Enclosure 3

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Wesdyne Report WDI-TJ-012-03-NP Rev. 2,
Triple Point Inspection using TOFD Ultrasonic Methods

(Non-Proprietary)

WESDYNE INTERNATIONAL

Westinghouse Non-Proprietary Class 3

DOCUMENT NUMBER & REV:

WDI-TJ-012-03-NP Rev. 2

TITLE: Triple Point Inspection using TOFD Ultrasonic Methods

COVER SHEET FOR:

- ☐ DESIGN SPECIFICATION
- ☐ FUNCTIONAL SPECIFICATION
- ☐ QUALIFICATION PROCEDURE
- ☐ FUNCTIONAL TEST PROCEDURE
- ☐ USERS MANUAL
- ☐ TRAINING PLAN
- ☒ TECHNICAL JUSTIFICATION
- ☐ CALIBRATION PROCEDURE
- ☐ OTHER

PLANT SITE/PLANT ALPHA:

KEY WORDS:

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The procedure approval signature of the cognizant manager below confirms that prior concurrence of required review groups has been obtained.

Originator – Jack Lareau	Signature	Date
	Rich D Ruth for JL	9/23/03
Don Adamonis	Signature	Date*
		9/23/03

*Effective/Revised Date

Triple Point Inspection using TOFD Ultrasonic Methods

Reference 1 - Excerpts from "MRP Inspection Demonstration Program" Updated December 11, 2002, 2002

Reference 2 - WDI-TJ-007-02, Rev. 0, Demonstration of Volumetric Ultrasonic Inspection of CRDM Nozzles Using the Open Housing Scanner for ANO-2

Reference 3 - WDI-UT-013, Rev. 2 CRDM/ICI UT Analysis Guidelines

Reference 4 - WDI-UT-10, Rev. 4, IntraSpect Ultrasonic Procedure for Inspection of Reactor Vessel Head Penetrations, Time of Flight Ultrasonic, Longitudinal Wave & Shear Wave

Reference 5 - E-mail- EPRI (Kietzman) to Entergy (Hamilton), February 28, 2002 Demonstration of Westinghouse Procedures on the Entergy Weld Flaw Mock Up

Introduction:

The purpose of this test sequence was to determine the feasibility of using the open housing scanner (7010 end effector) to interrogate the penetration tube/J-weld triple point region. A series of mock ups were used during this test sequence. The results of this testing is provided in the description below.

Description:

The ultrasonic volumetric inspection of the CEDM nozzles includes the ability to interrogate into the J–groove weld approximately 0.60" beyond the OD of the nozzle. The open housing scanner employs a TOFD pair of transducers that are[ ]^{a,c,e}

In order to demonstrate the ability of the open housing end effector to interrogate the triple point region, a series of laboratory tests were conducted using mockups fabricated by EPRI for the MRP demonstration project. In particular, two mockups were used, the first is referred to as the Entergy mockup and the second is referred to as the "K" mockup. Both of these mockups have reflectors in the weld metal. These mockups are described in references 1 and 2. A summary of these mockups is provided in Figures 1 and 2.

Entergy Mock Up (Figure 1) - In the Entergy mockup, there is a series of[ ]^{a,c,e} outboard of the nozzle OD. These reflectors were used to demonstrate that the TOFD pair focal length was sufficient to detect reflectors at these depths. The flat bottom holes down to 0.2" beyond the nozzle OD were detected, as reported in reference 2. This was documented in the demonstration report provided to the NRC on June 17, 2002. Accordingly, the inspection procedure, reference 4, specifies that the range of applicability is up to[ ]^{a,c,e} thickness. This depth range encompasses the thickness of the penetration tube material and the demonstrated depth into the attachment weld.

In addition, the Entergy mockup has a series of axial and circumferential Cold Isostatic Pressure (CIP) notches that are entirely in the weld metal. These notches are 25%, 50%, and ~100% through the thickness of the J-groove weld starting from the wetted surface (ID surface of RPV head). It was determined that the axial notches were not suitable for demonstration purposes because they were beneath a corresponding axial flaw in the nozzle wall which completely masked the presence of the weld flaws. The circumferential-oriented flaws (i.e. flaws in the circumferential-axial plane) in the attachment weld were detected during the blind phase of the demo. These are flaws 1, 5 & 6 in the mock-up drawing. See Figures 3 through 8.

Phase II EPRI Mock Up ("K" Mock Up) (Figure 2) - Further demonstration of the capability to examine the nozzle-to-weld interface using the Westinghouse open housing probe was conducted in the spring of 2002 as part of the MRP Phase II demonstrations. This second mockup ("K" mock up) contains radial, axial CIP notches in the weld within 0.06 inches of the weld fusion line.

During this demonstration, a pure axial/radial squeezed notch flaw was detected from the ID of the J-weld that extended thru-weld to the triple point of the J-weld. The flaw location was approximately 0.060"beyond the fusion line which provided the additional basis for the capability of the open housing probe.

Accordingly, the analysis guidelines, reference 3, were modified to include the requirement to evaluate the weld metal up to [ ]^{a,c,e} beyond the nozzle OD (See Table 1). The extra examination depth[ ]^{a,c,e} If crack tip type signals are detected in this zone, the indication is identified as a Weld Volume Indication (WVI). If a WVI is reported in field examinations, the analysis guidelines flow chart designates this as a "Special Interest" condition which calls for a confirmatory surface examination of the j groove weld. In the analysis training sessions, the topic of WVI's is specifically described in detail to assure that each analyst is aware of the triple point inspection issue.

In actual field experience, a number of WVI/Special Interest indications have been identified and surface exams have been performed.[ ]^{a,c,e} A number of WVI signals were identified in the weld and a J-groove weld penetrant test was conducted. The results were negative and the source of the reflectors was concluded to be grain boundary reflections in the weld.

The overall process with WVI/Special Interest designations is designed to be conservative and is predominated by false positives due to weld grain boundary reflectors. Early field experience has shown that approximately[ ]^{a,c,e} of the nozzles have this type of false positive results. The confirmatory surface examination is used for the final determination for this type of indication.

Conclusions:

It has been demonstrated, based on the Entergy and EPRI mockups, that PWSCC-type indications in the triple point region can be detected with TOFD UT technique employed by the open housing scanner (7010). Radial – axial and circumferential CIP flaws within 0.06 inches of the weld interface were detected.

The analysis guidelines specify that indications of this type be classified as WVI, a special interest category. J-groove welds of penetrations containing special interest findings are examined using surface inspection techniques to establish if cracking exists on the J-groove weld, the anticipated initiation site for such degradation.

Figure 1- ENTERGY MOCK-UP GRAPHIC a,c,e

Mockup Proposal for Entergy/MRP CRDM & Flaw Placement in Tube & J-Groove Weld Volumes

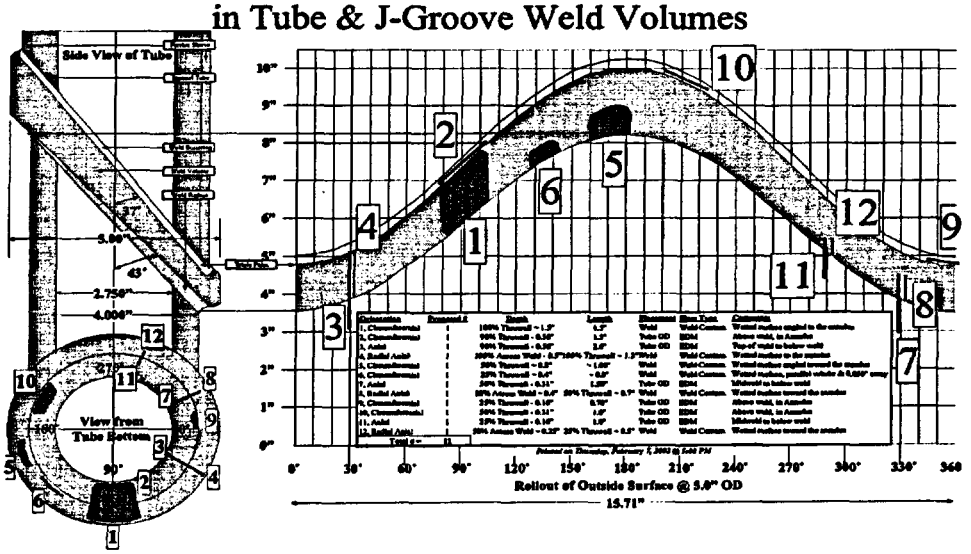
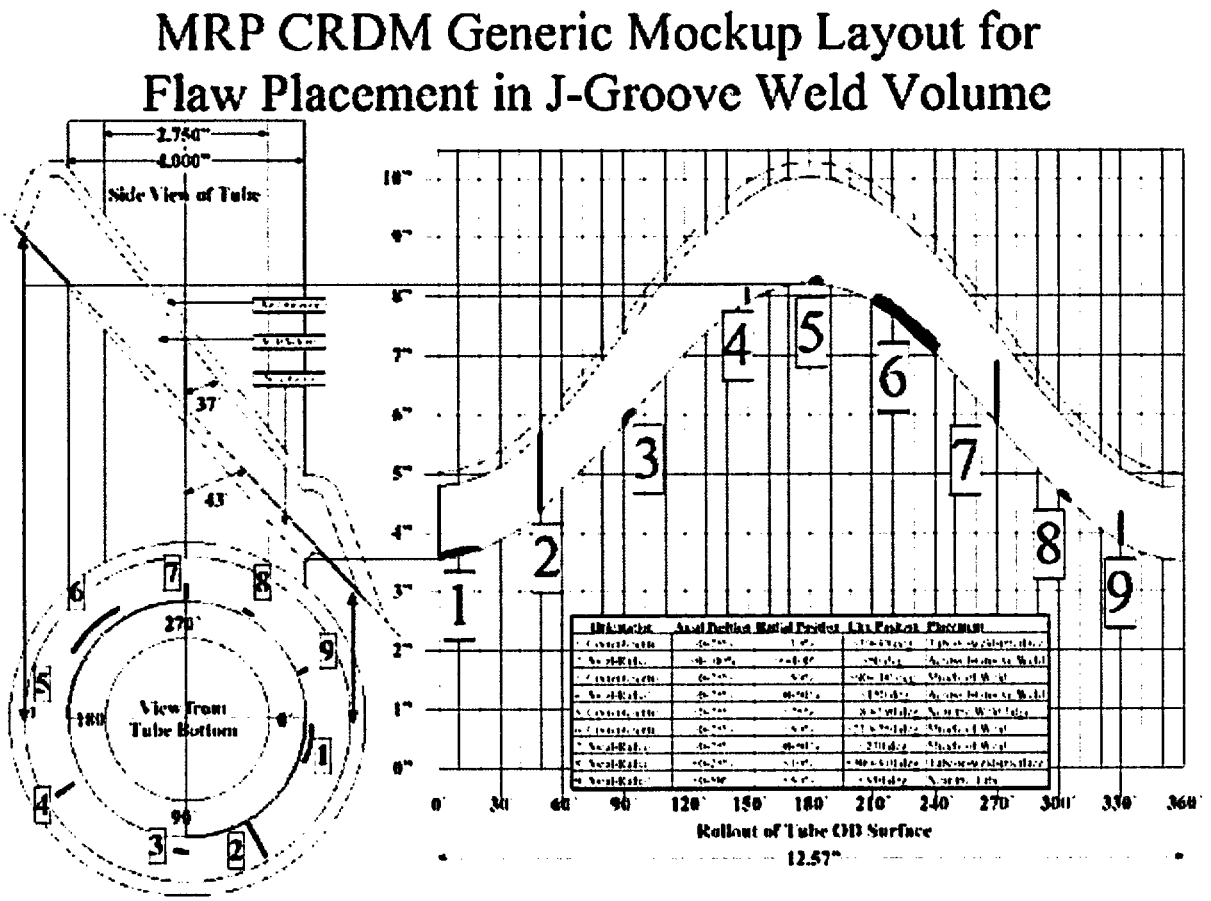


Figure 2 - "K" MOCK-UP GRAPHIC



a,c,e

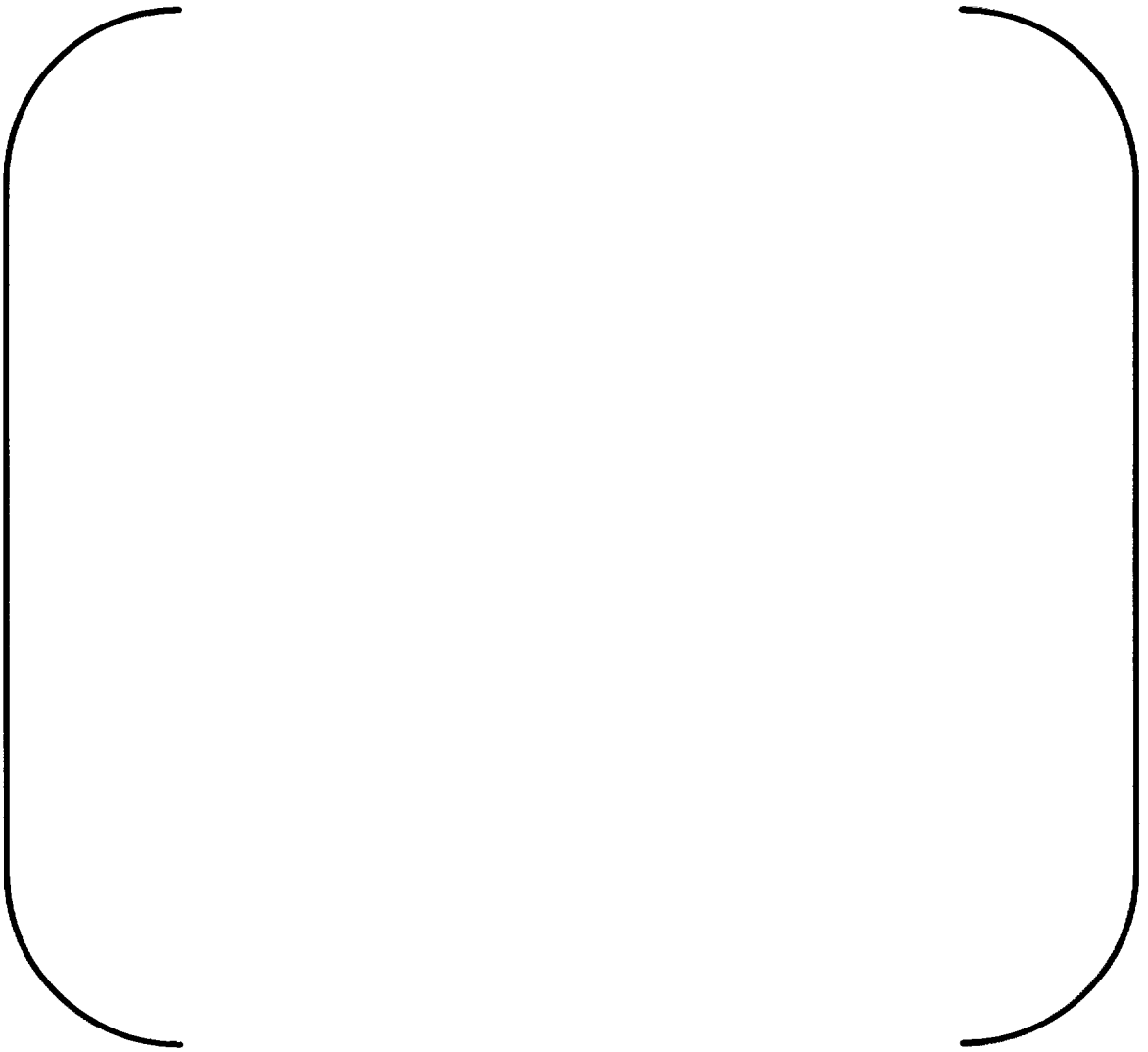
Figure 3 - Weld Flaw to Triple Point

Entergy Indication: # 1

WesDyne Indication: # 1F. This reflector was detected with the circ shooting transducer

Figure 4 - WDI-TJ-007-02

a,c,e



Entergy Indication: # 5

WesDyne Indication: # 1A and 1B. This reflector was detected with the circ. and axial shooting transducer. There were two signals associated with this indication noted on both channels one down in the weld and one at the weld to tube interface.

a,c,e

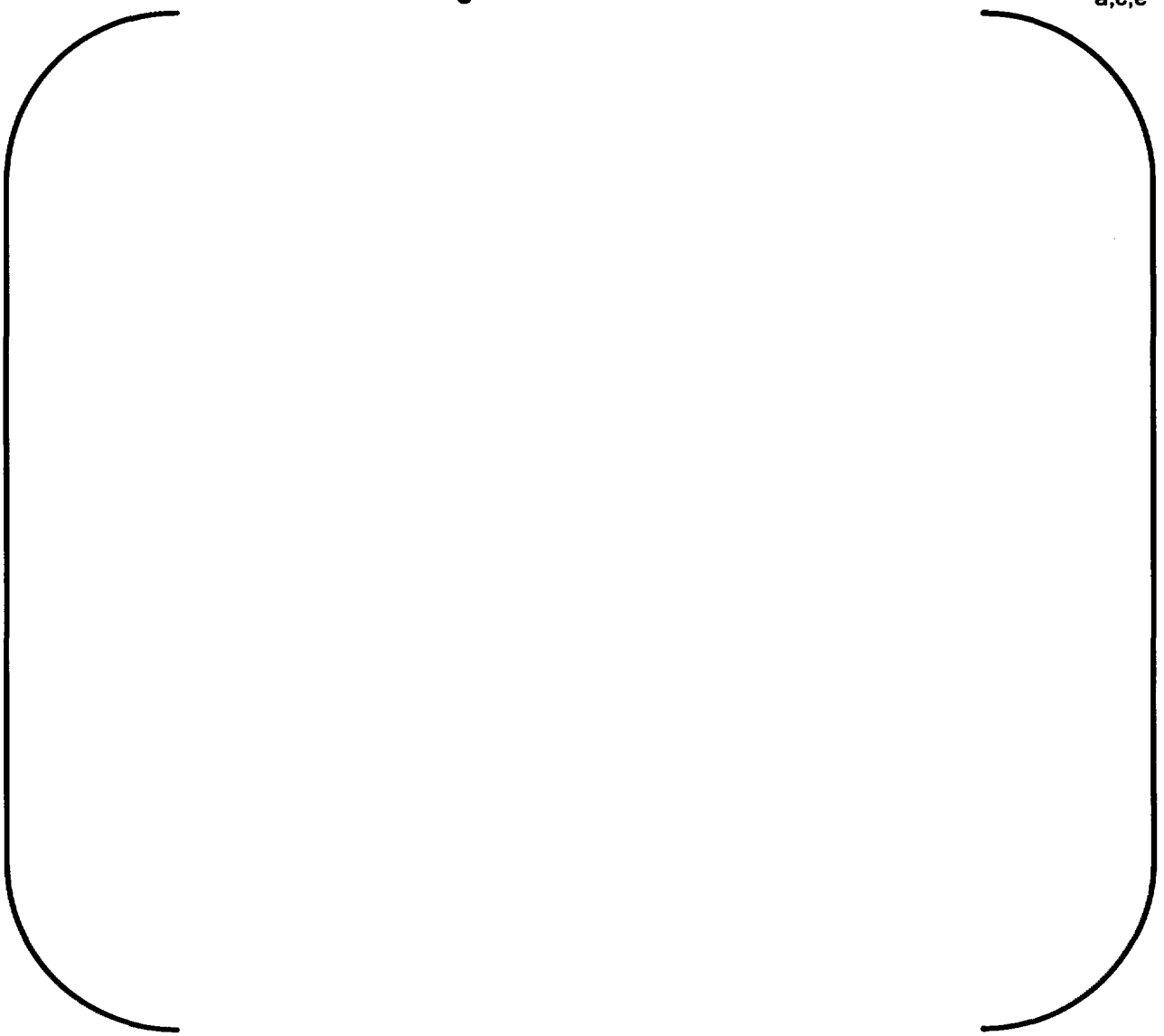
Figure 5 - WDI-TJ-007-02

Entergy Indication: # 5

WesDyne Indication: # 6. This reflector was detected with the circ and axial shooting transducer. There are two signals associated with this indication noted on both channels one down in the weld and one at the weld to tube interface. On the original analysis we only reported the indication @ the weld fusion zone on this channel

Figure 6 - WDI-TJ-007-02

a,c,e

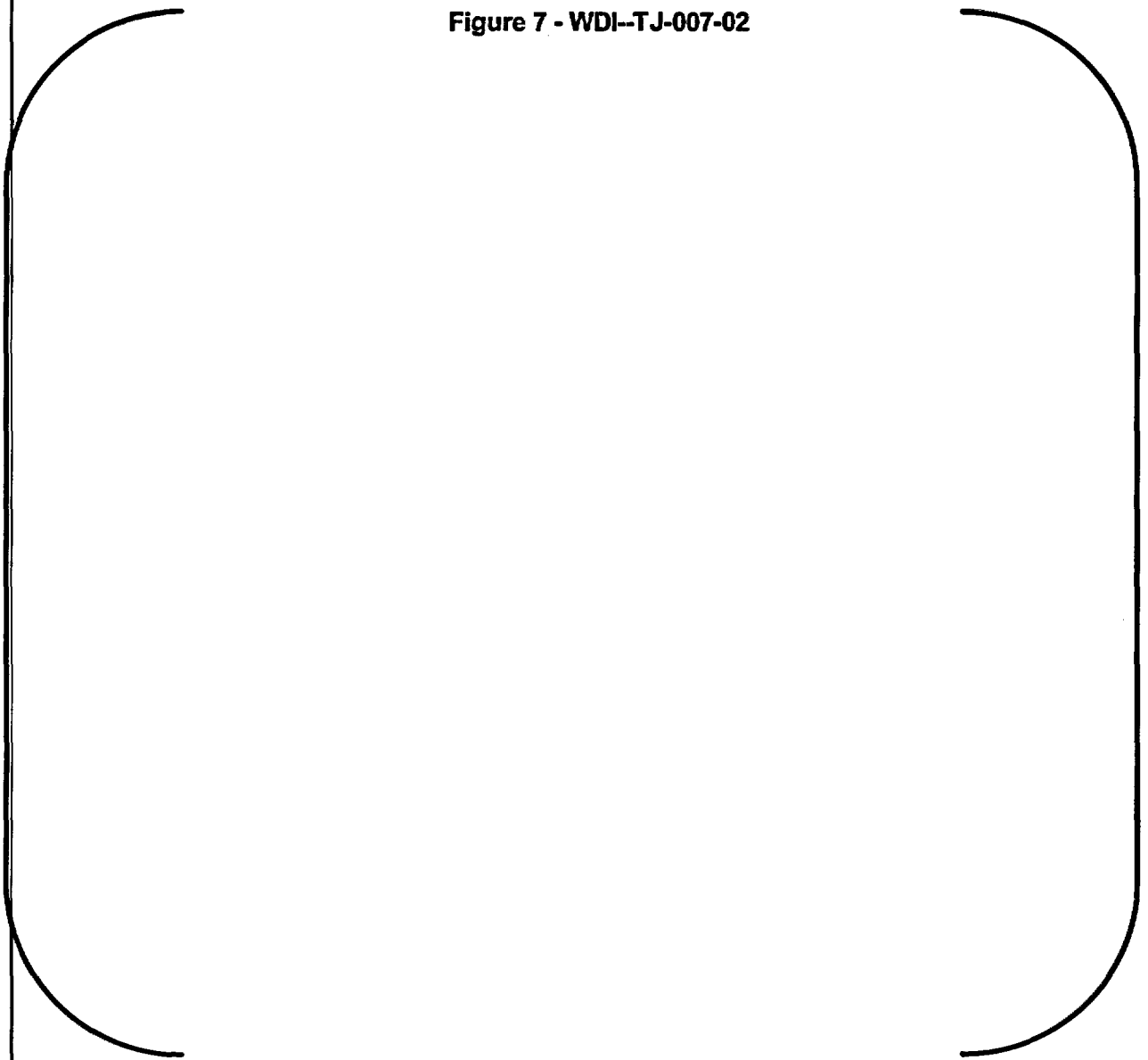


Entergy Indication: # 5

WesDyne Indication: # 6. This reflector was detected with the circ and axial shooting transducer. There are two signals associated with this indication noted on both channels one down in the weld and one at the weld to tube interface. On the original analysis we only reported the indication @ the weld fusion zone on this channel (the reflector in the weld was not reported with this channel)

a,c,e

Figure 7 - WDI--TJ-007-02

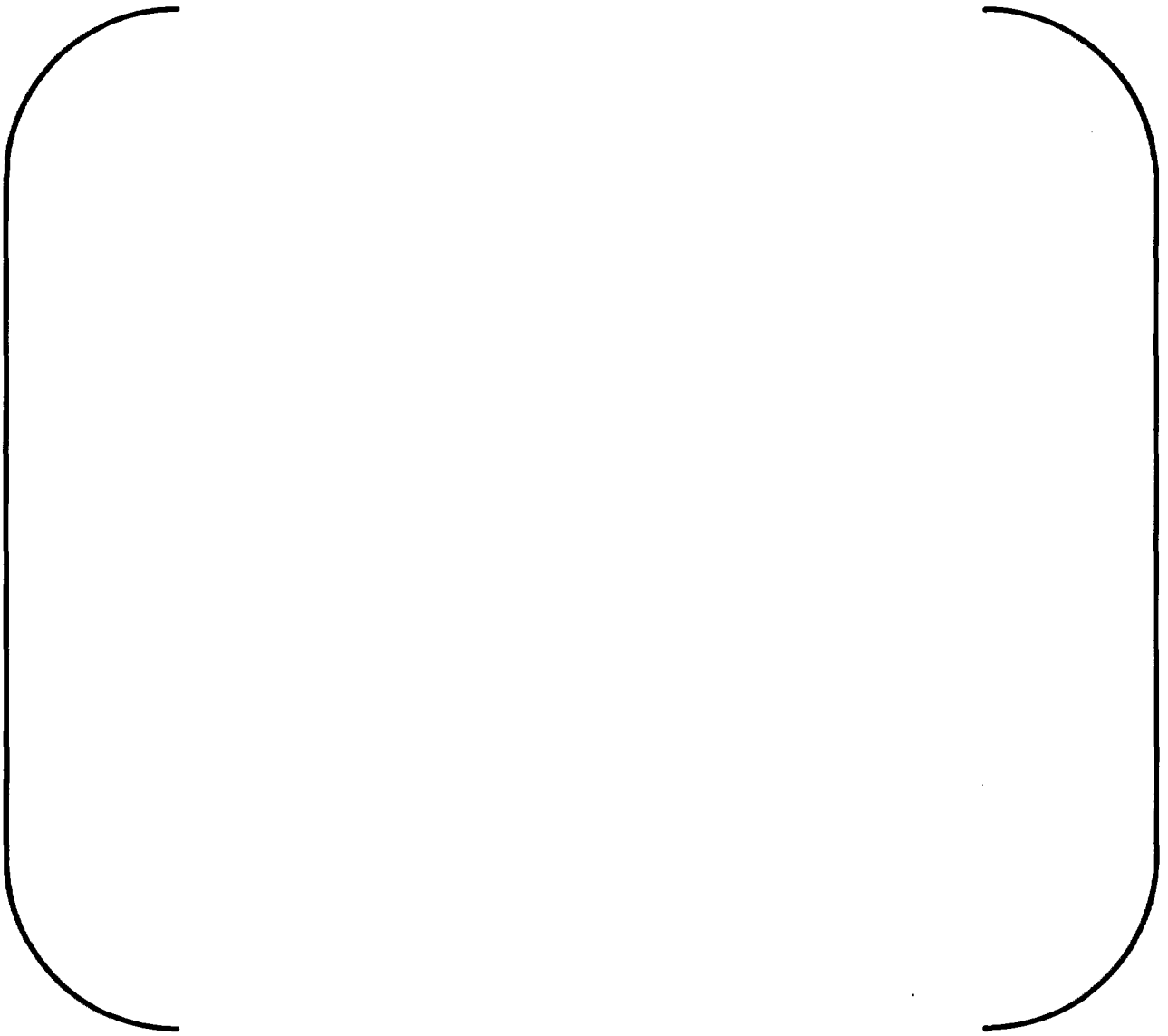


Entergy Indication: # 6

WesDyne Indication: # 5. This reflector was detected with the both the circ and axial shooting transducers.

Figure 8 - WDI-TJ-007-02

a,c,e



Entergy Indication: # 6

WesDyne Indication: # 1D. This reflector was detected with the both the circ and axial shooting transducers.

Table 1 – PENETRATION TUBE FLAW EVALUATION (Page 1 of 4)

CRDM Inspection Result Codes

Open Housing Probe Inspections

NDD: No Detectable Defect

WII: Weld Interface Indication

PTI: Penetration Tube Indication Note that an axial flaw may show up on only 2-3 scans on Channel 2

IPA: Indication Profile Analysis Resolution of indication

LOB: Loss of Backwall, linear indication. Main area of interest is just above the weld. This may indicate a deep flaw that is in the "blind" zone of the PCS24.

LCS: Loss of Coupling-Scanner, note the circ extent

LCG: Loss of Coupling-Geometry, note the circ extent

LIF: Loss of Interference Fit (Channel 4, second backwall)

VOL: Volumetric indication (Ch1 and 2 response comparison)

WVI: Weld Volume Indication (within 0.1" beyond fusion interface)

LOF: Lack of Fusion at the tube to weld interface (Channel 3) >50% of weld width

WBI: Weld butter indication (Channel 3, large area indication)

Criteria:

Weld region at 0 and 180 degree covered

PTI and WVI are special interest results

Channel 2 is the primary inspection channel for PTI and WVI indications. Channel 1 is used for additional and confirmatory data. Review every B scan on Channel 2 for axial and circumferential indications.

Table 1 - PENETRATION TUBE OD FLAWS EVALUATION (Page 2 of 4)

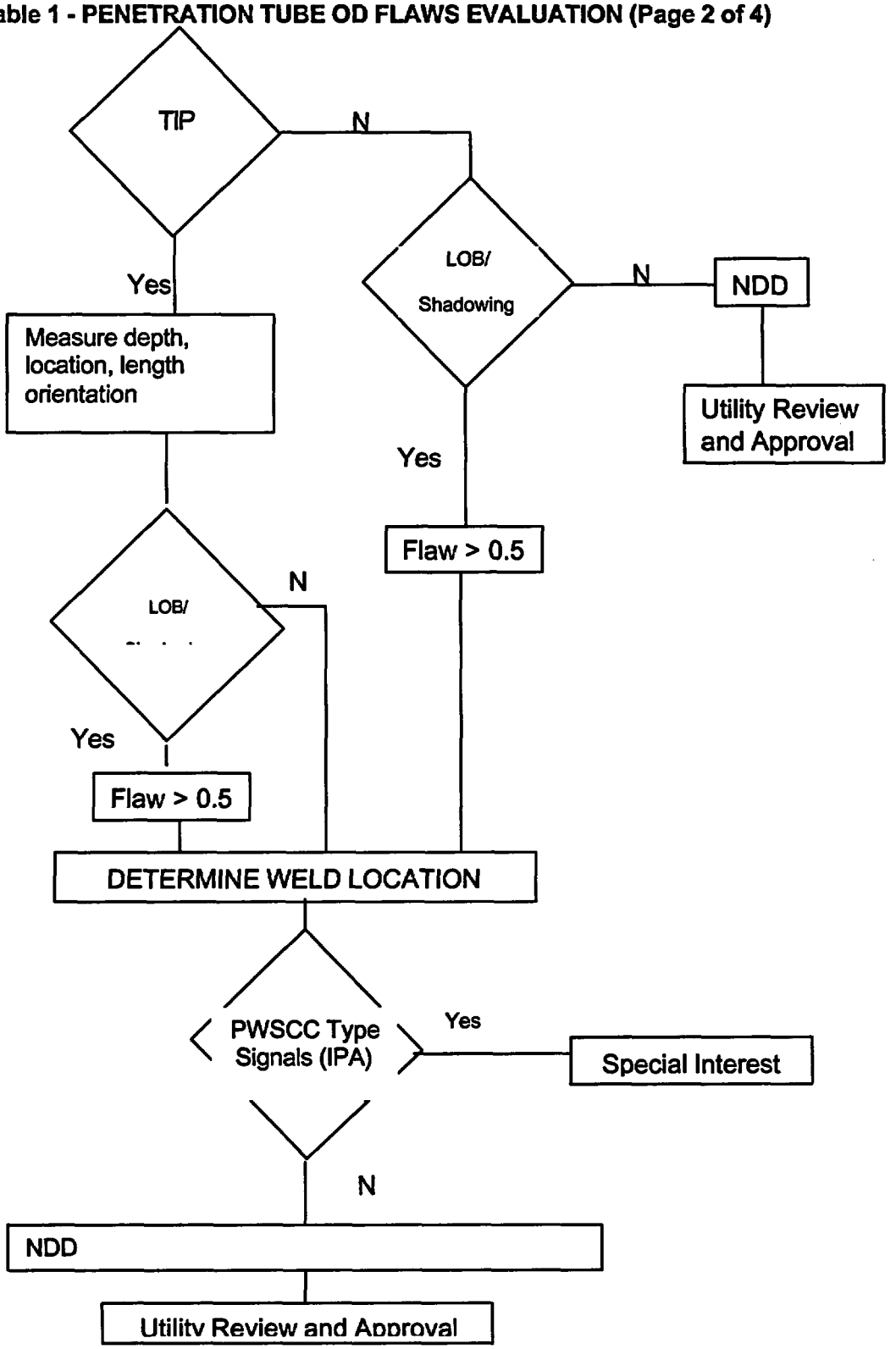


Table 1 - PWSCC TYPE SIGNALS (Page 3 of 4)

Linear in one direction, TOF like in the other hyperbolic echodynamic

intermediate amplitude, does not

OR

Linear region with loss of blackwall for PWSCC >0.5" deep from OD

False positives can be caused by

- Weld repairs
- Reflective weld interface grain structure
- Lack of fusion

Suspect signals are categorized as:

Special interest for additional surface inspection on the J groove weld surface

PWSCC, by definition must start on a wetted surface. The tube ID & OD

Table 1 - PENETRATION TUBE ID FLAW EVALUATION (Page 4 of 4)