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U. S. Nuclear Regulatory Commission
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Subject: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
Additional Information For Inservice Inspection
Relief Request 95-001 (TAC No. M94384)

Gentlemen:

On May 31, 1995, Entergy Operations submitted Relief Request 95-001 to the Arkansas Nuclear One, Unit 1 (ANO-1) Inservice Inspection Program for NRC review and approval (1CAN059508). This relief request provided the basis for supporting elimination of the required ultrasonic examination of the reactor vessel transition-piece-to-bottom-head weld and described the alternative examinations to be performed. Subsequent discussions with the staff identified three questions regarding the relief request which required a written response. This response was submitted on October 24, 1995 (1CAN109503).

By NRC letter dated February 15, 1996 (1CNA029602), ANO received a request for additional information regarding the subject relief request. Information was requested for five (5) areas. The response to this request is included in the attachments to this letter.

Very truly yours,

Dwight C. Mims

Dwight C. Mims
Director, Nuclear Safety

DCM/dwb

Attachments

A047 1/1

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Attachment 1

RESPONSES TO NRC REQUEST FOR ADDITIONAL INFORMATION

NRC Request "A"

Discussion of potential damage mechanisms - The licensee has cited neutron embrittlement as a potential damage mechanism for the shell welds in the beltline region only. The licensee should also address the following:

The reactor pressure vessel transition-piece-to-bottom-head weld is of a lesser wall thickness than the shell welds. Address the stresses and potential damage mechanisms associated with this weld. The discussion should include, but not be limited to affects of potential neutron embrittlement on the subject weld (considering the reduced wall thickness), corrosion, loads associated with welded attachments (12 flow stabilizer lugs are located on and above the subject weld), lower head penetrations, expansion/contraction stresses associated with reactor operation cycles and operating conditions.

ANO Response

The information relative to this question is contained in Item 2A of Structural Integrity Report No. SIR-96-022, which is included as Attachment 2. In addition, the drawings submitted with Relief Request 95-001 show the congested nature of the bottom head, both internally and externally, of the reactor vessel.

The hemispherical shape of the bottom head results in a thinner cross-section than is found in the beltline region. The stresses in the bottom head due to internal pressure are reduced as a result of the spherical configuration (as opposed to the cylindrical shape of the beltline). As a result, the stresses in the bottom head are similar to those in the beltline region as required by ASME Code, Section III, in order to maintain equivalent safety factors.

The potential damage and deterioration mechanisms addressed in Attachment 2 include general corrosion, stress corrosion cracking (including intergranular, transgranular and irradiation-assisted), erosion-corrosion, crevice corrosion, pitting, intergranular attack, hydrogen embrittlement, microbiologically-influenced corrosion, neutron embrittlement, thermal embrittlement, fatigue, and fabrication defects.

The stresses addressed in Attachment 2 include pressure, thermal transients, expansion/contraction stresses of cladding, loads associated with welded attachments (flow stabilizer lugs), stresses resulting from bottom head penetrations, and weld residual stresses.

In summary, when the above factors are considered, the bottom head weld is still demonstrated to be safe for the remaining operational life of the plant, i.e., 40 years from the beginning of commercial operation.

NRC Request "B"

Confidence that no flaw is present in the weld - The licensee has stated that the likelihood of a significant flaw existing in this weld is very small. In the case of the fabrication, preservice, and inservice examinations, the weld was found to be satisfactory. Confirm that there are no preexisting, recordable flaws, acceptable by Code.

ANO Response

The transition-piece-to-bottom-head weld (01-006) has had several different non-destructive examination (NDE) methods applied to it. First, it was radiographed to fulfill requirements of the original construction code. Afterwards, it received an ultrasonic (UT) examination while the reactor vessel was still in the fabrication shop during August 1971. This shop examination was performed from both the inside and outside of the vessel using 45-degree and 0-degree UT transducers.

It received another examination during March and April 1974, after the reactor vessel had been installed in ANO-1. This preservice examination included visual and volumetric methods. The volumetric examination was performed using automated underwater UT, as well as manual UT. The automated examinations were performed by Babcock and Wilcox (B&W) using their Automated Reactor Inspection System (ARIS), which is a remote underwater UT scanner. With the automated system, the extent of examination for this weld was limited due to interferences with the guide lugs, incore instrumentation guide tubes, and the flow stabilizers. The manual UT was performed in order to increase the amount of coverage obtained on this weld. Since the manual transducers are smaller and more maneuverable than the automated transducer heads, greater coverage was attained. Both the automated and manual examinations were performed from the inside of the vessel to standard, approved B&W UT procedures in use at that time. During the examinations, the weld received a 360-degree scan with the exception of those areas where physical interferences prevented examination by the automated method. During the manual examinations, the major obstructions were the flow stabilizers; however, the smaller manual transducers were able to maneuver around them. Consequently, the preservice examinations were essentially 100% complete.

A review of the NDE data sheets for these examinations revealed that there were no recordable planar indications found. Only one small recordable, but Code-acceptable, lamination was found using the automated UT. Laminations are inherent in any steel plate fabrications and are not considered to be detrimental to the part, especially when the laminations are small. There were no recordable planar (through-wall) indications that could grow with time and stress. This information was gathered from the B&W Baseline Inspection Report dated August 12, 1974.

The weld was examined inservice near the end of the first 10-year inspection interval during the fifth refueling outage (1R5). The actual examination date was December 19, 1982. The UT was performed in accordance with ASME Section XI, 1974 Edition with Addenda through Summer 1975, and NRC Regulatory Guide 1.150, Revision 0. These examinations were performed by B&W, who again used ARIS. The extent of examination for this weld was limited due to physical interferences as mentioned above. Even with these limitations, the weld was successfully inspected per the ASME Code requirements which mandated that a minimum of 5% of the circumferential length be inspected. The reactor vessel weld NDE data sheets, which document these inservice inspections, state that there were no recordable indications during this examination.

NRC Request "C"

Structural integrity - The licensee essentially proposes the elimination of the subject volumetric Code examination of the accessible portions of the weld. This implies that other RPV welds are more susceptible to failure than the subject weld. Based on a qualitative comparison of the fracture toughness of the beltline weld to the lower head weld, what is the estimated critical flaw size for the lower head weld (Appendix G ASME Code flaw size)?

ANO Response

The information relative to this question is contained in Item 2C of Structural Integrity Report No. SIR-96-022 (Attachment 2). Supporting information regarding critical flaw size is contained in Structural Integrity Report No. SIR-95-017 which is included as Attachment 3. This attachment provides flaw acceptance guidelines for the ANO-1 reactor vessel. The applicable guidelines for the subject weld are included in Appendix I of Attachment 3. The graphical guidelines are conservative and present flaw acceptance criteria for each of the particular vessel regions, which are described in Section 3.0 of this attachment. These charts show a maximum allowable flaw size which is dependent on flaw orientation, aspect ratio and on the material thickness.

To summarize the findings of these two Structural Integrity Reports, the bottom head weld in the ANO-1 reactor vessel is very stable. Safe operation of the reactor vessel is possible even if a major flaw were to exist. In the 6-inch-thick material, adequate strength would still exist even if this weld contained a crack three inches deep and eighteen inches long.

NRC Request "D"

Radiation fields - The licensee has not addressed the radiation dose potential associated with the examination of the subject weld. Provide information on the estimated exposure associated with the examination of the subject weld.

ANO Response

The estimated radiation dose to personnel while performing an examination of this lower reactor vessel weld using any underwater automated UT manipulator is minimal. The inspection system that was actually used at ANO-1 during the current (second) 10-year interval was the B&W Underwater Reactor Scanner Unlike ARIS (URSULA) system. The URSULA robotic manipulator is designed to examine the reactor vessel welds from the interior of the reactor vessel. The current technology used to perform the weld examination required minimal personnel working over the reactor vessel. After initial installation of URSULA, a large portion of a reactor vessel weld can be scanned without moving the manipulator base. The manipulator is controlled from a remote operations center located outside the reactor building, thus minimizing dose. Radiation dose is only accumulated when personnel are required to relocate the manipulator base or to effect equipment repairs should they be required.

To examine the weld from the vessel exterior presents considerable problems. Access to the region underneath the reactor vessel is limited and gained only by passage through a small tunnel leading from outside the biological shield wall to the area directly below the reactor vessel and inside the reactor vessel support skirt. This area is extremely congested with the 52 incore guide tubes that penetrate the bottom head, the bottom head insulation, and its support structure. The transition-piece-to-bottom-head weld is located above all of these interferences at the crotch location of the transition piece. Due to the congested nature of the area and the lack of automated equipment to scan the weld, a technician would have to access the area and perform a manual examination. It is estimated that the total dose exposure accumulated to perform this examination would be 25-35 person-REM with an associated cost of between $250,000 and $350,000.

Another option for examining this weld is to perform a complete off-load of the nuclear fuel and reactor internals at some future outage. At that time, the URSULA manipulator can examine the weld from the interior. The costs associated with this approach would be approximately eight days of critical path time which is equivalent to approximately $4,000,000. Also, there would be additional costs associated with the UT vendor. These costs are prohibitively high without a compensating increase in the level of plant safety.

NRC Request "E"

<u>Potential for damage caused by examinations</u> - The licensee cites limited access for examination and the potential for damage of incore instrumentation by the examination tool. Provide a detailed access study and determine the actual probability for potential damage due to the inspection tooling, (i.e., considering clearance requirements, tool operations, etc.). In addition, provide instances where damage, if any may have been associated with the subject weld, has occurred resulting from the use of the inspection tool at your plant or at any other plant with similar reactor pressure vessel designs.

ANO Response

The URSULA employs a two-by-two matrix of ultrasonic transducers in the scanning head. In order to scan a weld, the transducer shoe must be in contact with the vessel surface. The area surrounding the transition-piece-to-bottom-head weld is extremely congested with other reactor vessel components, such as the guide lugs, the incore instrumentation guide tubes, and the flow stabilizers. The reactor vessel components of immediate concern, should an impact occur with the URSULA scanning head, are the incore instrument guide tubes. These slender tubes protrude from the inner surface of the bottom head approximately 12 inches and are 3/4-inch nominal pipe size. Alignment of these tubes is critical as they are inserted into a mating tube on the lower section of the core barrel when it is placed in the vessel. Any misalignment of these tubes due to an impact with the scanning head would cause significant damage not only to the incore guide tube, but also to the mating tube on the core support assembly and any adjacent tubes if significant deflection were to occur while installing the core barrel. Repair to the damaged incore instrumentation guide tube and any other affected components would cause significant expenditures of critical path time and dose exposure.

The first deployment of the URSULA manipulator was at ANO-1. While developing the scan plan for the vessel inspection, it was determined that access to the transition-piece-to-bottom-head weld would be less than 7%. The scan plan was developed using 3D CAD software (ROBOCAD) which incorporates the actual vessel dimensions and all the interferences. This allowed the programmers to determine how much of the weld would actually be accessible for scanning.

Determining the actual probability for potential damage due to the inspection tooling is impractical. However, it is the vendor's opinion that the URSULA manipulator possesses enough strength to bend an incore guide tube if it were to be positioned incorrectly. Knowing this, it was Entergy's opinion at the time of the reactor vessel examination that the probability of damage to the incore guide tubes was sufficient to warrant discussions with NRR. Following a discussion of our concerns, NRR verbally agreed that the very-limited examination of the bottom head weld was unnecessary. Since its first utilization at ANO-1, no other B&W plant has performed a reactor vessel examination with URSULA. One B&W plant will be performing a reactor vessel examination with URSULA during the early spring of 1996. They also intend to eliminate the examination of this same bottom head weld because of the same problems encountered at ANO-1.

Attachment 2