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Digital Radioscopic Imaging of Heavy Wall Piping

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Introduction

- This presentation describes the application of digital flat panel imagers, electrically generated x-rays and state of the art image processing and archival software for weld inspection of heavy wall piping using the double wall, single image technique.
Traditional RT of Heavy Wall Pipes

Traditional RT of butt welds in piping has used film and gamma sources, which while relatively easy to deploy, result in:

- Very long exposure times when used on heavy wall piping of upwards of 30mm wall thickness;
- Low production rates;
- Increasing safety concerns regarding control of gamma sources, especially the higher energy sources such as Co60
Digital Radiography Objectives

The objective was to inspect, in accordance with ASME B31.1 and API 1104 codes, heavy wall piping during field construction operations by:

- Use of the higher x-ray energies and higher dose rate available from portable, electrically operated x-ray tubes;
- Use of state of the art digital imagers to rapidly acquire images;
- Use of digital image processing and archival software to enable reading of the image immediately after acquisition;
- Verification of image quality by the field radiographer before moving equipment for the next shot enables immediate corrective action and re-shooting with minimal loss of time.
Improved Safety – Reduced Environmental Impact

The use of electrically generated x-ray improves personnel safety and reduces environmental impact:

- Eliminates the use of Gamma Isotope Sources and multiple exposures
- Gamma Isotope Source accountability requirements eliminated
- Electrically powered with emergency stop system – Power Off = No radiation possible
- Highly collimated X-ray beam decreases barrier distances for increased personnel safety, and lower impact on construction operations
- Eliminates the use of x-ray film, film chemistry and darkroom and eliminates environmental impact of chemicals
Piping to be Inspected

• Heavy wall piping from 14 inches diameter up to 30 inches diameter, schedule 160, and wall thicknesses from 30mm to 49mm was required to be inspected in situ during construction of gas plant.
Preparation of Piping to be Inspected

- Preparation of pipe to be inspected. Attachment of number belt, and IQI wire packs
X-Ray Equipment Used

- For pipe wall thicknesses of up to 41.5mm, x-rays of 300kVp were used.

300kVp portable x-ray unit mounted on pipe.
X-Ray Equipment Used

- For pipe wall thickness in excess of 41.5mm, x-rays of 7.5MeV generated by a Betatron were used.

Deployment of betatron
Digital area imagers were used.

- 400mm x 400mm active area
- 200mm x 200mm active area
- Weatherproof enclosure
- Rugged design for mounting
Inspection System Controls

- X-ray system controls were rugged for use in construction site conditions.
- Imaging computer – Tuff Book/Weatherproof
Technique Qualification

- For each pipe diameter and wall thickness the imaging technique had to be developed and qualified.
- Qualification using a test piece is shown here -
Technique Qualification

- Qualification of the Digital Imager was in accordance with ASTM E2737 Standard Practice for Digital Detector Array Performance Evaluation and Long-Term Stability
- Typical qualification image of 30 cm section of weld is shown in following with duplex wire gauges on inside and outside of test pipe.
- 8 FE EN wire packs shown at each end of the weld section.
Typical Image – Double Wall, Single Image
Spatial Resolution per EN
Tungsten Inclusions

- Tungsten inclusions, illustrate spatial resolution performance.
**Important Conclusions**

- Heavy wall piping from 14 inches diameter up to 30 inches diameter, schedule 160, and wall thicknesses from 30mm to 49mm were successfully inspected.
- Medium energy portable x-ray units generating 300kVp energies at relatively high dose rates, and high energy portable x-ray units generating energies up to 7.5MeV at lower dose rates were safely and successfully used in the field.
- Images were successfully qualified and exceeded imaging performance of traditional film techniques.
- Safety and Environmental Impact significantly enhanced by the use of Digital radioscopy.