NAVIGATING STANDARDS TO AID IN THE SELECTION OF BLADE INSPECTION SYSTEMS

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Abstract: Over recent months, large strides have been taken toward a broader industry acceptance of digital imaging technology for the final inspection of blades and vanes. Extensive, collaborative efforts have proven the technology through probability of detection and film comparison studies. To further promote the acceptance of digital imaging, much work has gone into the creation of industry standards to provide guidance through selection and installation stage, and then ensure continued process quality control in high volume production.

Through the purchasing decision, guidance can be found for the selection for critical imaging chain components. Standards allow for vendor comparisons to select application appropriate Digital Detector Arrays (DDAs). Other tools provide direction in choosing sources to pair with the DDA and assist technique set up.

Ease of use and long-term stability should also be considered. Standards committees stress the importance of ensuring image quality over time and provide guidance to achieving this. Traditional film tools have been converted to digital software versions to create a familiar experience for interpreters. To complete the imaging chain, advanced methods for data retention and management are regulated through the DICONDE imaging communication protocols.

Introduction

Radiography standards have continuously evolved over the years to make the transitions from medical to industrial and film to digital. There are a multitude of standards that cover each of the components of a total inspection solution, as well as standards dedicated to covering a specific portion of the process. Navigating through the various standards is critical in ensuring that the proper system has been chosen for a given application. For the specific application example of an aerospace blade casting inspection with a DDA, most of the applicable standards will be ASTM documents.

System Selection

In recent years, much effort has been put into the development of standards for Digital Detector Arrays (DDA's). The first of these documents to be released, E2597 Standard Practice for Manufacturing Characterization of DDA's enables potential purchasers to compare DDA's using a common standard for reporting quantitative results. Previously, each manufacturer had their own method for collecting and reporting DDA data, which made it nearly impossible for purchasers to accurately compare products. In addition, the data being reported often had little relevance to the industry or application. E2597 regulates methods for data collection and provides industry and application relevant output by providing quantitative results based on true capabilities versus theoretical values for basic spatial resolution, achievable contrast sensitivity, material thickness range, efficiency and lag. The Standard Practice for Manufacturing Characterization of DDA's also brings consistency among DDA manufacturers by standardizing pixel definitions. The standard defines seven different types of bad

pixels, three groups classifications and naming convention for labelling groups. By regulating DDA data collection and reporting, this standard empowers potential users to make an educated purchasing decision for their specific inspection requirements.

As mentioned above, there are on-going development efforts for DDA standards to help users better understand, select, utilize and maintain inspection systems containing DDA technology. Another standard in progress but not released as of the submission of this paper (01/19/10), the ASTM Work Item WK-7492 Guide for DDA's focused on the education of the construction of various DDA types, inherent properties and basic usage could further aid in the system selection process.

System Setup

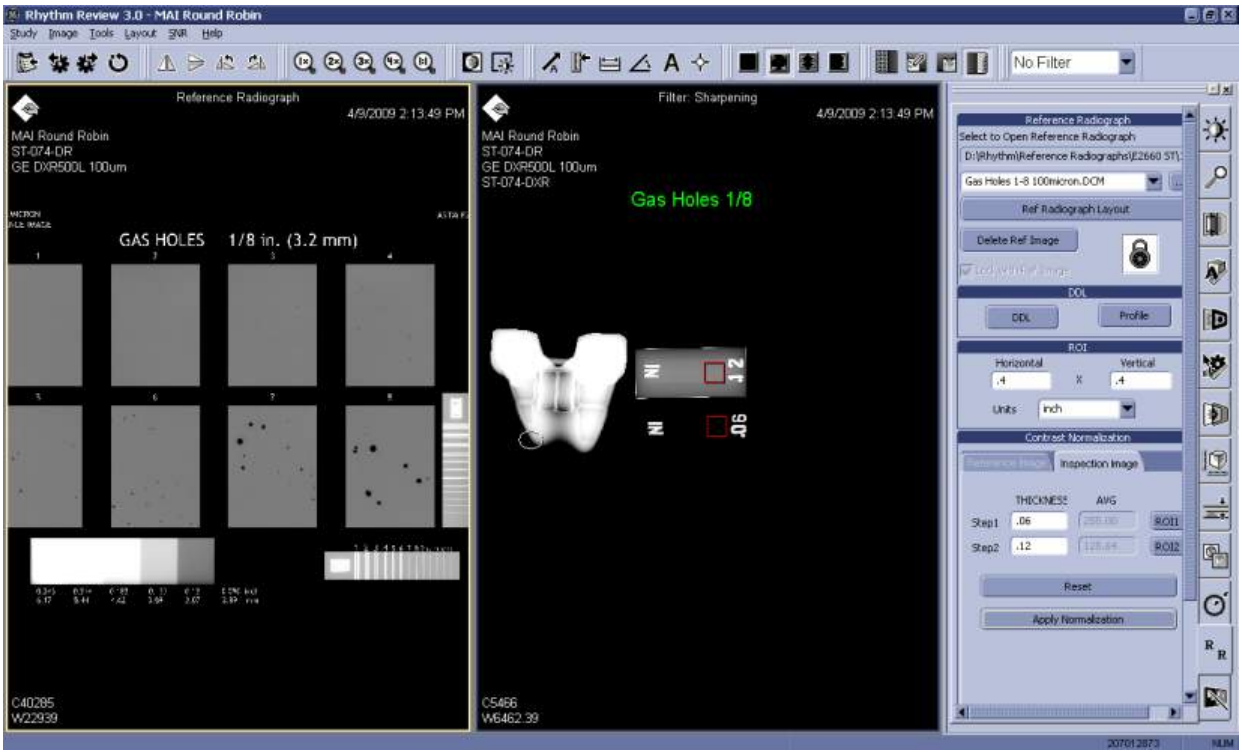
The setup and development of techniques is one of the most critical and time consuming components to meeting image quality requirements for an application. There are numerous inputs to be taken into consideration and recorded during this process, from source information such as mA, kV, focal spot size to setup parameters like source to detector distance, source to object distance, geometric magnification and many others. Because this information is so important in the qualification of a system for a specific application, the documentation of it is required. This information could be documented manually or could be stored digitally with each imaging utilizing the protocols described in E2339 Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE). The DICONDE file format stores critical application information in designated fields with corresponding DICONDE tags. Many DICONDE tags are specified and consistent among all vendors and users, there are also some generic tags available for specific user defined information. Below is an example of how critical technique setup information can be stored, then documented with each part taken with that unique technique setting.

Technique Information	DICONDE Tag
Part Job Number	0010:0020 Component ID
Customer Identification	0010:0010 Component Name
	0020:0010 Study ID
Technique unique identification used (with revision level.)	300A:01B0: Tech Name
Part serial number	0100:1000 Serial Number
Image Acquisition System (Type and unique identification).	0015:2131 Study Generic Field 2
X-ray Potential	0018:0060 kVP
Tube Current	0018:1151 Xray Tube Current
Geometric Magnification	0028:0030 Pixel Spacing

In addition to technique development, a user must establish procedures for the overall inspection process. These procedures should items like establish environment conditions for operation, system performance measurements and image viewing guidelines among many others. Guidance on system performance measurements are covered in ASTM Work Item WK-13186 Standard Practice for

Examination using DDA's also not released as of the submission of this paper (01/19/10). This document provides suggestions for proper IQI placement and formulas for determining appropriate geometric magnification requirements to achieve acceptable contrast to noise for your application.

For casting applications, reference images are available for aiding in the identification and classification of various defects. Originally used in film radiography, the references images were converted into a digital radiography format to allow for their continued usage. Three different ASTM standard regulate the release and usage of digital reference images - E2422 Standard Digital Reference Images for Inspection of Aluminum Castings, ASTM Work Item WK-17855 Standard Digital Reference Images of Investment Steel Castings for Aerospace Applications (not released as of the submission of this paper (01/19/10)), ASTM Work Item WK-21603 Standard Digital Reference Images for Titanium Castings (not released as of the submission of this paper (01/19/10)). After extensive probability of detection studies and proved the successful conversion to digital reference, these standards were written to ensure that POD is maintained through proper usage. These standards recommend a contrast normalization be applied through software helps the interpreter view the reference and production image equivalently (see example below of software being applied for side by side comparison).



Ensuring Proper Use and Long-term Stability

After the system is setup and qualified for a specific application, it is imperative that the integrity of the system is maintained over the duration of time that particular system is in production. System maintenance includes but is not limited to periodic system checks, a plan for addressing component degradation and changes in the system setup and image archival. There are several standards to address these particular issues. ASTM Work Item WK-16413 Standard Practice for DDA's Performance Evaluation and Long-Term Stability (not released as of the submission of this paper

(01/19/10) is written to help guide users in determining proper tests for evaluating current system performance and the frequency of each test. It also addresses bad pixel management concerns. E2339 Standard Practice for Digital Imaging and Communication in Nondestructive Evaluation (DICONDE) also provides support in long-term stability. Many aerospace castings require inspection data and images to be retained for lengthy periods of time, sometimes almost 50 years. The DICONDE format provides longevity to inspection data by vendor specific or proprietary formats that change or disappear over time. Regardless of the which vendor system the data was capture on, if captured in truly DICONDE format, the data can be viewed in any DICONDE viewing software. The DICONDE tags discussed earlier in this document, make searching for specific data efficient regardless of how much time as passed. Any of the fields identified with DICONDE tags can be queried and inspection data can be retrieved.