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10 CFR 50.55a

2130-02-20214
July 26, 2002

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: Oyster Creek Generating Station
Facility License No. DPR-16
Docket No. 50-219
Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel

References:
1) AmerGen letter 2130-00-20300 dated November 10, 2000, "Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
2) AmerGen letter 2130-00-20304 dated November 14, 2000, "Modification to Proposed Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
3) USNRC letter dated November 16, 2000, "Request to Use an Alternative Repair of the Control Rod Drive Housing Interface with the Reactor Vessel at the Oyster Creek Nuclear Generating Station"

In accordance with 10 CFR 50.55a(a)(3)(i), enclosed for NRC review and approval is a proposed alternative to 10 CFR 50.55a(g). The alternative consists of roll-expansion repairs to control rod drive (CRD) housing penetrations at Oyster Creek. This request is similar to the request submitted by AmerGen Energy Company, LLC (AmerGen) for Oyster Creek in Reference 1 and approved by the NRC in Reference 3. At the time of the Reference 1 request the facility was in a refueling outage and two CRD housing penetrations were observed to be leaking. AmerGen repaired the penetrations as described in References 1 and 2 before restart from the outage. The CRD housing penetrations repaired in November 2000 are the only two CRD housing penetrations that have leaked in over thirty years of plant operation. No additional CRD housing penetrations have been found leaking during subsequent inspections nor have the two repaired penetrations exhibited any further leakage.

The NRC approval in Reference 3 was for the current operating cycle up to the next (1R19) refueling outage. This request is for approval of an alternative to a Code repair of the two CRD housing penetrations discovered leaking in Fall 2000 and the repair of any additional CRD housing penetrations that exhibit leakage during future inspections. AmerGen intends to employ the roll-

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expansion repair technique as described in Boiling Water Reactor Vessel and Internals Project (BWRVIP) Report, "Roll/Expansion Repair of Control Rod Drive and In-Core Instrument Penetrations in BWR Vessels (BWRVIP-17)," as used in repair of the two penetrations in Fall 2000, for repair of any additional penetrations that may exhibit leakage until expiration of Oyster Creek's operating license on April 9, 2009. A weld repair according to BWRVIP-58, "BWR Vessel and Internals Project, CRD Internal Access Weld Repair," or an equivalent Code repair, will be employed if roll-expanded penetrations do not meet the leakage limits in BWRVIP-17 or more than five CRD penetrations continue to leak after roll-expansion repairs. NRC approval of this alternative is requested by October 4, 2002, which is the scheduled start date for the 1R19 outage.

The roll-expansion repair technique is a proven effective method of eliminating CRD housing penetration leakage as indicated by the experience at Oyster Creek and its sister plant Nine Mile Point Unit 1, where thirty-two of thirty-three roll-expanded CRD housing penetrations have not exhibited leakage in up to 18 years of plant operation. If Oyster Creek's operating license is not renewed beyond April 2009, then roll-expansion repaired CRD housing penetrations will only have been in service for about 9 years at Oyster Creek. In the event that AmerGen decides to submit an application for the renewal of Oyster Creek's operating license, CRD housing penetration leakage will be addressed by a roll-expansion/weld repair program included in the application.

If you should have any questions, please contact Mr. John G. Hufnagel at 610-765-5507.

Very truly yours,

JGHufnagel for

Michael P. Gallagher
Director, Licensing & Regulatory Affairs
Mid-Atlantic Regional Operating Group

Enclosure: Oyster Creek Generating Station
Proposed Alternative to ASME Section XI Code Requirements

c: H. J. Miller, USNRC Administrator, Region I
P. S. Tam, USNRC Senior Project Manager, Oyster Creek
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File No. 00086

OYSTER CREEK GENERATING STATION
PROPOSED ALTERNATIVE TO ASME SECTION XI CODE REQUIREMENTS

Introduction

In accordance with 10 CFR 50.55a(a)(3)(i), AmerGen Energy Company, LLC (AmerGen) requests authorization to utilize an alternative to 10 CFR 50.55a(g) which invokes the requirements contained in specific Editions of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI for Inservice Inspection and Repair and Replacement Programs. Specifically, Article IWA-4000 of Section XI of the ASME Code describes the Code repair process. A Code repair requires the removal of the flaw and a subsequent weld repair. Additionally, IWA-5250 of Section XI requires that the source of leakage detected during the conduct of a pressure test on a system be located and evaluated for corrective measures and repair. The control rod drive (CRD) housings and stub tubes are considered ASME Section XI Code Class 1 components. AmerGen is requesting approval of an alternative repair at the Oyster Creek Generating Station. The selected repair has been demonstrated to be successful for repairing leaking penetrations at other facilities and at Oyster Creek. The roll-expansion repair technique has been routinely employed in the field with proven equipment and thus reduces personnel exposure versus a weld repair technique that is as yet not demonstrated in any actual repair application.

The roll-expansion repair technique, inspection and leakage criteria contained in Boiling Water Reactor Vessel and Internals Project (BWRVIP) Report, "Roll/Expansion Repair of Control Rod Drive and In-Core Instrument Penetrations in BWR Vessels (BWRVIP-17)" (Reference 4), provide an acceptable level of quality and safety in lieu of a Code repair.

As discussed below, the repair will meet the qualification criteria described in BWRVIP-17, as it applies to Oyster Creek, without exception. The proposed roll-expansion repair has been demonstrated to ensure the continued integrity of the CRD housing and reactor vessel, and to ensure that the associated components perform their intended safety function. Controls over repair processes have been established to ensure that the repair will be performed in a safe and efficient manner.

AmerGen requests approval of this alternative until April 9, 2009 when the current operating license expires. Previous approval of this alternative was requested by AmerGen (References 1 and 2) and authorized by the NRC in Reference 3.

Background

During refueling outage 1R18 at Oyster Creek, visual inspections performed during the reactor pressure vessel (RPV) leak test identified water leaking from the under-vessel area at the mirror insulation in the vicinity of CRD housings 42-43 and 46-39. Further inspection determined that the leakage originated at the interface of the RPV lower head and CRD housing. The penetrations were roll-expansion repaired in accordance with BWRVIP-17.

Although the exact origin of the leak has not been determined, several possibilities exist: these include 1) the stub tube, 2) the stub tube-to-housing weld, or 3) the RPV-to-stub tube weld (see attached figure). AmerGen will remove a control rod guide tube during the 1R19 refueling outage, currently scheduled to commence on October 4, 2002, to gain access to the lower plenum of the RPV. An examination of the bottom head in the area of the stub tubes associated with CRD housings 42-43 and 46-39 will be performed with a remote observation vehicle to support the root cause determination of the leakage. Based upon review of the stub tube repair program during original construction, the most likely cause appears to be related to the stub tube overlay performed by a certain welder.

During a 1967 hydrostatic test of the reactor vessel, a leak was discovered from a CRD penetration. The leak was found to be unrelated to cracking of the stub tube nozzles. However, while investigating the cause of the leak, a significant number of cracks were located by dye penetrant examination in the furnace-sensitized stub tube material above the Inconel weld to the reactor vessel shell. A program was initiated to determine the cause and develop a repair procedure for the stub tube nozzle cracks. The defects were intergranular cracks located in the stub tube material above the Inconel weld, localized, and shallow in depth. The cracks were removed to sound material by grinding, and the stub tubes were repaired by weld overlay. The weld overlay consists of machine-applied 308L weld overlay on the stub tube body, which is tied into the weld attaching the CRD housing to the stub tube by manual (SMAW) welding with Type 308L weld metal. The overlay is tied into the existing INCO 182 SMAW vessel-to-stub tube weld using INCO 182 weld metal. The stub tube repair program is summarized in the Updated Final Safety Analysis Report, Section 5.3.3.2.

The following information is provided in support of the alternative repair. This information is provided in a format discussed in Section 3.9.2 of BWRVIP-17.

I. Description of the Repair

Specific Description of the Repair

The repair activity, performed during the 1R18 outage in November 2000, involved a roll-expansion of CRD housings 42-43 and 46-39 into the bore region of the RPV lower head. The roll-expansion process has also been utilized to repair RPV lower head CRD housings at Nine Mile Point Unit No. 1 (NMP-1), which employs a CRD housing design similar to Oyster Creek's. The roll-expansion repair mitigates leakage due to cracking of 1) the stub tube, 2) the stub tube-to-housing weld, or 3) the RPV-to-stub tube weld.

Design Objectives

To date, the roll-expansion process has eliminated leakage from CRD housings 42-43 and 46-39. Similar results in eliminating CRD housing penetration leakage are expected for any future roll-expansion repairs. The housings were plastically expanded within the RPV lower head bore to create radial contact pressure between the housing and the vessel bore. Proper contact pressure is achieved by controlling the radial expansion of the housing and by utilizing additional passes to increase the contact length. The process will have no harmful effects on affected CRD housings.

Design Criteria

The CRD housings are diametrically expanded to ensure that the contact pressure at the housing-to-RPV lower head bore is about three to five times the RPV system pressure, i.e., 3000 psi - 5000 psi. Localized yielding of the housing results along the rolled interface. Since the yield strength of the RPV lower head is greater than that of the CRD housing, the net effect is plastic deformation and wall thinning of the CRD housing. Wall thinning of 3% - 5% in the housing thickness is specified in order to achieve a continuous contact pressure between the housing and the vessel bore. Experience has shown that a roll length between 4½ and 5½ inches combined with wall thinning in the range of 3–5% is effective in mitigating leakage. The diameter of the CRD housing is increased by 0.070" ±0.006". The roll expansion process, equipment and personnel are qualified on a mockup to ensure that process parameters are maintained during in-plant application.

The actual CRD housing wall thinning was in the range of 5.8% for CRD 42-43 and 6% for CRD 46-39. AmerGen provided a discussion in Reference 2 regarding these wall thinning results. The report concluded that, while greater than the nominal range for a typical initial roll, the wall thinning achieved for CRDs 42-43 and 46-39 was within design parameters and there were no negative impacts.

II. Safety Evaluation

Component Failure Analysis

Although the exact origination of the leak has not yet been determined, several possibilities exist: these include 1) the stub tube, 2) the stub tube-to-housing weld, or 3) the RPV-to-stub tube weld (see attached figure). These components are constructed of stainless steel with the exception of the RPV-to-stub tube weld, which is Inconel. The most likely cause of leakage for these components in this service is crack growth resulting from Intergranular Stress Corrosion Cracking (IGSCC), which is well understood and bounded. All industry experience related to this cracking has shown ample time to react from the time of significant leakage to failure. In addition, prior to performing the repair, the CRD housing is ultrasonically examined to verify its structural integrity in the area to be rolled and at the location of the CRD housing-to-stub tube weld. This examination will include that portion of the housing above and below the stub tube-to-RPV weld.

Safety Analysis for the Repaired Penetration

The alternative repair provides an acceptable level of quality and safety. It has been designed to ensure the continued integrity of the CRD housings and reactor vessel, and to ensure that the associated components perform their intended safety function. Repair process controls have been established to ensure that the repair is performed in a safe and efficient manner. This repair has been evaluated as follows:

1) Leakage from the housing-to-stub tube welds, stub tube-to-vessel welds or through-wall leakage in the stub tube.

   The leakage that can be generated through any or all of these locations is not considered safety significant since any leakage will be measured as part of the unidentified leak rate, which has a Technical Specification limit of 5 gpm. Additionally, existing Technical Specifications limit the increase in unidentified leakage within any 24-hour period of steady state operation to 2 gpm. Any leakage will be well within plant system make-up capabilities. Therefore, leakage is not a safety concern.

2) Rod ejection due to total stub tube failure.

Rod ejection from stub tube-to-CRD housing failure is not credible because the weld nugget attached to the CRD housing would not allow the housing to eject if the stub tube was completely cracked. The stub tube-to-CRD housing weld (J weld) is examined ultrasonically as part of the roll-expansion repair process. No indications were found in the J-welds for CRDs 42-43 and 46-39.

In the extremely unlikely event that rod ejection occurs, then the shoot-out steel installed under the RPV, will limit the movement of the CRD housing, such that, total ejection and/or missile generation is not possible. Leakage from the total displacement of a single CRD housing has been determined to be approximately 150 gpm. This flow rate is well within the capacity of the core spray system, which is designed for a much larger loss of coolant event. Additionally, the shoot-out steel is positioned below the control rod drives and designed for the maximum force which could be imposed by a ruptured control rod drive housing, so that axial motion would be prohibited or limited.

The ability of the control rod drive collet fingers to stop rod ejection has been investigated using dynamic drop tests. Free-fall drop tests of weights equal to the rod weight were conducted to simulate index tube impact on the collet. Height of the free-fall was varied to cover a range of impact velocities from zero to 15 feet per second (maximum possible rod ejection velocity in the control rod drive is calculated to be 10 feet per second). Instrumentation recorded impact velocity and instant of collet finger engagement in the index tube while high speed motion pictures recorded the deformation of one of the collet fingers. In each test the ability of the collet to stop the ejection and hold the index tube was demonstrated. Thus, even in the event of a housing failure, the control rod would not be ejected from the core. (FSAR Section 3.9.4.4)

3) Loads during scram

Loads on the CRD housing that result from a scram (CRD deceleration) could lift the housing relative to the bottom head of the RPV. The upward force is from the inertia of the drive and the control blade as their upward velocity is stopped at the end of the insertion (or scram) stroke. The possibility of upward motion of a housing at the end of the scram has been investigated. Vessel pressure above 372 psi results in a downward force on the housing that is sufficient to resist motion caused by the end-of-scram force (including a suddenly-applied load factor of 2). If the scram occurs below 372 psi the insertion function of the drive will already have been accomplished.

4) CRD misalignment such that rod insertion is affected.

   CRD misalignment can only occur with a 360° through-wall crack in the CRD housing-to-stub tube weld or stub tube-to-vessel weld, or rod ejection. Misalignment will be minimized, should it occur, by the roll-expansion repair. Testing will be performed to verify drive operability. Rod movement is verified periodically as normal required surveillance and any potential problems will be identified.

5) CRD Housing Displacement.

   The roll-expansion repair can cause the top end of the CRD housing to be displaced relative to the lower flange in the horizontal direction, which could potentially cause misalignment of the control rod blade with the reactor core and create difficulties in control rod blade insertion. As discussed in the NRC safety evaluation for NMP-1 (dated June 29, 1984), the effect of CRD housing misalignment, with respect to the reactor core, was evaluated by General Electric. Test results indicate that there is no significant increase in scram time for a 1-inch displacement of the CRD housing. The maximum potential displacement of the NMP-1 CRD housing was determined to be 0.35 inch. Therefore, since the Oyster Creek configuration is similar, the functional requirement of the CRD to insert the control rod blades is not adversely affected by the roll-expansion repair. Additionally, scram time testing will be performed on all drives that undergo the roll-expansion process.

6) Structural loads

   Stress analysis performed by Combustion Engineering for the NMP-1/Oyster Creek CRD housing configuration has shown that the load-carrying capacity of the rolled area exceeds that of the weld, therefore, the load-carrying capacity is not compromised by rolling. Furthermore, Oyster Creek-specific fatigue usage factors were found to remain essentially the same after implementation of the roll-expansion repair. The CRD housing and RPV lower head will continue to meet plant design fatigue requirements.

Penetration Leakage Acceptance Limits

As stated previously, the leakage that can be generated through any and all possible locations is not considered safety significant since allowable total unidentified leakage is limited to 5 gpm and the allowable increase in unidentified leakage within any 24-hour period of steady state operation is limited to 2 gpm by Oyster Creek Technical Specifications. Additionally, acceptable leakage limits, as documented in BWRVIP-17 and clarified by References 5 and 6, will be followed. The maximum number of leaking CRD housings or stub tubes will not exceed five.

III. Repair Evaluation and Qualification

The roll-expansion repair will meet the qualification criteria in Section 3 of BWRVIP-17, as it applies to Oyster Creek, without exception.

IV. Pre-Repair and Post-Repair Inspection

Prior to performing the repair, the CRD housing will be ultrasonically tested (UT) to verify its structural integrity in the area to be rolled and at the location of the CRD housing-to-stub tube weld (including the portion of the housing above and below the weld with coverage of the heat-affected zone). The examinations will be performed in accordance with an IGSCC-qualified procedure. Dimensional inspections will be performed, as appropriate, to determine the pre-rolled inside diameter of the CRD housing. Additionally, all repaired CRDs will be stroke-timed and scram-tested prior to returning them to service.

Following repair and prior to plant restart, the UT will be repeated and dimensional examinations performed. The purpose of the follow-on UT examination is to confirm that no cracks developed during rolling. The purpose of the dimensional inspection is to determine the as-rolled ID of the housing so that wall-thinning can be verified. An ASME Section XI inservice leak test, post-repair, will be performed to determine the extent, if any, of remaining leakage.

A VT-2 visual examination will be performed during the pressure test to satisfy the requirements of ASME Section XI, IWA-5246. The examinations will be performed at the nominal operating pressure of the Class 1 boundary, based on ASME Section XI IWA-4000 requirements for pressure testing the installation of mechanical joints.

During subsequent refueling outages, UT examination of the CRD housings that are roll-expansion repaired will be performed when normal CRD maintenance activities make access to the housing ID available.

Summary

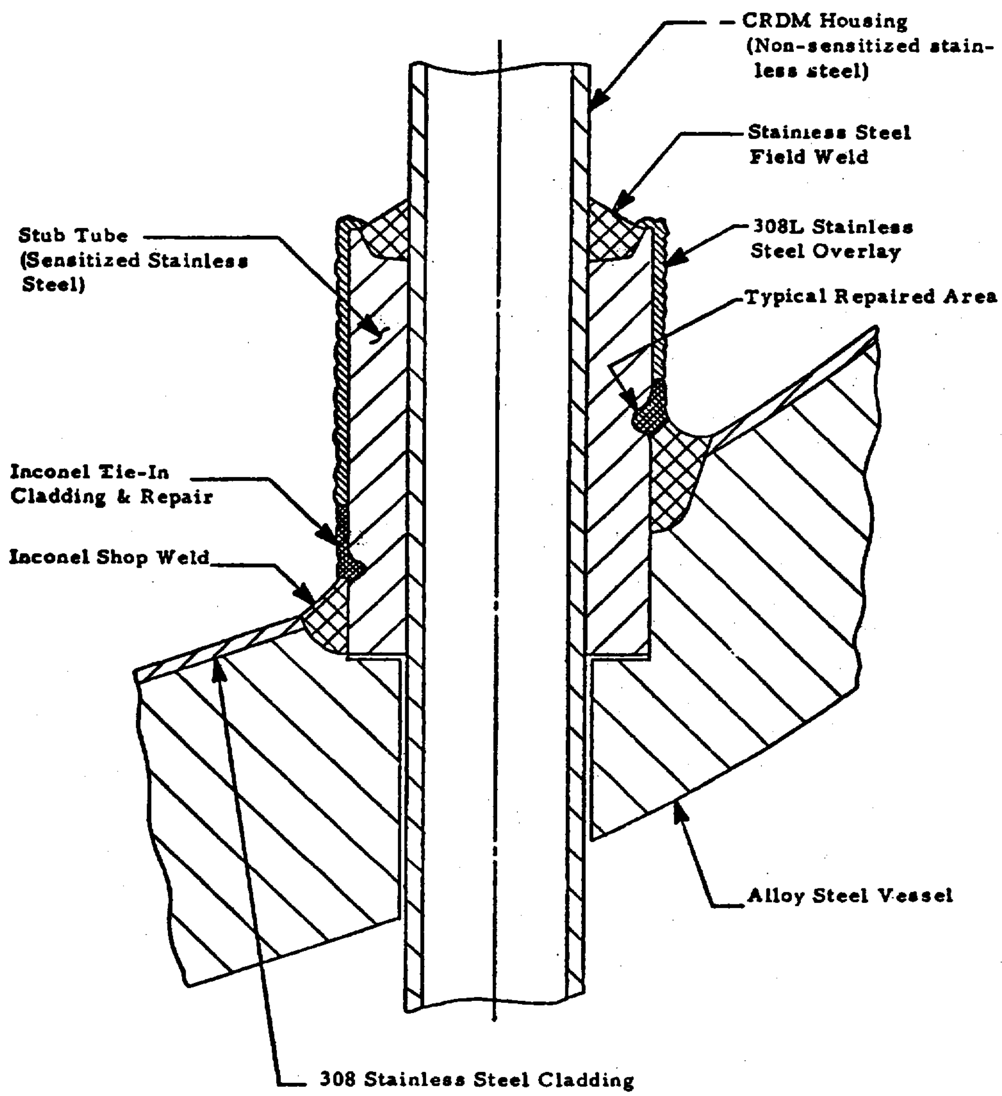
Based on industry experience and at Oyster Creek, roll-expanding the CRD housing into the reactor pressure vessel penetration bore has been evaluated to be an appropriate alternative repair for use at Oyster Creek. The housings are plastically expanded within the RPV lower head bore to create a radial contact pressure between the housing and the vessel bore. Proper contact pressure is achieved by controlling the radial expansion of the housing and by utilizing additional passes to increase the contact length. The roll-expansion repair alternative provides an acceptable level of quality and safety in lieu of a Code (weld) repair until the current operating license expires in April 2009 as follows:

- The roll-expansion repair will meet the qualification criteria in Section 3 of BWRVIP-17, as it applies to Oyster Creek, without exception. Additionally, pre-repair and post-repair inspections will be performed to ensure the adequacy of the repair. Subsequent post-repair UT examinations will occur when routine maintenance otherwise affords access to the CRD housings.
- The roll-expansion process effectively eliminates, or reduces to an acceptable level, leakage from CRD housing penetrations whether it is from the housing-to-stub tube weld, stub tube-to-vessel weld or through-wall leakage in the stub tube. The two repaired CRD housings at Oyster Creek and thirty-two of the thirty-three repaired housings at NMP-1 have not leaked since repair in up to 18 years of service. The one leaking penetration at NMP-1 is well within the limits specified in BWRVIP-17 and the NRC safety evaluation (Reference 7) for the NMP-1 repair program.
- For CRD housings 42-43 and 46-39, the housing-to-stub tube weld, or J-weld, were examined by UT during the roll-expansion repair in Fall 2000 and were found free of indications.
- The roll-expansion process has no harmful material effects on CRD housings, stub tubes or reactor vessel.
- Potential failures, which might occur as a result of this repair, have been evaluated and found to pose no increase in plant risk.

A weld repair according to BWRVIP-58, "BWR Vessel and Internals Project, CRD Internal Access Weld Repair," or an equivalent Code repair, will be employed if roll-expanded penetrations do not meet the leakage limits in BWRVIP-17 or more than five CRD penetrations continue to leak after roll-expansion repairs.

References

1) AmerGen letter 2130-00-20300 dated November 10, 2000, "Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
2) AmerGen letter 2130-00-20304 dated November 14, 2000, "Modification to Proposed Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel"
3) USNRC letter dated November 16, 2000, "Request to Use an Alternative Repair of the Control Rod Drive Housing Interface with the Reactor Vessel at the Oyster Creek Nuclear Generating Station (TAC No. MB0461)"
4) Boiling Water Reactor Vessel and Internals Project (BWRVIP) Report, "Roll/Expansion Repair of Control Rod Drive and In-Core Instrument Penetrations in BWR Vessels (BWRVIP-17)"
5) AmerGen letter 2130-01-20031 dated January 19, 2001, "Alternative Repair of Control Rod Drive Housing Interface with Reactor Vessel – Clarification of Leakage Inspection"
6) USNRC letter dated January 8, 2002, "Oyster Creek Nuclear Generating Station – Clarification of Leakage Inspection (TAC No. MB1065)"
7) USNRC letter dated March 25, 1987, "Request to Utilize an Alternative to the Requirements of 10 CFR 50.55a(g) (TAC 61181)"


CRDM Housing (Non-sensitized stainless steel)
Stainless Steel Field Weld
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Inconel Shop Weld
Alloy Steel Vessel
308 Stainless Steel Cladding

Figure