Making the Conversion to Digital

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GE Industrial X-ray & CT Forum
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First Shuttle Flight 1981
Orion EFT-1
Space Craft

Juno

Genesis

GRAIL
Gravity Recovery and Interior Laboratory
DRAW – Digital Radiography for Aluminum Welds
CCD Camera with FOS
CCD Camera on Weld Machine
Aluminum Weld Example
Incomplete Joint Penetration
DR Requirements

1997: ASTMs addressing non-film radiography are limited to Radioscopy:

- E1000, Standard Guide for Radioscopy
- E1255, Standard Practice for Radioscopy
- E1411, Standard Practice for Qualification of Radioscopic Systems
Industry Organizations

AIA
Aerospace Industries Association

ASTM International

ASNT
The American Society for Nondestructive Testing®

JEDEC
Global Standards for the Microelectronics Industry

FEDERAL WORKING GROUP ON INDUSTRIAL DIGITAL RADIOGRAPHY
Cooperation Among Government Agencies
Advancing Digital Radiography

Nadcap®
http://www.astm.org/

- ASTM International is a globally recognized leader in the development and delivery of voluntary consensus standards.
- ASTM International is one of the largest voluntary standards developing organizations in the world.
- ASTM Committee E07 on Nondestructive Testing was formed in 1938. E07 meets twice a year, in January and June. The Committee, with a membership of over 400, currently has jurisdiction of over 175 standards, published in October in the Annual Book of ASTM Standards; Volume 03.03
The FWG-IDR is an organization consisting of federal and contractor employees (limited to contractors that are directly supporting federal contracts) with responsibilities for the application of nondestructive testing methods.

The goal of the Federal Working Group on Industrial Digital Radiography (FWGIDR) is to assist industrial radiographic activities that are supporting U.S. government funded nondestructive testing efforts with the transition from film radiography to digital radiography.

http://dwgndt.org/fwgidr.htm
FWGIDR

Published 10 white papers that are available for download from website:

• Recommended Training Curriculum for Digital Radiography Personnel (LI, LII and LIII)

• Guide for the Qualification of Digital Radiography Systems and Processes

• Hardware for High Energy Applications

• Guide for the Standardization and Management of Digital Data

• Accomplishments of Data Standardization and Management Task Team

• DICONEDE Conformance and Verification

• Checklist for the Qualification of Computed Radiography Systems

• Checklist for the Qualification of Digital Detector Array Systems
https://asnt.org/

• The world’s largest technical society for nondestructive testing professionals

• Providing a forum for exchange of NDT technical information; NDT educational materials and programs; and standards and services for the qualification and certification of NDT personnel

• Penetrating Radiation Committee
ASNT Penetrating Radiation Committee

• The Committee is responsible for generating the appropriate materials relating to Penetrating Radiation

• Supporting the Handbook Committee in generating and updating the Radiographic Testing Handbook (2017)

• Update ANSI/ASNT CP-105 - ASNT Standard Topical Outlines

• Update Recommended Practice No. SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing

• Develop and update associated study materials (e.g., Study Guides, Q&A Books, etc.)
http://www.aia-aerospace.org/

- The Aerospace Industries Association is the collective voice of the U.S. aerospace and defense industry.
- NDT Sub-Committee is responsible for NAS-410, Certification & Qualification of Nondestructive Testing Personnel, Rev 4 December 19, 2014
- Harmonized with EN4179, Aerospace Series – Qualification and Approval of Personnel for Nondestructive Testing
http://www.jedec.org/

• JC-13 Government Liaison Committee: responsible for standardizing quality and reliability methodologies for solid state products used in military, space, and other environments requiring special-use condition capabilities beyond standard commercial practices.

• Activities include the development, coordination, and maintenance of standards documents regarding product quality and reliability, validation systems, and process management.

• Radiography Team responsible for MIL-STD radiography requirements
MIL-STD-750
Semiconductors

MIL-STD-883
Microcircuits

- Personnel training and certification requirements
- DR System Qualifications
- Operating Procedures
- Part Specific Techniques

http://www.dla.mil/LandandMaritime/
Nadcap is an industry-managed program. This means that customers from industry are represented at every level of the organization, helping to shape the overall vision as well as contributing to the daily activities of the program.

DR and CR Audit Criteria may be downloaded from:

https://www.eauditnet.com
FS50B Film Digitizer
The main engine did not ignite, a fuel line had become clogged.
Space Craft Tube Welds
Digitized Radiograph of Polyester plug sample

Polyester plug is only faintly visible
Radiograph is digitized with 50 micron resolution, converted to 16 bit tiff format, the pseudo-color filter (Yellow/Red/Purple) is applied.
Production weld radiographs have a greater advantage in applying the pseudo-color filter. By using the IQI, color can be adjusted to show high contrast color difference with a 0.005” thickness change.

0.030” shim with 0.005” thick IQI to represent PM double wall thickness.

0.050” shim with 0.005” thick IQI to represent double wall Weld thickness.
Weld radiograph technique is designed for weld inspection so details of the orifice are not readily visible.
A single line has too much noise in the signal to produce an accurate reading.

Using a line tool, the pixel values along the plane of the orifice can be measured.
By averaging 25 lines, the signal can be read to an accurate dimension.

This orifice is 0.060” diameter.
Use of Digital Radiography for Final Part Acceptance of Aerospace Castings

Leading Digital Equipment Manufacturers:
GEIT, Fuji, Northstar Imaging, VJ Technologies, YXLON
MAI Output

- Guidelines for the Use of Digital Detector Arrays and Computed Radiology for Aerospace Casting Inspections
  - published Aug. 2011
  - authorized for public distribution under case number 88ABW-2011-4752.

- Each participating Prime developed their own internal specification

- Each participating Prime converted at least one part to DR or CR

- Training for L2s and L3s based on FWGIDR Training Outlines
Hellfire Missile Housing
Hellfire Casting
GE Flex CR System
Space Craft Service Valve

Crack at base of tube, hardware behind tube blocks conventional film x-ray
Service Valve Z Axis

50 micron Slice of crack below surface
Service Valve X Axis

Crack seen from X axis
Challenges for a Successful Implementation

- Most first timers don’t know the scope of what they are getting into
- I’m meeting many folks that have systems more than a year old that are not in production because they don’t know where to begin
- They also have limited budget and need good advice