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NRC PUBLIC DOCUMENT ROOM

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NUCLEAR REGULATORY COMMISSION

ABNORMAL OCCURRENCE EVENT

DEGRADED PRIMARY COOLANT BOUNDARY IN A BOILING WATER REACTOR

Section 208 of the Energy Reorganization Act of 1974, as amended, requires the NRC to disseminate information on abnormal occurrences (i.e., unscheduled incidents or events which the Commission determines are significant from the standpoint of public health and safety). The following incident was determined to be an abnormal occurrence using the criteria published in the FEDERAL REGISTER on February 24, 1977 (42 FR 10950). Appendix A (Example II.A.2) of the Policy Statement notes that a major degradation of the primary coolant pressure boundary of a commercial nuclear power plant can be considered an abnormal occurrence. The following description of the event also contains the remedial actions taken.

Date and Place - On June 17, 1978, Iowa Electric Light and Power Company reported to the NRC an event at the Duane Arnold Power Plant, a boiling water nuclear plant located in Linn County, Iowa.

Nature and Probable Consequences - The reactor had shut down on June 17, 1978 due to an unrelated problem experienced during a

surveillance test. Prior to this unplanned shutdown, a primary coolant system leak of approximately three gallons per minute (gpm) from an unidentified source had been detected by the plant's leakage monitoring equipment. Although this leak rate was within the technical specification limit of five gpm, the licensee took advantage of the unplanned shutdown to perform an inspection to identify the source of the leakage. The leaking water was collected in the reactor building drain system and pumped to the plant's radioactive waste treatment system for processing.

During the inspection of the reactor coolant system piping, a through-wall crack was found in a nickel-steel alloy (Inconel) fitting joining the ten inch diameter recirculation pipe to the reactor vessel. The recirculation line, a part of the primary system pressure boundary, directs primary coolant flow to two jet pumps located inside the reactor vessel. The jet pumps are utilized to circulate the primary coolant through the reactor core. There are a total of eight such vessel nozzle penetrations for the reactor's 16 jet pumps. The crack was in the recirculation line to nozzle transition piece, near the attachment weld for the piping leading to the jet pumps. The crack was approximately eight inches long on the outer diameter (i.e., through-wall) and, based on ultrasonic testing results, was determined to extend about three-quarters around the circumference of the inner diameter.

Non-destructive testing of the remaining seven similar transition pieces revealed that five had indications (potential cracks or weld irregularities) that may also require repair; however, these indications do not penetrate through the pipe wall.

Since the leak could not be isolated, such as by closing a valve, for repair by conventional means, special procedures were necessary to make repairs. The leak, however, did not pose a threat to public health or safety. The plant was shutdown, and any leaking water was collected and processed by the radioactive waste treatment system. Water lost from the primary system was replaced by plant systems designed for that purpose. Later, all fuel assemblies were removed from the reactor vessel to facilitate repairs.

The primary coolant pressure boundary is one of several barriers to prevent the release of radioactive materials. Plant operations are not permitted if this boundary is degraded. An Emergency Core Cooling System is available if a pipe should break.

Cause or Causes - The cause of the cracking has not yet been established. As part of the repair procedure, a failure analysis will be conducted. During vessel fabrication, all eight of these nozzle fittings were mistakenly machined and then weld repaired. Due to the proximity

of the crack location to the weld repair area, it is suspected that the weld repair contributed to the propagation of the crack. However, other potential causes are being actively evaluated. The General Electric Company (GE) has compared the design of the transition pieces utilized in the Duane Arnold facility with those used in other BWR plants and, based on information to date, considers this cracking problem to be specific to the Duane Arnold plant.

Action Taken to Prevent Recurrence

Licensee - The licensee is exploring methods of repair. The plant is expected to be shutdown for several months, depending upon the extent of the problems experienced during repair. The licensee and GE reviewed all planned actions with the NRC in a meeting on July 7, 1978. The licensee is proceeding to remove the cracked nozzle transition piece and will send the specimen to a laboratory for failure analysis. The licensee has performed additional non-destructive examinations of the other seven nozzle transition pieces. Five had indications which could be attributed to either slag, non-fusion or cracks in the area of the repair welds made during fabrication. On this basis, the licensee intends to replace all eight transition pieces.

Reactor Vendor - The General Electric Company is continuing efforts to identify the specific cause of the cracking and to pursue any

possible generic implications with other BWR plants. GE will keep the NRC informed of their review and meetings will be held as necessary.

NRC - The NRC has reviewed information submitted by GE which classifies the BWR recirculation line to nozzle transition piece designs utilized in operating BWR facilities into five categories, the most unique of which is that utilized in the Duane Arnold facility. Only two other operating facilities, Brunswick Units Nos. 1 and 2, utilize designs similar to that used at Duane Arnold. However, the transition piece cross section utilized in these facilities is thicker (approximately one inch as compared to approximately one-half inch) than that of the Duane Arnold design.

Based on the information currently available, the NRC believes that the combination of the weld repair, the location of the attachment weld for the jet pump piping, and the thin transition piece cross section contributed to the propagation of the crack at Duane Arnold. No other BWR facility is known to have this same combination of factors in its design.

The methods of repair, the cause of the cracking, and any generic implications are being actively pursued with the licensee and reactor vendor. The proposed repair procedures and the failure

analysis will be reviewed. Any repairs will be reviewed and inspected before the plant will be allowed to resume operation.

For the Nuclear Regulatory Commission

Samuel J. Chilk
Secretary of the Commission

Dated at Washington, D.C. this 2nd day of August, 1978.