Entergy

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Stephenie L. Pyle
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Arkansas Nuclear One

2CAN121206

December 17, 2012

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

SUBJECT: Clarification on Initial Flaw Size and Qualified Examination Area
Revised Request for Alternative ANO2-ISI-007
Code Case N-770-1 Baseline Examination
Arkansas Nuclear One, Unit 2
Docket No. 50-368
License No. NPF-6

REFERENCES:
1. Entergy letter dated December 4, 2012, "Revised Request for Alternative ANO2-ISI-007 Code Case N-770-1 Baseline Examination" (2CAN121201)
2. Entergy letter dated September 10, 2012, "Response to Second Request for Additional Information Request for Alternative ANO2-ISI-007 Code Case N-770-1 Baseline Examination" (2CAN091205) (ML12255A388)

Dear Sir or Madam:

The NRC has previously provided their approval of the Entergy Operations, Inc. (Entergy) Request for Alternative ANO2-ISI-007 for Arkansas Nuclear One, Unit 2 (ANO-2). However, the approval was limited until January 1, 2013 (approximately 40 months from the last inspection). At that time, these welds would have to be re-inspected unless additional information was provided to and approved by the NRC. Reference 1 was submitted to the NRC to provide the additional information.

In Reference 1, Entergy stated that the largest undetected flaw that could exist due to the examination limitations was 10% through wall. Based on additional discussions with the NRC, it was concluded that Entergy did not provide the basis for that statement and that it was different than what had been provided in Reference 2. The purpose of this submittal is to clarify the statement related to the largest undetected flaw size and to provide the basis for that statement. In addition, this submittal clarifies the procedurally qualified examination area.

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Dissimilar metal weld (DMW) examinations are conducted with procedures and techniques developed and qualified for use through the Performance Demonstration Initiative (PDI) Program, exclusively to meet the requirements of American Society of Mechanical Engineers (ASME) Code, Section XI, Appendix VIII, Supplement 10 (Dissimilar Metal Welds). In developing the circumferential ultrasonic scan coverage calculations, the limitations associated with the Performance Demonstration Qualification Summary (PDQS) for the examination procedure utilized, SI-UT-130, Revision 3, "Procedure for Phased Array Ultrasonic Examination of Dissimilar Metal Welds", as well as that of the electronic (focal law) skewing was considered.

Both the Reactor Coolant Pump (RCP) suction and discharge DMW have similar weld preps at the cast austenitic stainless steel (CASS) safe-end and ferritic piping. The ferritic piping is buttered with an Alloy 82/182 filler metal. Westinghouse generic industry Primary Water Stress Corrosion Cracking (PWSCC) flaw analyses considered an axial flaw in the center of the DMW as illustrated in the attached RCP Suction DMW (weld 10-014) drawing for the following reasons.

The root of these welds require an inside diameter (ID) backgroove to sound base and weld metal with a subsequent Alloy 82/182 backfill weld out. This process will increase the residual stresses at the ID root. In addition, the weldment is diluted with the stainless steel (CASS) on the stainless steel (CASS) side. Therefore, if a PWSCC flaw were to initiate, it has the highest probability to occur in the centerline of the ID root weld. With an assumed flaw having a 2-to-1 aspect ratio and a 10% through wall initial flaw depth, the assumed flaw would essentially cover the width of the root of the DMW. This assumed flaw originating at the center of the DMW is larger than and bounds a flaw originating from the corner near the stainless steel (CASS) to DMW root. Whereas if a flaw were assumed to initiate near the stainless steel (CASS) to Alloy 82/182 weld interface, a corner type flaw would only grow in the direction of the susceptible material, resulting in a smaller flaw than the assumed centerline flaw. Additionally, the neighboring stainless steel weld has a beneficial effect on the DMW for PWSCC (compressive residual stress). The only other possible crack initiation site is near Alloy 82/182 to clad interface. The axial flaw will arrest as it radially intersects the carbon steel pipe. Crack propagation beyond the carbon steel ID from the clad would have been readily detected from the past examination. Therefore, the most conservative crack location is at the centerline of the weld root.

Procedure SI-UT-130 contains the requirement that the examiner must perform manual and electronic skewing of the phased array probe assembly. As stated in the PDQS, the SI-UT-130 procedure is not qualified to detect axial flaws on the far side of a single-side access component containing a tapered weld configuration. The procedure is qualified to detect axial flaws on the near side in conjunction with the required skewing discussed above. These procedures are qualified to detect flaw depths as shallow as 10% of the nominal pipe wall thickness as documented in Supplement 10, paragraph 1.2(c)(1). This 10% flaw would have a specific reflective area, which could be "credited" as the minimum detectable reflective area. Although it specifies a minimum flaw depth for detection and sizing, Supplement 10 does not mandate a specific aspect ratio (*a/l*) for the flaws nor a maximum reflective area. Supplement 8 for Bolts and Studs does contain requirements for reflective area. Therefore using the requirements of ASME Code, Section XI, Appendix VIII, Table VIII S8-1, a quantitative comparison can be made. The referenced Table VIII-S8-1 defines a Maximum Notch Dimension with a specified Reflective Area of 0.059 square inches for bolts or studs greater than 4" diameter and 0.027 square inches for 2" up to 4" diameter.

A quantitative comparison of these reflective areas to the area of half of a minimum 10% through wall flaw, as defined in Supplement 10, is presented below. The minimum flaw aspect ratio of ASME Section XI, IWB-3514 would be a 2-to-1 aspect ratio. For this application of the 10% through wall flaw, the flaw depth is 0.33" (suction nozzle DMW). The reflective area of half of this flaw (that portion in the "qualified half" of the DMW) is defined by the following equation and results in an area of 0.086 square inches.

$$A_f = 1/4\pi r^2, \text{ where r is the 10\% flaw depth } 0.33"$$

$$A_f = 0.086 \text{ square inches}$$

As calculated, the reflective area of the flaw that extends into the qualified examination volume is larger than the maximum allowed Reflective Area as defined in Supplement 8, and would thus be considered a large enough flaw to be detectable. When compared to the greater than 4" diameter bolting configuration show above, there is a conservative margin of 45%. When compared to the 2" to 4" diameter bolting configuration, there is a margin greater than 3 times.

A flaw with a greater aspect ratio (width greater than height), such as a 3-to-1 flaw, would produce a much larger reflective area, on the order of 1.5 times the size of a 10% 2-to-1 through wall flaw, within the qualified examination volume, and thus increase the "detection margin" from the Supplement 8 defined areas proportionally. A flaw having a 3-to-1 aspect ratio would be fully constrained by the CASS backgroove.

In addition, transducer scanning over the weld was achievable. While this technique is not specifically qualified per the PDI program, it does generate additional interrogation of the material. In the discussion above the qualified coverage was truncated at the centerline of the designed weld. This specific definition of qualified coverage is currently not in the NRC approved versions of ASME Code, Section XI, but is EPRI PDI stated demonstration methodology.

The favorable contours of the subject welds, combined with use of electronic skewing, demonstrate that the portions of the weld beyond the centerline were interrogated. It is therefore reasonable to conclude, in conjunction with the quantitative comparison above, that a conservatively positioned 10% through wall flaw at the inside diameter would have been detected. A weld profile drawing for the limiting weld (weld 10-014) is attached.

Reference 1 transmitted to the NRC revised analyses to include the effects of the stainless steel (CASS) weld and an inner diameter weld repair of 50% wall thickness without post-repair heat treatment. The conclusions of the analyses are that a postulated initial flaw that is 16.7% through wall would grow to the ASME Code allowable flaw size of 75% through wall in approximately 54 months from the inspection. The above discussion related to the initial flaw size does not alter the conclusions reached in Reference 1 - the crack growth analysis supports operation of ANO-2 until the next scheduled refueling outage in which the welds will be inspected.

This submittal contains no regulatory commitments.

Should you have any questions, please contact me.

Sincerely,

SLP/rwc

Attachment: Revised Scan Profile

cc: Mr. Elmo E. Collins
Regional Administrator
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Arlington, TX 76011-4511

NRC Senior Resident Inspector
Arkansas Nuclear One
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U. S. Nuclear Regulatory Commission
Attn: Mr. Kaly Kalyanam
MS O-8 B1
One White Flint North
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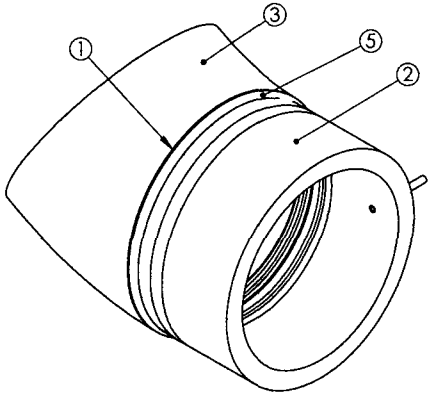
Rockville, MD 20852

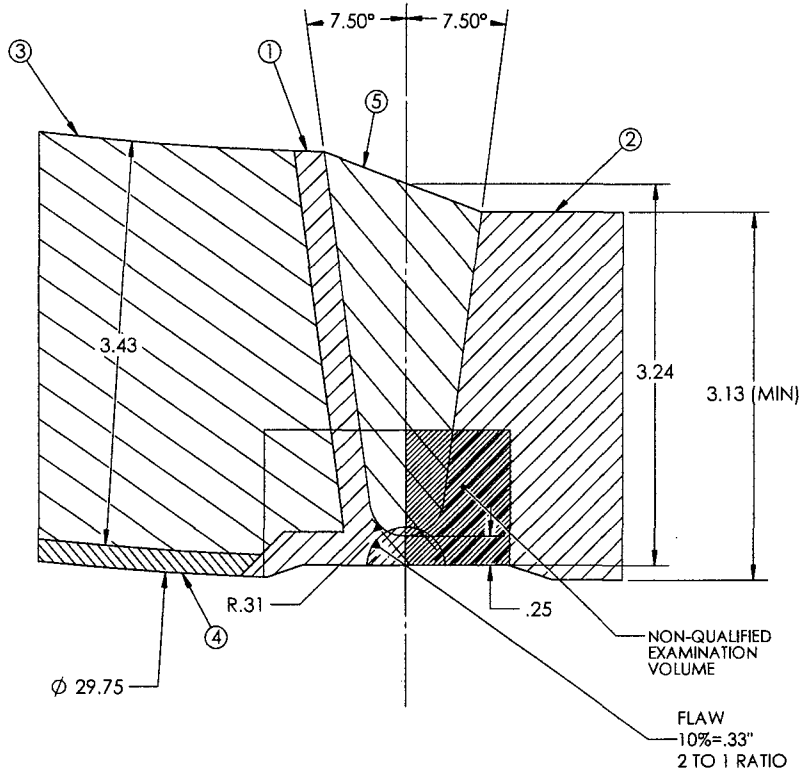
Attachment to

2CAN121206

Revised Scan Profile



SCHEMATIC VIEW OF THE NOZZLE



PARTS LIST		MATERIAL
1	BUTTER	ALLOY 82/182
2	SAFE END	SA-351 Gr.CF8M
3	ELBOW	SA-516, GRADE 70
4	CLADDING	STAINLESS STEEL
5	DM WELD	ALLOY 82/182

DESIGN INPUT DOCUMENTS
M-2001-C10-8-3
M-2001-C10-20-5
ENTERGY DESIGN INPUT RECORD EC7038 ANO2-DIR, REV 4

Structural Integrity Associates, Inc.®

TITLE: REACTOR COOLANT PUMP SUCTION DISSIMILAR METAL WELD

UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSION TOLERANCES PER REFERENCES	DRAWN BY:	FH	12/14/2012
	REVIEWED BY:	JWA	12/14/2012
	APPROVED BY:	MT	12/14/2012

NUCLEAR SAFETY RELATED YES ☒ NO ☐

DRAWING NO.	1201329.501
PROJECT NO.:	1201329.00
PLANT:	ARKANSAS NUCLEAR ONE UNIT 2
MATERIAL:	SEE PART LIST
FINISH:	N/A

DWG SIZE:	REVISION:	QTY:
B	0	1
WT. N/A	SCALE: 1:24	SHEET 1 OF 1