resolution is needed in the areas of inservice inspection, modification, and design qualification.

RECOMMENDATIONS AND PROPOSED COURSE OF ACTION:

1. NRR will evaluate the basis for continued operation of affected plants including assurance that appropriate interim actions are taken.
2. NRR will evaluate on a priority basis the need for installing accelerometers on a safe end at Duane Arnold and other units.
3. IE will obtain refueling outage schedules from Type 3 plants and other plants as requested by NRR.
4. IE will inform NRR and the NRC Pipe Crack Study Group of the results of safe end inspections and metallographic examinations as they are obtained.
5. IE will inspect for compliance with any requirements established by NRR.

CONCURRENCE:

D. W. Woodruff for
Edward L. Jordan, Assistant Director
for Technical Programs, DROI, IE

9/22/78
Date

Brian Grimes
B. K. Grimes, Assistant Director
for Engineering and Projects, DOR, NRR

9/27/78
Date

Enclosures:
1. Recirc Inlet Nozzle Summary
2. PNO-78-163

cc: R. S. Boyd, DPM
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R. J. Mattson, DSS
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TYPE 1

600

INCONEL, SAFE END AND THERMAL SLEEVE END, LONG CREVICE BEHIND FILLET WELD:

A. DUANE ARNOLD, B. BRUNSWICK 1 AND 2

TYPE 2

TYPE 304 TUNING FORK SAFE END AND THERMAL SLEEVE, PLUS EXTRA SLEEVE:

MONTICELLO, VERMONT YANKEE

TYPE 3

TYPE 316 SAFE END, SINGLE TYPE 304 THERMAL SLEEVE, SHORT FILLET WELD CREVICE (.09").

DRESDEN 2 AND 3, PEACH BOTTOM 2 AND 3, BROWNS FERRY 1, 2, AND 3, QUAD CITIES 1 AND 2

TYPE 4

DOUBLE THERMAL SLEEVE (304) WELDED TO NOZZLE FORGING I.D. BUILDUP, TYPE 304 SAFE END:

PILGRIM, MILLSTONE, COOPER, HATCH 1 AND 2, AND FITZPATRICK

TYPE 5

NO THERMAL SLEEVE (OR JET PUMP) TYPE 316 SAFE END:

OYSTER CREEK, NINE MILE POINT 1, BIG ROCK POINT, DRESDEN 1 (304L)

LAS
5/29/73

September 14, 1978

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-78-163

This preliminary notification constitutes EARLY notice of an event of POSSIBLE safety or public interest significance. The information presented is as initially received without verification or evaluation and is basically all that is known by IE staff on this date.

Facility: Iowa Electric Light & Power Company, Duane Arnold (DN 50-331), Palo, IA

Subject: JET PUMP RISER CRACK

The jet pump riser crack problem at Iowa Electric Light and Power Company's Duane Arnold facility has been previously reported by PNO-78-125 and 125A dated June 19 and 29, 1978, respectively. Metallographic samples were taken from the nozzles and sent to Battelle-Columbus and Southwest Research for examination. Preliminary results obtained to date indicate that the cracks are inter-granular in nature and initiate in the area of the crevice formed by the thermal sleeve and inconel transition piece.

Carolina Power and Light Company's (CP&L) Brunswick Nuclear Plants 1 and 2 are similar in design and material fabrication to the Duane Arnold plant. Due to the similarity, plans have been made for CP&L to conduct nondestructive examination of a selective number of nozzles for crack indications. Brunswick Unit 2 is presently shutdown, and testing will be conducted prior to its return to power.

There is some potential for the crack problem to exist at other similar plants. This problem is currently being reviewed by the NRC staff.

These plants are: Browns Ferry Units 1, 2, & 3
Dresden Units 2 & 3
Peach Bottom Units 2 & 3
Quad Cities Units 1 & 2

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Nearer Than Browns Ferry

A 270° crack in its reactor piping may have brought the Duane Arnold Nuclear Plant closer to a meltdown accident than did the renowned fire at the Browns Ferry Nuclear Plant in 1975.

by David Dinsmore Comey

Until recently, the March 22, 1975, fire at the Browns Ferry Nuclear Power Plant near Decatur, Alabama, was the closest the American nuclear industry had come to a major accident at a civilian nuclear power plant. The fire destroyed the reactor control circuits, starting a "boil-off" of primary coolant in the reactor core. At the same time, it disabled emergency core cooling systems. Fortunately, the "boil-off" was halted before a core meltdown began.[1]

On June 17, 1978, however, the Duane Arnold Energy Center in Cedar Rapids, Iowa, came closer — according to industry experts — to a "loss-of-coolant" accident than did Browns Ferry in 1975. This incident has received very little media attention.

On June 17, 1978, reactor operators were testing the control valves on the Duane Arnold Center, a 538 megawatt boiling water reactor operated by Iowa Electric Light and Power Company. Suddenly, because of problems with electrical relays in the reactor protection system, the reactor accidentally shut down. Only then, when an inspection of the reactor drywell was made, was it discovered that a primary coolant pipe was leaking from a four-inch long crack.

The leaking pipe was one of eight 10-inch diameter pipes used to transfer cooling water from the recirculation system to the jet pumps inside the reactor. The crack was located in a section of the pipe known as a "safe end forging" that joins the pipe to the inlet nozzle on the reactor pressure vessel. This "safe end," located near the bottom of the reactor core, is a highly undesirable location at which to have a pipe break. A "design basis accident" analysis performed by the U.S. Nuclear Regulatory Commission (NRC) states that "a complete circumferential break of one of the recirculation loop pipes" would result in the worst "loss-of-coolant" accident possible at a boiling water reactor.[2]

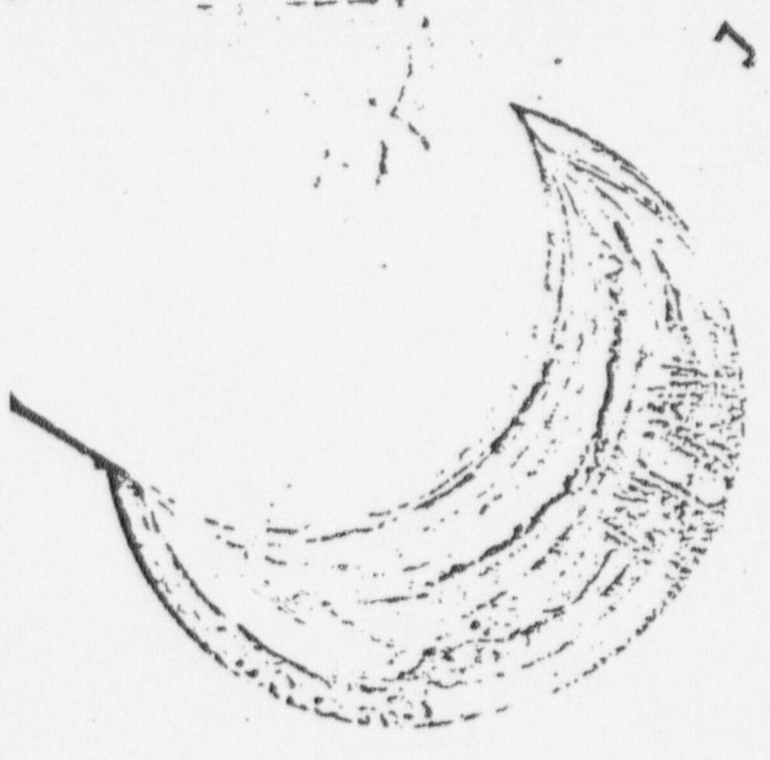
The leak continued even after the reactor was de-pressurized. (See accompanying photo.) As a result, the reactor was cooled down and the fuel in the reactor core was removed to the spent fuel po[ol]. Radiographic and ultrasonic testing showed that, although the visible crack was four inches long, this crack actuall[y] extended approximately 270 degrees around the circumference of the pipe. When the other seven recirculation pipe safe ends were radiographed and ultrasonically tested, all seven were found to be cracked to some extent: four had significant indications of intermittent cracking around their entire circumferences.

As of this writing, all eight safe ends are scheduled to be replaced by newly designed forgings being fabricated at Coulter Steel and Forge Company in Berkeley, California. The plant cannot be restarted before late October, and the utility estimates that repair costs will be about $2 million. The Iowa Commerce Commission estimates that Iowa Electric will probably spend more than $15 million to purchase power from other utilities while the plant is shut down. The Commission's chairman, Morris Van Nostrand, says he expects the utility to make an "aggressive" attempt to recover repair costs from General Electric.

The original safe ends were manufactured by Lanape Forge in Pennsylvania, under subcontract to Chicago Bridge and Iron, which in turn was a subcontractor to General Electric, the reactor manufacturer. A drawing error caused machinists at Lanape to cut a groove that was 3/8 of an inch too deep around each pipe. These grooves were then filled in with weld metal. Records at Lanape, CB&I, and GE show that these repairs were approved as meeting required safety codes.

An NRC official says, "Quite obviously we weren't aware of the repairs, and

At CBE, we call this a picture of the world's first nuclear shower. Water spurts from the reactor pipe even after the reactor has been depressurized.



no one here is happy repaired parts were used." But an NRC inspector says that the repairs would have met even the more stringent safety codes in force today.

Because the three companies involved in fabricating the safe ends at Duane Arnold manufactured similar fittings for the Brunswick Nuclear Plant near Wilmington, North Carolina, which is owned by Carolina Power and Light, CBE has questioned whether Brunswick might not suffer the same problem as Duane Arnold. Because the safe end walls at Brunswick are approximately one-inch thick, however, while those at Duane Arnold are only 1/2-inch thick, the NRC believes that Brunswick shows no cause for concern. All GE nuclear power plants other than Brunswick use a different safe-end design from that at Duane Arnold.

But it is worth noting that, at another GE plant, approximately two months before the incident at Duane Arnold, an unscheduled inspection conducted on April 26, 1978, during the re-[illegible]ling of the Cooper Station of Nebraska Public Power south of Omaha discovered indications of cracking on three of the recirculation loop pipes where the safe-end welds join the nozzles. The defects were ground out without violating minimal wall thickness codes, and the NRC has accepted the repairs [illegible] atisfactory.

The NRC still does not know why the safe ends at Duane Arnold cracked,[3] even though the repairs made to the improperly machined piping met both past and present code requirements.

Fortunately, neither the Duane Arnold or Cooper reactors were operating wh[illegible], the cracks were discovered. We may not be so lucky the next time.

FOOTNOTES

[1] Details may be found in David D. Comey, "The Incident at Browns Ferry," *Not Man Apart*, September 1975, reprinted in: Peter Faulkner (ed.), *The Silent Bomb* (N.Y., Random House, 1977).

[2] *Preliminary Safety Analysis Report, Bailly Generating Station Nuclear 1*, p. 14.6.12.

[3] The NRC has obtained one of the cracked safe ends and sent it to Battelle Memorial Laboratory in Columbus, Ohio for destructive testing that may reveal the cause of the cracking. This testing will be an independent check on the testing being performed for Iowa Electric at Southwest Research in San Antonio, Texas.

Civil Liberties *Continued from page 7.*

measures would be expensive. But nuclear facilities could be turned into impregnable "fortresses." If this were the case, there would be no necessity of conducting surveillance in order to be aware of potential threats; any attack could be repelled.

"Is it better to torture a suspected terrorist than to let a city go up in flames?"

Such measures would not, however, protect against the possibility that an employee might smuggle in explosives or override safety devices in such a way as to cause a reactor to melt down or a waste storage facility to disperse its radioactive contents over a wide area.

In order to protect against potential sabotage from within the facility, the NRC recently proposed an "accession authorization program" for employees at nuclear power plants. The program would include "background investigations as to character, associations, and loyalty, conducted under standards and specifications established by the Commission." Employees would be subjected to "full-field background investigations" by the Federal Bureau of Investigation and other agencies, in which past fellow employees, landlords, personal and professional acquaintances, neighbors, and intimate personal relations would be interviewed. Other methods of investigation being discussed would include psychological testing, clinical evaluation, and polygraph examinations.

Mr. Shattuck, in his testimony on behalf of the ACLU, said that most of these proposed measures are infringements or violations of protections now guaranteed by the Constitution and by case law. The NRC has estimated that more than 21,600 people will be subject to such investigative clearances by 1985, and Mr. Shattuck characterized this number as "alarming." He said, "The proposal would set a dangerous precedent by extending a security clearance system historically confined to sensitive government positions to an entire industry, thereby broadly affecting the private sector." He proposed that the NRC seek less intrusive, "non-investigative safeguard measures which would not undermine the Constitutional rights of nuclear industry employees."[5]

The ACLU position seems to be that it is possible to operate a major nuclear power program and still protect the civil liberties of the people employed in this program. But I disagree. Only thorough investigations will protect against the possibility of sabotage from within a nuclear power plant and the loss of hundreds of thousands of lives. This situation can be described in the same terms used by Russell Ayres with respect to a plutonium economy: To protect the public it is necessary to deny the civil liberties of a significant segment of the population.

The ACLU calls the NRC's security proposals "alarming."

Nuclear power thus represents a threat to our civil liberties as great as any other this country has faced. The many other drawbacks and hazards of nuclear power have become obvious in recent years. But on civil liberties grounds alone, nuclear power deserves to be abandoned.

Footnotes

[1] David D. Comey, "Nuclear Power: the Ult[illegible] mate Internal Subversion", December 197[illegible] luncheon address to American Bar Assoc[illegible] ation, Washington, DC; also David D. Come[illegible] "Die sozialen Zwänge der Kernenergie [illegible] *Kernenergie* (Frankfurt am Main, Fischer Ve[illegible] lag, 1976), pp. 122-138.

[2] David D. Comey, "The Perfect Tro[illegible] Horse," *Bulletin of the Atomic Scientist*[illegible] June 1976, p. 34.

[3] Russell W. Ayres, quoted in *Chicago Da*[illegible] *News*, Nov. 29, 1975, p. 3. See also h[illegible] "Policing Plutonium: The Civil Liberties Fa[illegible] out," *Harvard Civil Rights — Civil Liberti*[illegible] *Law Review*, Vol. 10, No. 2 (Spring 1975), p[illegible] 369-443. (Reprints may be obtained for $3[illegible] from William S. Hein, Inc., 1285 Main Stre[illegible] Buffalo, NY 14209).

[4] Russell W. Ayres, quoted in *Washin*[illegible] *Post*, Nov. 17, 1975, p. A24.

[5] John H.F. Shattuck, "Testimony of Ame[illegible] Civil Liberties Union," June 8, 1978, Doc[illegible] No. RM-50-7, U.S. Nuclear Regulatory Co[illegible] mission, Washington, DC [illegible] 555.