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Westinghouse Electric Corporation Energy Systems

Nuclear Technology Division
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March 24, 1994

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

Subject: Closeout of an Interim Report of an Evaluation of a Deviation or Failure to Comply Pursuant to 10CFR21.21(a)(2)

Reference: (1) ET-NRC-93-3994, Interim Report of an Evaluation of a Deviation or Failure to Comply Pursuant to 10CFR21.21(a)(2), dated October 19, 1993

The attached information is provided as a closeout to Interim Report 93-022. Preliminary information was previously provided per Reference 1 pursuant to the requirements of 10CFR Part 21 to submit an Interim Report on issues that will not be completed within 60 days from the discovery of the deviation or failure to comply.

A closeout to Interim Report 93-022 is enclosed for the following Potential Issue under Westinghouse evaluation:

1. Reactor Vessel Head Adaptor Penetration Attachment Weld Defect

If you have any questions regarding this matter, please contact Mr. H. A. Sepp of my staff at 412/374-5282, or myself.

Sincerely,

N. J. Liparulo, Manager
Nuclear Safety and Regulatory Activities

Attachment

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Westinghouse Electric Corporation
Energy Systems
P.O. Box 355
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Interim Report No. 93-022
Date: 3/23/94

SUBJECT:

Closeout to an Interim Report of an Evaluation of a Deviation or Failure to Comply Pursuant to 10CFR21.21(a)(2).

TITLE:

Reactor Vessel Head Adaptor Penetration Attachment Weld Defect

BASIC COMPONENT SUPPLIED BY:

Westinghouse Electric Corporation

NATURE OF DEVIATION:

As provided in the original issue of Interim Report 93-022 (Ref. 1), Westinghouse identified a potential issue related to a phenomenon discovered in the reactor vessel head at the Vattenfall AB Ringhals Unit 2 plant.

During an augmented inspection of the reactor vessel head at Ringhals Unit 2 the utility discovered an apparent flaw in the head penetration attachment weld of penetration number 62. All 65 attachment welds were inspected via ultrasonic test with indications noted at a total of 15 locations. The flaw at penetration No. 62 appeared to extend at least 145 degrees around the circumference of the Inconel buttering-to-carbon steel interface. Subsequent surface grinding and the inspection of boat samples taken from the flaw location revealed a flaw indication to a depth in excess of 21 mm. The boat samples have also revealed significant weld-to-carbon steel separation below the cladding surface indicative of a lack of fusion during the welding process resulting in the separation of the attachment weld at the buttering to the reactor vessel head base metal. The as-found condition of penetration No. 62 was summarized as follows:

- A gap (flaw) exists between the carbon steel base metal and Inconel buttering. This gap proceeds around the circumference of this interface for approximately 145 degrees.

- The 145 degree gap proceeds from the vessel ID cladding interface along the base metal-to-buttering interface (along the "J" groove surface) extending to the penetration tube.

- Although the gap did not appear to extend 360 degrees around the interface, it was unclear as to the integrity of the remaining base metal-to-buttering weld still in contact.

- The gap between the carbon steel base metal and buttering does not appear 100% through the interface along the vessel ID surface.

- The Inconel buttering has surface flaws in it. It would appear that some cracking has occurred from both the inside and outside surfaces.

Fourteen other penetration attachment welds have also been reported to have sub-surface indications at the weld to carbon steel interface.

In addition to the aforementioned flaw (gap), another location was discovered to have UT indications. This location is between the outside diameter (O.D.) of the Alloy 600 penetration tube (head adaptor tube) and the attachment weld. Indications were noted in 24 of 65 head penetrations inspected in this area. While the exact dimensions of these indications were difficult to characterize, the indications at selected penetrations appear to have developed 360 degrees around the penetration tube but do not extend the entire length of the weld in the axial direction.

In both cases the indications appear to be from fabrication and are not service induced. Additionally, the indications do not appear to have grown during service.

SAFETY ASSESSMENT:

The welds on the reactor vessel head between the head adaptor tubes and the vessel head itself form a part of the reactor pressure boundary and as such, the integrity of these welds is important. The complete failure of such a weld could cause leakage, and while the ejection of a head adaptor tube is considered an unlikely event, leakage onto the carbon steel of the reactor vessel head would lead to boric acid degradation of the carbon steel head.

Considering the issue of an ejection of a head adaptor tube, for the flaw (gap) discovered between the Inconel buttering and the carbon steel of the reactor vessel head, the design of the head penetration tube, the "J" groove and the attachment weld is such that the ejection of the adaptor together with its weld still connected, is not considered a credible accident.

For the situation where UT indications have been identified between the attachment weld and the head adaptor tube, the complete ejection of the tube is still not considered a likely event. For locations with a full rod travel housing the proximity of the top of the rod travel housing to the missile shield would likely prevent the complete ejection of the tube and thereby limit leakage. It is noteworthy that not all plants are designed with the missile shield sufficiently close enough to the top of the rod travel housing to provide a means to mitigate an ejection event. The CRDM drive rod would provide some degree of lateral stability to the postulated break and its presence would also help serve to limit leakage. Spare penetration locations on the top of the vessel head must rely on the "as-built" interference and the condition of the adaptor to limit leakage should a complete weld failure occur between the penetration tube and the attachment weld. There is no CRDM drive rod at these locations and the pressure housing does not extend up to the vicinity of the missile shield. The penetrations are approximately four (4) inches in diameter which would equate to an opening of approximately twelve (12) square inches per penetration.

This description represented an extremely conservative worst case situation. At this time all that has been reported from Ringhals Unit 2 is the presence of UT indications in the aforementioned locations. There has been no leakage or other indication of a loss of integrity in the welds. Indeed, this still may only represent a situation whereby state-of-the-art UT techniques have shown common manufacturing indications in these welds.

During manufacture of reactor vessel heads, the ASME Code required PT examination of the welds. Volumetric inspections were not required.

The integrity of these attachment welds is verified during fabrication to comply with the applicable ASME Code design requirements through:

a) Qualified Welding Process
b) Qualified Welders
c) Liquid Penetrant Testing
d) Shop Hydrostatic Testing
e) In-plant Hydrostatic Testing at Startup

Section XI of the ASME Code does not specify a detailed volumetric or surface inspection and evaluation of the head adaptor-to-reactor vessel closure head attachment weld. It is believed that Section XI, Paragraph IWB 1220(a) exempts this location from examination because if the attachment weld were to fail between the Inconel buttering and the carbon steel vessel head, the resulting shape of the tube and attached weld will be captive in the partial penetration weld cavity in the closure head. The penetration will not be ejected from the reactor vessel head and reactor coolant leakage will be restricted such that it would be within either the normal capacity of the makeup system or would be handled by the Safety Injection (SI) system as a small break loss-of-coolant accident (SB LOCA). This assessment is valid for the cracking phenomenon between the Inconel buttering on the vessel head and the carbon steel vessel head itself.

Concerning the UT indications between the attachment weld and the Alloy 600 penetration tube, this may only represent a situation whereby state-of-the-art UT techniques have shown common manufacturing indications in these welds. During manufacture the ASME Code requires PT examination of the welds. No volumetric inspections are required. Both types of flaws were included in the Westinghouse evaluation listed in the Corrective Actions paragraph which follows.

DATE OF DISCOVERY OF DEVIATION:

September 27, 1993

CORRECTIVE ACTIONS TO DATE:

Westinghouse has completed an extensive evaluation of this issue. It has been determined that a substantial safety hazard does not exist. Both in terms of a lack of fusion and flaw size, no situation exists that would reasonably lead to the catastrophic failure of a vessel head penetration. Westinghouse and the Westinghouse Owners Group (WOG) will continue to investigate this situation via the WOG Alloy 600 Task Team.

EVALUATION COMPLETION SCHEDULE DATE:

Complete

N. J. Liparulo, Manager
Nuclear Safety and Regulatory Activities