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HDRTTR
(High Definition Real Time Radiography)

Advances in Technology

API 2010 Winter Standards Meeting
New Orleans, LA
January 28, 2010
Gamma Radiographic Inspection

History

0.1 Ci of Ra-226 1930s-1940’s

“Fishpole” method for pulling through a long pipe.

Photos courtesy of: NUREG/BR-0024 Working Safely in Gamma Radiography.
Pipeline X-Ray History

Pipeline X-Ray Machine 1968
Pipeline X-Ray History

- In 1960’s, most pipeline radiography was conducted using low kilovoltage x-ray machines (170 kV to 225 kV) with a combination of fluorescent (calcium tungstate) screens and high speed, light sensitive film.

- Iridium 192 Gamma sources and lead foil screens were used primarily for weld inspection on fabrication (elbows, flange welds, etc.).

- In the years following, as the pipe wall thickness and diameters increased, it became necessary to increase the X-Ray kilovoltage which in turn was detrimental to the quality of the radiograph when using fluorescent screens.

- New techniques were developed such as using a combination of fluorescent screen on front and lead on back, and also a special screen material manufactured using lead screen impregnated with calcium tungstate. Both techniques produced radiographs much faster than lead screens, but had less desirable results when using higher kV radiation. As a result, a combination of gamma ray sources and lead foil screens replaced x-ray machines for most double wall exposures.
HDRTR
HISTORY & BACKGROUND

In 2005 SPS independently funded the development of a 2nd Generation RTR system specifically designed for pipe weld inspection using new components & software to facilitate inspections particularly geared for a high resolution and high production demanding environment both On and Offshore.

- 2005 – SPS Acquired XTEK developers of the RTR Technology to further develop the RTR technologies, GEN I
- 2008 – Performed HDRTR Offshore Market Lay Barge (Tyrihans) Norway (HDRTRSW-1) GEN II
- 2009 – Introduced HDRTR to the landline market (HDRTRSW-1 / HDRTRDW-1) GEN III
- 2009 Performed HDRTR Offshore Market Lay Barge (Pluto) Australia (HDRTRSW-1)
PRODUCT DEVELOPMENT
New for 2009

• Ruggedized Land-Line and Laybarge Cooled Dual Head System using components developed in ‘tie-in’ program, covering 10” to 30” pipe diameters (SW2)

• Tie-In version for fully external (DW1) X-ray inspection of 16” to 36” pipeline girth welds using 300kV CP Highly Directional X-ray Source and single head, cooled detector

• High Resolution (24 micron) detector also variant for thin wall tubes
Hi-Res HDRTR

General Description
The Hi-Res HDRTR detector has been developed for critical welds on pipelines. It has twice the resolution of the original RTR product and its combined electronics and CCD into the same package increases the overall signal to noise ratio. The detector produces results exceeding that of D4 film used with typical gamma sources. Applications also include thin wall pipes/tubes, fuel lines, aerospace engine components, laser and electron beam welds.

Specification:
- CCD Size: 1024 x 128 pixels at 24 micron pitch
- Resolution: >18 line pairs per mm
- Sensitivity (IQI): better than 2% on 2.5mm thick plate/pipe
- Active size: 24.6 mm length x 3.07mm TDI width
- Scan speed: up to 35mm/second
- Energy Range: 20 to 300 kV
- Output: 16 Bit USB2
HDRTR Hardware
HDRTR Equipment

2 Systems for targeted applications

- HDRTRSW1
  - Extremely Fast Production applications
  - Lay Barge/ Landline production welding
  - Fabrication and Spooling

- HDRTRDW1
  - Tie-In Welds
HDRTR-SW2

• General Description

The HDRTR-SW2 (Land-Line) girth weld system has been designed for operation from a vehicle in the field, used in conjunction with an X-ray crawler. It is also suited for offshore, lay-barge HDRTR where high production is required.

This new water cooled, twin head system inspects girth welds without the use of film. The X-rays source is an SPS panoramic x-ray crawler placed inside the pipe. The system inspects pipes from 10” to 30” diameter and shares the same major components as the Tie-In system.

• Twin water cooled and Peltier chilled HDRTR detection heads
• Water cooled electronics module, motor control and USB to Ethernet adapter
• Miniature closed loop pumped water chillers'
• Weight reduced orbiting scanner (<68lbs) with on-board stepper motor/drive
• Standard Shaw welding band with laser cut drive rack
• Universal software package for either tie-in or land-line/lay barge use
• Small diameter (15mm) 25 meter signal umbilical to power supply unit/ laptop
SPS X-ray tube crawler system
HDRTR-SW2 Land-Line & Lay-Barge Production Version
3D CAD Model
HDRTR SW2

- From 10 inch to 30 inch diameter currently
HDRTR-SW2 Land-Line & Lay-Barge RTR for 10” to 30” Diameter Pipe
Twin head cooled HDRTR-SW2 Detection Head on 16” pipe
HDRTR SW3-LD

Large Diameter Piping
up to 48 inch
diameter expected to be released 2nd Q 2010
The HDRTR Inspection Process
Single Wall Scanner
HDRTR-SW2 (Land-Line): –
Estimated/Actual Inspection Times
.750 wall thickness API pipe, 1.6% Wire IQI Sensitivity (source side)
300kV/3mA CP Internal Panoramic

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HDRTR-DW1 (Tie-In)

3D CAD Model of finalized production system on pipe band
HDRTR-DW1
(Tie-In)
System Diagram
HDRTR-DW1
Scanner

Single Head HDRTR-DW1 Tie-In X-ray detector with e-box, cooler & extended width scanner/band
General Description
The Tie-In HDRTR system inspects girth welds totally externally to the pipeline (DWSI) using a light/compact orbiting detection head (<66lbs) and a strong/stable X-ray tube orbiting assembly. This version covers diameters up to 36 inch. The equipment consists of the following main components:

• 300kV High Frequency CP directional x-ray tube with fan beam collimator
• Water cooled HDRTR detection head with Peltier cooled detector chip
• Water cooled electronics module, motor control and USB to Ethernet adapter
• Miniature closed loop, pumped water chiller carried on the detector
• Extra wide pipe band with pipe specialized pads for use on pipe coating
• Small diameter (15mm) 25 meter signal umbilical to power supply unit/ laptop
• Small diameter (10mm) 30 meter umbilical to X-ray tube
• Universal software package for either tie-in or land-line/lay barge use
• Proprietary ‘beam search’ software to align the detector with the highly collimated X-ray source for increased safety and reduced barrier distances.
X-ray tube on extended width bug & band
HDRTR DW1

- Up to 30 inch diameter currently
Tie-in weld on 20” OD Pipeline Road Crossing
Typical Double wall setup
HDRTR-DW1 (Tie-in inspection times: .600 wall thickness API pipe, 1.8% Wire IQI Sensitivity (source side))

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*6 minutes allowed to attach band, fit bugs/detector/x-ray tube, put up safety barrier, remove bus/band. 4 minutes to remove all equipment from band to vehicle.
Inspection Data
HDRTR Software
HDRTR Image Results

Incomplete Penetration due to Hi/Lo
HDRTR Image Results

Incomplete Fusion on the cover pass
HDRTR Image Results

Elongated Slag Inclusions
Conventional RT Image Results
HDRTR Image Results
Comparison with D-4
HDRTR Image Results
Immediate Results with capability exceeding that of film Radiography
  • Interpretation takes place while the system is acquiring data thus reducing overall inspection cycle time = **No Wait Time for Film Processing**
  • Time to weld disposition the weld significantly less than gamma = $Savings$
  • Data, Images and reports can be e-mailed for further analysis
  • Retakes are virtually eliminated

Enhanced interpretation of results
  • Capability for further automation of interpretation
  • Sensitivity exceeds 1104 specifications and Gamma Radiography

Safest form of Radiography
  • **No Gamma Source required**
  • No Chemicals
  • Highly Collimated beam reducing exposure risk to personnel and others

Archives the weld image and disposition report digitally
  • Results Archived electronically indefinitely