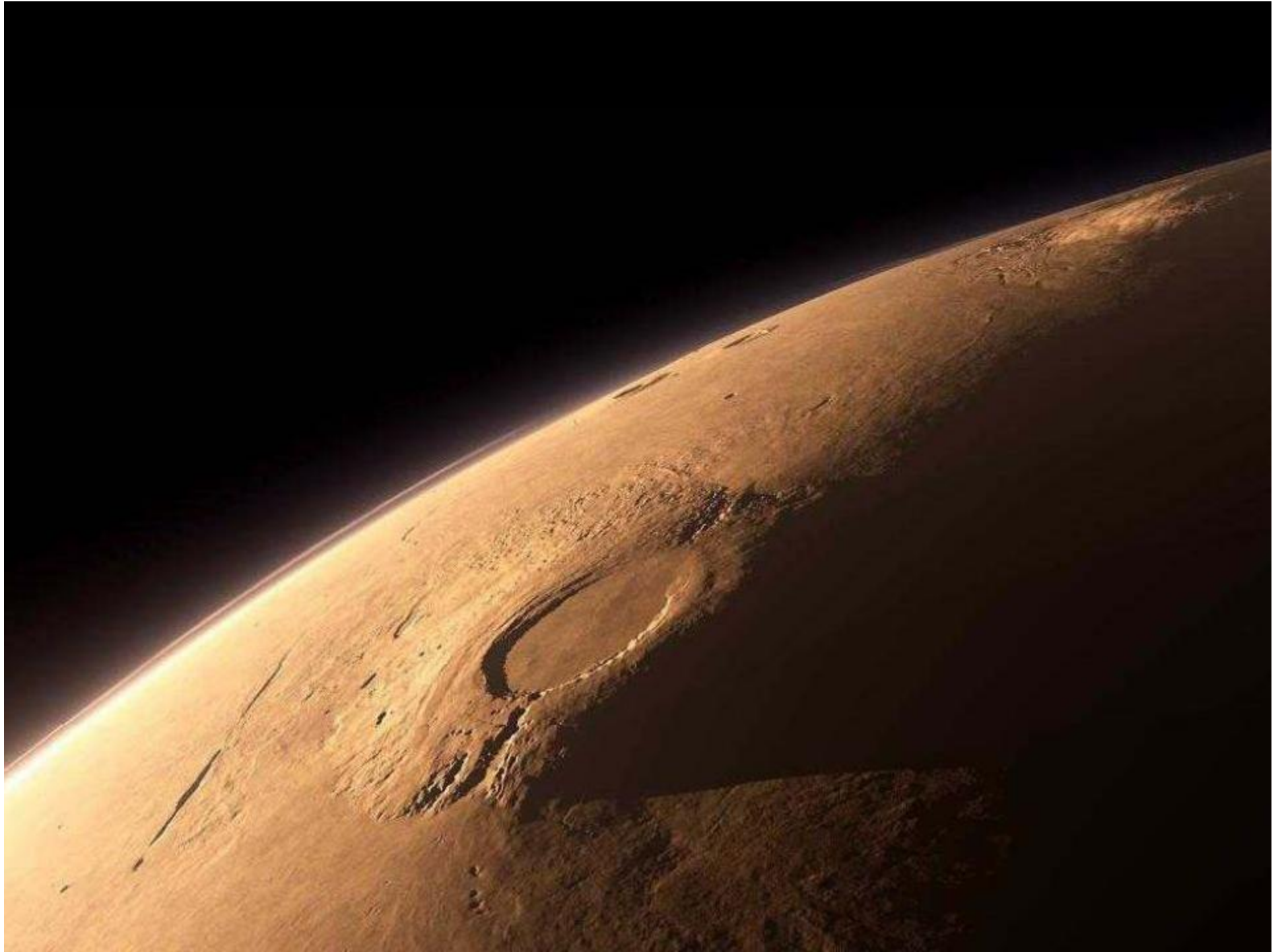




# Industry Organizations for NDT in Aerospace

**John P Ellegood, RT Level 3  
Lockheed Martin Space Systems Co.  
Three Rivers Technical Conference  
August 6, 2008**





**YANKEE GO HOME!**

**MARS  
FOR  
MARTIANS**



**NO MORE  
SPIRIT**



# Agenda



- **PRI – NADCAP**
- **AIA**
- **ASNT**
- **ASTM International**
- **FWG-IDR**
- **Summary**

# Key Points



- **Accreditation – Approval**
- **Training, Qualification and Certification Requirements**
- **Process Control and Documentation**
- **System Qualification and Long Term Stability**
- **Future Direction of Digital Radiological Technology**

# PRI – Performance Review Institute



- **PRI – Performance Review Institute**
  - **[www.pri-network.org](http://www.pri-network.org)**
  - **PRI works with industry, government and individual organizations to identify and meet customer demand in all areas of businesses relating to quality**
  - **PRI is led by a BOD with the responsibility for strategic direction and financial stability. The BOD is comprised of leading Quality Executives of some of the worlds largest mobility-related companies. (e.g. Lockheed Martin, Boeing)**
  - **Key Programs include NADCAP and PRI Registrar**

# NADCAP



- **NADCAP – (formerly) National Aerospace and Defense Contractors Accreditation Program**
  - An industry managed, consensus approach to OEM oversight of special processes and product suppliers and is an integral part of the supplier management system of most of the world's aerospace prime manufacturers.
  - NADCAP provides independent certification of manufacturing processes for industry.
  - Most OEM's require NADCAP accreditation and supplement NADCAP's surveys with their own requirements.

# NADCAP cont.



- **Special Processes**

- **Aerospace Quality Systems such as:**

- **Chemical Processing – Anodizing, Chemical Milling, etching**
    - **Electronics – printed circuit boards, cables and harnesses**
    - **Heat Treating – metal systems, heat treating processes, heat treating equipment, brazing and hot forming**
    - **Nondestructive Testing – Liquid Penetrant, Magnetic Particle, Ultrasonic and Radiographic Testing**
      - Currently developing a survey/checklist for digital radiology
  - **NDT Newsletter published 3 to 4 times annually**
  - **NDT Handbooks and Checklists**

# Aerospace Industries Association - AIA



- [www.aia-aerospace.org](http://www.aia-aerospace.org)
- AIA – represents the nation’s leading manufacturers and suppliers of civil, military, and business aircraft, helicopters, unmanned aerial vehicles, space systems, aircraft engines, missiles, material, and related components, equipment, services and information technology.
- AIA is the “voice” of the aerospace, defense, and homeland security industry.

# AIA Cont.



- **AIA's councils and committees provide the mechanism to determine the best solutions to industry wide problems and make policy recommendations to the BOD**
- **Administration, Acquisition Policy, Civil Aviation, Communications, International Affairs, National Security and Space Systems**

# AIA Cont.



## – National Security

- **Quality Assurance Committee**

- **QA NDT Working Group**

- **National Aerospace Standard (NAS) 410, NAS Certification & Qualification of Nondestructive Test Personnel**

- **Revision 3 published March 2008 (5 year revision cycle)**
    - **Significant Changes include:**
    - **Trainee must be documented with expected certification date**
    - **Vision requirements updated**
    - **Added Thermography and Shearography as standard methods**
    - **Added a training and experience table for 1<sup>st</sup> Level 3 in an emerging method**

# AIA QA NDT WG



- **Current Work**

- **National Aerospace Non-Destructive Testing Board (NANDTB)**
- **NANDTB is an independent national aerospace organization representing a nation's aerospace industry that is chartered by the participating prime contractors and recognized by the nation's regulatory agencies to provide or support NDT qualification, examination, and/or certification services in accordance with NAS410/EN4179.**
  - **The NDT WG is seeking approval from QAC to establish an NANDTB as is already done by most countries**
  - **The aim of a NANDTB is to provide objective verification and documentation of the capability of NDT personnel**

# ASNT



- **ASNT exists to create a safer world by promoting the profession and technologies of nondestructive testing**
- **[www.asnt.org](http://www.asnt.org)**
- **NDT Handbook, Vol. 4, Radiographic Testing – get the book and the CD**
  - **Sections include:**
  - **Radioscopy**
  - **Digital Radiographic Imaging**
  - **Computed Tomography**

# ASNT Cont.



- **ASNT is currently updating the Level 2 Study Guide: Radiographic Testing Method and Radiographic Testing Q&A Book**
- **ASNT is also currently developing new books covering Computed Tomography, Computed Radiography and Digital Imaging**
- **For more information contact Cindi Leeman [cleeman@asnt.org]**

# ASTM International



- **Originally known as the American Society for Testing and Materials, was formed in 1898 due to failures in Railroad tracks**
- **[www.astm.org](http://www.astm.org)**
- **ASTM International is one of the largest voluntary standards development organizations in the world**
- **There are over 130 technical committees covering diverse industry areas ranging from metals to the environment**
- **E07 Committee on Nondestructive Testing**

# ASTM E07 Committee



- **E07 Committee on Nondestructive Testing**
  - **Currently has jurisdiction of over 175 standards**
  - **17 Sub committees – 12 are technical**
    - **E07.01 Radiology (X and Gamma) Method**
    - **E07.11 Digital Imaging and Communications in Nondestructive Evaluation (DICONDE)**
  - **Sub committees are further divided into task groups that work on individual documents**

# E07 Committee Cont.



- **Radiology is divided into 3 basic types:**
  - **Film Radiography**
  - **Radioscopy – Image Intensifier based systems**
  - **Digital Detector Arrays (DDA)**
    - **Charge-Coupled Device (CCD)**
    - **Flat Panel**
    - **Linear Arrays**
    - **Complementary Metal Oxide Semiconductor (CMOS)**

# Film Radiography



- **Film Radiography**
  - **Standard Guide E94 – 5 yr revision to start in January 2009**
  - **Standard Practice E1742 – updates to geometric unsharpness to start in January 2009**
  - **NIST SRM 1001 Film Density Strip – ASTM to officially request SRM 1001 to meet 4.5 film density allowable**
    - **SRM 1001 currently unavailable**

# Radioscopy



- **Radioscopy**
  - **Standard Guide E1000**
  - **Standard Practice E1255**
  - **Standard Practice for System Qualification E1411**
  - **All 3 documents are outdated and are in revision – complete rewrites are planned to be ready for ballot by January 2009**

# Digital Detectors



- **DDA**
  - **E2597 Standard Practice for Manufacturing Characterization of Digital Detector Arrays – Published in January 2008**
  - **Intended for manufacturers or integrators**
  - **Sets requirements for quantitative comparison of DDA's so that an appropriate DDA is selected to meet NDT requirements**

# Digital Detectors Cont.



- **E2597 explains variables such as:**
  - **Basic Spatial Resolution**
  - **Signal to Noise Ratio (SNR)**
  - **Bad Pixel**
    - **Various types and definitions**
  - **Efficiency**
  - **Image Lag and Burn in**
  - **Internal Scatter**

# DDA Practice



- **WK13186 New Standard Practice for Radiological Examination Using Digital Detector Arrays**
  - Establishes minimum requirements for radiological examinations
  - Intended to be equivalent to E1742

# DDA Practice Cont.



- **Standard Practice will set acceptance levels for:**
  - **Acceptable IQI 2T hole (number of pixels and signal)**
  - **Window Width (contrast)**
  - **Window Level (brightness)**
  - **Image Zoom for Display**
  - **Geometric Magnification – min/max**
  - **Maximum Unsharpness**

# Digital Detectors Cont.



- **WK16413 Standard Practice for Qualification and Long Term Stability of digital Detector Arrays**
  - Specifies the fundamental parameters of DDA systems to assure satisfactory and repeatable results
  - Defines a series of tests for the user to select and perform at 30 day intervals to assure process control.
  - Intervals may change

# Digital Detectors Cont.



- **Proposed user tests include**
  - **Spatial resolution – SR – unit: micron**
  - **Contrast sensitivity – CS - %**
  - **Material thickness range – MTR - mm**
  - **Signal to noise ratio – SNR**
  - **Signal level - SL**
  - **Image lag – Lag - %**
  - **Burn In – BI - %**
  - **Offset Level - OL**
  - **Bad pixel distribution**

# Digital Detectors Cont.



- **When is “End of Life”?**
  - **Current thought is when any key variable changes by 20% or more**
  - **Should be specified in contractual agreements as well as which variable to test**

# Digital Detectors Cont.



- **WK7492 Standard Guide for Digital Detector Array Selection**
  - The scope is to help with understanding the tradeoffs in systems for various applications
  - Define the factors in making comparisons among systems
  - Defines key DDA factors such as SNR, Spatial Resolution, Bad Pixels, etc.
  - Intended to help with digital conversion by making informed decisions without bias

# ASTM E07 Documents



- **E94 Standard Guide for Radiographic Examination**
- **E431 Standard Guide to Interpretation of Radiographs of Semiconductors and Related Devices**
- **E747 Standard Practice for Design, Manufacture and Material Grouping Classification of Wire Image Quality Indicators (IQI) Used for Radiology**
- **E801 Standard Practice for Controlling Quality of Radiological Examination of Electronic Devices**

# ASTM E07 Documents



- **E1000 Standard Guide for Radioscopy**
- **E1025 Standard Practice for Design, Manufacture, and Material Grouping Classification of Hole-Type Image Quality Indicators (IQI) Used for Radiology**
- **E1161 Radiologic Examination of Electronic Component Parts and Devices**
- **E1165 Standard Test Method for Measurement of Focal Spots of Industrial X-Ray Tubes by Pinhole Imaging**

# ASTM E07 Documents



- **E1255 Standard Practice for Radioscopy**
- **E1316 Standard Terminology for Nondestructive Examinations**
- **E1411 Standard Practice for Qualification of Radioscopic Systems**
- **E1441 Standard Guide for Computed Tomography (CT) Imaging**
- **E1453 Standard Guide for Storage of Media that Contains Analog or Digital Radioscopic Data**

# ASTM E07 Documents



- **E1475 Standard Guide for Data Fields for Computerized Transfer of Digital Radiological Examination Data**
- **E1570 Standard Practice for Computed Tomographic (CT) Examination**
- **E1647 Standard Practice for Determining Contrast Sensitivity in Radiology**
- **E1672 Standard Guide for Computed Tomography (CT) System Selection**

# ASTM E07 Documents



- **E1695 Standard Test Method for Measurement of Computed Tomography (CT) System Performance**
- **E1742 Standard Practice for Radiographic Examination**
- **E1936 Standard Reference Radiograph for Evaluating the Performance of Radiographic Digitization Systems**

# ASTM E07 Documents



- **E2002 Standard Practice for Determining Total Image Unsharpness in Radiology**
- **E2007 Standard Guide for Computed Radiology (Photostimulable Luminescence (PSL) Method)**
- **E2033 Standard Practice for Computed Radiology (Photostimulable Luminescence Method)**

# ASTM E07 Documents



- **E2339 Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE)**
- **E2445 Standard Practice for Qualification and Long-Term Stability of Computed Radiology Systems**
- **E2446 Standard Practice for Classification of Computed Radiology Systems**

# FWG-IDR



- **Federal Working Group for Industrial Digital Radiography**
  - The FWG-IDR was formed in 2007 by the Department of Energy's (DOE) Nuclear Weapons Community (NWC) Digital Radiography Thrust Area Team. The FWG-IDR consists of government organizations such as the DOE's National Laboratories, Department of Defense (DOD) NDT organizations (i.e. Air Force, Army, and Navy) and select government contractors, such as Lockheed Martin and Northrop Grumman.

# FWG-IDR Cont.



- **The FWG-IDR was formed with the intent of bringing together a wide base of the industrial (government) radiography complex to discuss the future of industrial radiography.**

# FWG-IDR Cont.



- **Keys Issues:**

- **Digital radiography technology is rapidly growing**

- **this is due to research and development that has taken place in medical radiographic imaging but has not considered the wider applications of industrial radiography**

- **The future of industrial radiographic film is questionable**

- **e.g. Kodak was for years the industry standard but has slipped in quality and customer service and ended up selling their entire x-ray film division. Now, the standard M type film and single emulsion R type film are no longer available causing many users to re-qualify film techniques using other types of film, in some cases an equivalent replacement film is not available and a loss of quality in inspections is the result as is the case with Neutron radiography**

# FWG-IDR Cont.



- **Key Issues Cont.**

- There is an increasing demand for more quantitative analysis.

- These issues, along with the numerous advantages of digital technologies, are driving the radiographic base towards digital radiography methods; however, in some cases the technology is being miss-used due to poor training and improper selection of equipment.

# FWG-IDR Cont.



- **Key issues common across government agencies were grouped into four categories:**
  - **Personnel Training and Certification**
  - **System Qualification**
  - **Digital Imaging Hardware for X-ray Applications**
  - **Data Standardization and Management**

# FWG-IDR Cont.



- **The government (including government contractors) represents a significant marketing base for the NDE vendor community**
- **If we can find common issues to address and focus our concerns, we may collectively provide sufficient incentive for research activities and the industrial vendor base to meet our particular needs**

# FWG-IDR Cont.



- **Examples:**

- **Navy Nuclear Submarine Weld Inspections**
- **LM Space Craft Propulsion Tube Weld Inspections**
- **CR is best fit for film replacement techniques but does not have resolution and image quality to meet requirements for critical applications**

# FWG-IDR Cont.



- **FWG-IDR is striving to become the industry leader in directing how the industry will meet the need for total film replacement**
- **The FWG-IDR hopes to collectively provide sufficient incentive for research activities and the industrial vendor base to meet our particular needs and will solicit government funding activities to meet these needs if necessary**

# Summary



- **Industrial Digital Radiology is rapidly changing and improving**
- **Digital Systems are becoming more sophisticated to meet industry requirements**
- **Requirements are changing**
- **You need to continue to be informed and educated to grow with the industry**
- **There are several organizations you can access to stay abreast of these changes**