Enclosure 4

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Wesdyne Report WDI-TJ-006-03-NP, Rev 3,
UT of Interference Fit Samples for Leak Path
(Non-Proprietary)

WESDYNE INTERNATIONAL

Title:
Ultrasonic Testing of Interference Fit Samples for Leak Path Detection

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Author(s):	Cognizant Manager:						
R. Devlin For R Devlin 08.14.03	Don Adamonis 8/14/03						
Customer	Required		Yes		No		Date

SUMMARY

An evaluation was performed to determine the detection capabilities of the existing CRDM penetration ID UT techniques to detect simulated wastage of the carbon steel behind a RPVH penetration.

The inspection technique involves monitoring the backwall signal of the CRDM sleeve. In the shrink fit area some of the energy that is normally reflected back to the transducer would be transferred into the RPV head thus reducing the backwall signal amplitude in the shrink fit area. In an area with erosion of the head material behind the sleeve (leak path) the signal response from the sleeve backwall signal will increase.

Two techniques described below were capable of clearly detecting the [a,c,e] [a,c,e] in the carbon steel sleeve with a shrink fit.

The best results were achieved using a [a,c,e] [a,c,e] The backwall signal amplitude difference between the shrink fit and the grooves was up to [a,c,e] giving the ability to detect areas of erosion on the head in the range of [a,c,e] wide and above.

The [a,c,e] probe monitoring the backwall signal from the longitudinal wave also produced good results. Monitoring the first backwall signal amplitude difference between the shrink fit area and the grooves produced a difference in signal amplitude between [a,c,e] [a,c,e] giving the ability to detect areas of erosion on the head in the range of [a,c,e] wide and above. The technique requires that the backwall signal be reduced to a range that it can be monitored. Two methods may be used to reduce the TOFD backwall signal. [a,c,e]

[a,c,e]

1. Introduction

The purpose of this test sequence was to determine the feasibility of using one of the existing inspection techniques now in service for inspecting CRDM RPV head penetrations as a method for detecting leak paths in the RPV head material.
The CRDM penetration above the J weld has a manufactured shrink fit as it passes through the head. It is expected that in the area of the shrink fit some of the ultrasonic energy will pass into the head producing a reduced signal response. An area of erosion on the ID of the head penetration that is normally in contact with the OD of the CRDM would produce a gap in the shrink fit section and might be detectable with ultrasonic inspection techniques.

2. Equipment:

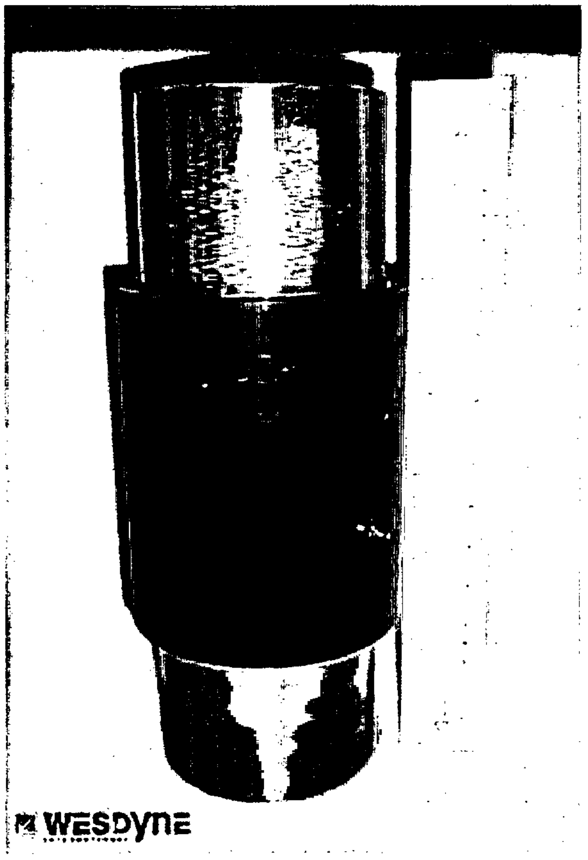
All of the testing was performed with a standard IntraSpect 4 channel data acquisition system configured as it would be used in the field to perform head penetration inspections. This consisted of a Data Acquisition Subsystem (DAS) [a,c,e] [a,c,e]
A 7010 Open housing scanner was used to manipulate the probes in the test samples.
A 50' umbilical cable with triax data lines were used to connect the scanner to the DAS.
The probe modules used consisted of a standard open housing [a,c,e] probe module set with [a,c,e] a combo [a,c,e] blade probe with [a,c,e] [a,c,e]

Test Sample's: Two test samples were manufactured for use in this testing.

Sample 1: Interference Fit

The first sample was manufactured from a 12" section of CRDM penetration material with a 2.71" ID diameter and a .720" wall. A 6" long section of carbon steel sleeve was shrunk on to the penetration with a 2 mil. diametrical shrink fit. The interference fit (shrink fit) area was 5" long. The remaining 1" was machined to be 3 mil diametrically oversized simulating the counter bore in the RPV head. The sleeve was heated in an oven and then assembled over the center of the CRDM penetration. The shrunk on sleeve had four machined artifacts consisting of [a,c,e]
[a,c,e]

Sample 2: Slip Fit
The second sample was manufactured from a 12" section of CRDM penetration material with a 2.71" ID and a .720" wall. A 6" long section of carbon steel sleeve was machined to provide a slip fit from 0.0 to +.5 mils on the CRDM penetration. The sleeve was slipped over the center of the CRDM penetration. The sleeve had the same four machined artifacts describes in sample # 1.



Test Sample # 1

3. **Data:**

Each test sample was scanned using the open housing probe set and the blade probe. The subsequent images present the results of the data that was acquired.

a,c,e

This probe generated the best results producing discernable signal responses from [a,c,e] the wide groove, approx. [a,c,e] differentiation between the shrink fit area and the defects. This probe setup produced the highest difference between the signal from the shrink fit area and the non shrink areas on the sample. The striping noted in the shrink fit area determined to be caused by the machining process used on the sleeve. The machining of the sleeve was done on a lathe which is less rigid than the actual manufacturing process. The horizontal striping does not occur in the actual RPV heads.

a,c,e

[ ]

This probe generated good results producing discernable signal responses from the [a,c,e] wide groove, approx. [a,c,e] amplitude differentiation between the shrink fit area and the defects.

[a,c,e]

[ ]

This probe generated good results producing discernable signal responses from the [ ][a,c,e] wide groove, approx. [ ][a,c,e] amplitude differentiation between the shrink fit area and the defects.

a,c,e

The results from this probe was fair, producing discernable signal responses from the [ ]a,c,e wide groove and the [ ]a,c,e amplitude differentiation between the shrink fit area and the defects.

a,c,e

This scan demonstrates the effect of water in the grooves and side drilled holes. Water in the grooves did not show any change in the signal responses received from the dry sample test.
Ultrasonic couplant had to be used in the holes and did show a reduction in the signal amplitude when compared to the dry sample test.

[ ] a,c,e

This test was performed by[ ] a,c,e so that a multiple backwall signal could be monitored. The inspection sensitivity was left at normal levels.

This probe generated poor results producing no discernable signal responses from the holes. The [a,c,e] wide groove can be detected but the surrounding noise level would make it hard to call unless its location was already known .

a,c,e

This test was performed by dropping the [a,c,e] down to a level that the backwall signal could be monitored (L-Wave and Shear Wave). The sensitivity was reduced by [a,c,e]feature of the IntraSpect system.

This probe generated good results producing discernable signal responses from the [a,c,e] wide groove, [a,c,e] differentiation between the shrink fit area and the defects. This test produced the best results on the [a,c,e] diameter hole.

a,c,e

This test was performed by dropping the [a,c,e] backwall sensitivity down to a level that the backwall signal could be monitored (L a,c,e Wave and Shear Wave). The sensitivity was reduced by [ ] feature of the IntraSpect system.

This Test generated poor results producing no discernable signal responses from the grooves or holes. This result was caused by a large area of the signal being in saturation. The scan was performed a number of times adjusting the DAC level but to date a good scan of the second backwall has not been achieved. The time required to setup and maintain the signals in the desired range using this technique could be prohibitive.

a,c,e

This probe provided fair results producing discernable signal responses from the [ ]a,c,e wide groove, and the [ ]a,c,e amplitude differentiation between the shrink fit area and the defects detected.

a,c,e

This test generated poor results producing no discernable signal responses from the carbon steel sleeve or the defects in the sleeve. The results of this test indicates that an erosion area would not be detected in a non shrink fit (slip fit) section of a penetration using the ultrasonic techniques tested.

a,c,e

This test generated poor results producing no discernable signal responses from the carbon steel sleeve or the defects in the sleeve. The results of this test indicates that an erosion area would not be detected in a non shrink fit (slip fit) section of a penetration using the ultrasonic techniques tested.

4. Conclusions

It has been demonstrated, based on the data acquired to date, that an erosion area in the RPV head can be detected using ultrasonic inspection techniques.

The best results were achieved using a[a,c,e] probe monitoring the backwall signal from the CRDM penetration. The backwall signal amplitude difference between the shrink fit and the grooves was up to[a,c,e]giving the ability to detect areas of erosion on the head in the range of [a,c,e] and above.

The results acquired on the [a,c,e]probe monitoring the backwall signal from the longitudinal wave also produced good results. Monitoring [a,c,e] produced a difference in signal amplitude between [a,c,e]giving the ability to detect areas of erosion on the head in the range of [a,c,e] wide and above. The technique requires that the backwall signal be reduced to a range that can be monitored. The inspection sensitivity required for defect detection and sizing using the TOFD probe normally produces a saturated backwall signal. [

a,c,e]

The results acquired on the [a,c,e]signal from the CRDM penetration could be used but again the results are not as good as the[a,c,e]. The signal amplitude difference between the shrink fit and the grooves was in the [a,c,e] range.

An added inspection of the shrink fit area will require retooling of the 7010 OHS in some cases to allow for a longer stroke to accommodate the extended inspection area.

Water in the grooves did not affect the signal response from the groove. Ultrasonic couplant placed in the holes did reduce the signal amplitude [a,c,e] below the backwall amplitude in the shrink fit area.

None of the techniques described in this test sequence were capable of detecting any of the artifacts in the slip fit sample.