

# Non-Destructive Evaluation of Launch Tube Welds with Radiography

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**Abstract**—The non-destructive testing of launch tube weld with radiography was investigated and evaluated with AWS D1.1 standard. The paper started with preparation of launch tube and radiographic inspection. X-Ray inspection then was done and gotten the result. The judgment of inspection results were concluded by certified person and finally, the evaluation with AWS D1.1 standard was conducted as well.

The result shown that weld position P1 was not conformed to AWS D1.1 which allowed size of incomplete penetration did not exceed 4 mm. The other welds were corresponded to as mentioned standard. Additionally, the corrective actions for incomplete penetration either provided for future actions.

**Keywords**—Non-destructive evaluation, Weld, Launch tube, Radiography

## I. INTRODUCTION

**R**ADIOGRAPHY is the general term given to material inspection methods that are based on the differential absorption of radiation. [1] Because of differences in density and variations in thickness of the part or differences in absorption characteristics caused by variations in composition, different portions of a test-piece absorb different amounts of penetrating radiation. These variations in the absorption of the penetrating radiation can be monitored by detecting the unabsorbed radiation that passes through the test-piece.

Radiographic inspection is extensively used on castings and weld, particularly where there is a critical need to ensure freedom from internal flaws. [2] It is appropriate to apply radiographic technique for volumetric flaws such as lack of fusion, cracks, porosity, incomplete penetration etc. [3] A radiographic weld image is produced by permitting X-ray source to penetrate the welded component and expose a photographic film which is then inspected by a certified inspector using a view box. [4] Nowadays, industrial radiography of welds is widely used for the detection of defects in the petroleum, chemical, nuclear, naval, aeronautics and civil construction industries, among others.

## II. RESEARCH METHODOLOGY

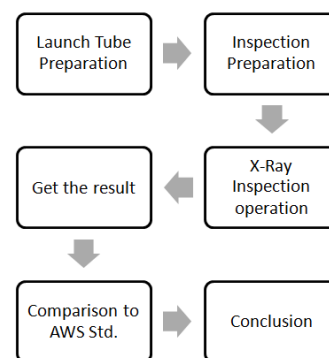


Fig. 1 shown research methodology

The research methodology was first applied by preparation of launch tube and inspection equipment, X-Ray Inspection. The operations for inspection with X-Ray then carried out for example marked inspection date/number, stuck IQI on film, attached of film and radiation source on launch tube, etc. Weld images would be occurred on X-Ray film and then primary judged for quality and qualify of each weld by certified body. The comparative evaluation according to AWS D1.1 had been obtained on next stage which would be secondary judged for decision which welds have to rework.

## III. X-RAY PARAMETERS

Source of radiation – IR-192

Size of source – 3.0×2.7 mm

Exposure time – 30 sec

Material thickness = 3 mm

Distance from source to film: 12"

Film type: KODAK "AA" Size 3.5"×8.5"

Lead shielding thickness: Front 0.005" and Back 0.005"

Image Quality Inspector (IQI)

Inspection position: The position is shown in Fig.2

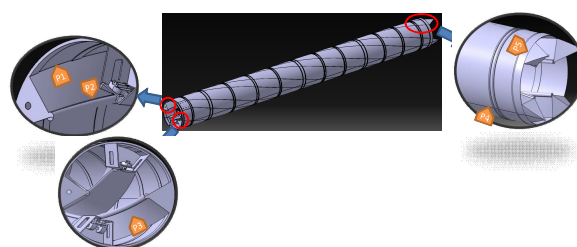


Fig. 2 Inspection position on launch tube

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#### IV. AWS D1.1 STANDARD

The American Welding Society (AWS) code contains the requirements for fabricating and erecting welded steel structures. When this code is stipulated in contract documents, conformance with all provisions of the code shall be required, except for those provisions that the engineer or contract documents specifically modifies or exempts.

#### V. WELD DISCONTINUITIES

[5] Weld discontinuities or weld defects are interruptions in the desirable physical structure of a weld. A discontinuity constituting a danger to the fitness-for-service of a weld is a defect. By definition, a defect is a condition that must be removed or corrected. The word "defect" should therefore be carefully used, because it implies that a weld is defective and requires corrective measures or rejection. Thus, repairs may be made unnecessarily and solely by implication, without a critical engineering assessment. Consequently, the engineering community now tends to use the word "discontinuity" or "flaw" instead of "defect." In this paper, three categories of weld defect have been defined for acknowledgement.

- Excessive Penetration (EP) exists molten metal sometimes runs through the root of the weld groove producing an excessive reinforcement at the backside of the weld. In general this is not continuous but has an irregular shape with characteristic hanging drops of excess metal.
- Incomplete Penetration (IP) occurs when the weld metal fails to penetrate the joint. It is one of the most objectionable weld discontinuities. Lack of penetration allows a natural stress riser from which a crack may propagate. The appearance on a radiograph is a dark area with well-defined, straight edges that follows the land or root face down the center of the weldment.
- Porosity (P) is the result of gas entrapment in the solidifying metal. Porosity can take many shapes on a radiograph but often appears as dark round or irregular spots or specks appearing singularly, in clusters, or in rows. Sometimes, porosity is elongated and may appear to have a tail. This is the result of gas attempting to escape while the metal is still in a liquid state and is called wormhole porosity. All porosity is a void in the material and it will have a higher radiographic density than the surrounding area.

#### VI. X-RAY INTERPRETATION

The inspection results of X-Ray have been judged by certified person at least RT level II. The result of judgment shown on Fig.3-7.

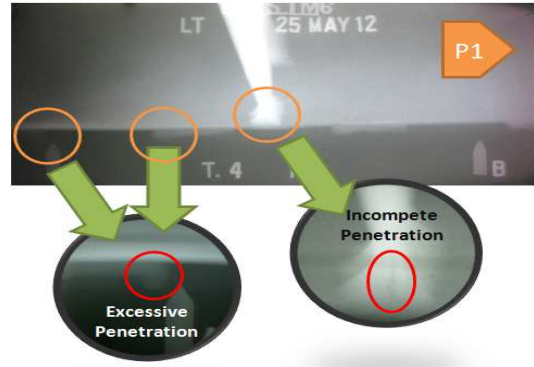


Fig. 3 Inspection result of position P1

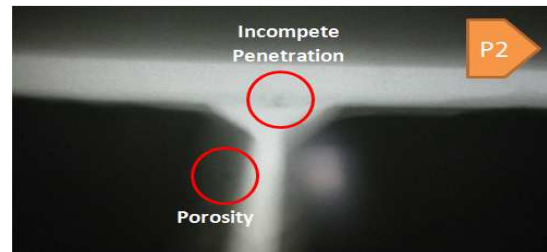


Fig. 4 Inspection result of position P2



Fig. 5 Inspection result of position P3

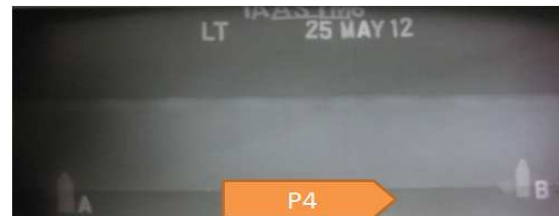


Fig. 6 Inspection result of position P4

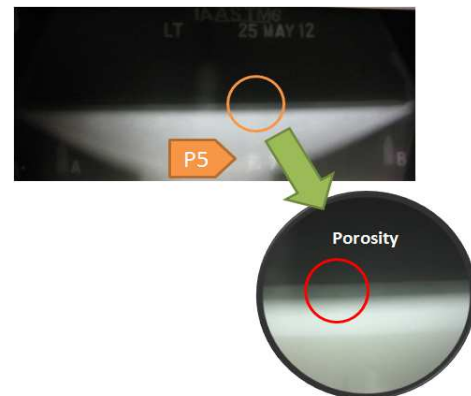


Fig. 7 Inspection result of position P5

## VII. X-RAY EVALUATION

The weld quality evaluation obtains with a comparative to AWS D1.1 standard which is the minimum requirement of launch tube building. The result of comparison exhibits on table 1 as below.

TABLE I  
 EVALUATION X-RAY RESULT WITH AWS D1.1

No.	Position	Defect	Size	AWS D1.1	Evaluation
1	P1 weld size 5 mm.	EP	1 mm. in length	2 mm. max	Conform
		IP	4 mm. in length	4 mm. max	Non-Conform
2	P2 weld size 5 mm.	P	1 mm. in dia.	2 mm. max	Conform
3	P3 weld size 5 mm.	Found nothing	-	-	Conform
4	P4 weld size 5 mm.	Found nothing	-	-	Conform
5	P5 weld size 5 mm.	P	1 mm. in dia.	2 mm. max	Conform

The weld position P1 contains IP size about 4 mm. AWS D1.1 allows weld discontinuity in case of weld size 5 mm. not exceed 4 mm. in size. Generally, this weld position conforms to standard however, it is marginal accepted and position P1 plays a vital characteristic because it reinforces rail support and will be loaded with impact in service. Consequently, weld position P1 has been rejected and needing corrective action such as removing obsolete weld bead, re-welding, and then inspection again.

## VIII. CONCLUSION

This paper studied non-destructive inspection, judgment, and evaluation of launch tube's weld. The judgment of weld performed by certified NDT at least RT level II person. AWS D1.1 had been adopted to assess which welds conformed. The discussion case was weld position P1 which decided as marginal accept because it relied on lower bound of AWS standard. However, P1 could not accept due to it impacted to efficiency of launch tube.

## ACKNOWLEDGMENT

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