As the digitization of X-ray technology continues to expand in the NDT inspection world, many manual inspection tasks can now be fully automated. The main benefits are a significant increase in productivity and efficiency as well as higher end-product quality.

In this regard, a leading aerospace manufacturer has been seeking improvements to their inspection workflow in order to reduce the time required to perform detailed inspection of welded cylindrical drums used in their aircraft turbines. The use of digital image acquisition was the central idea for realizing these efficiency goals. After extensive preliminary assessments, the capabilities of the available digital methods such as CR (Computed Radiography) and DDA (Digital Detector Array) were approved internally by the manufacturer.

The objects to be inspected are cylindrical drums which are built up step-wise with segments attached using electron beam welding. The drums can be up to 1 meter in diameter and require a maximum of 11 individual weld inspections which are up to 3.2 meter in length each.

An additional requirement from the manufacturer was that the automated inspection process be compatible with different types and sizes of drums – so a flexible and easily configurable solution was crucial. Furthermore, quality assurance required inspection to be performed after each assembly step (i.e. after each welding and material heat-up/release action).

In the past, the inspection process involved the use of analog X-ray roll film on every weld in combination with a 360° X-ray source head. This typically took between 1 and 7 hours depending on each interim production step and the number of welds to be inspected.

The complete procedure was as follows:

1. Transport drum to X-ray bunker.
2. Mount drum.
3. Align X-ray source.
4. Place X-ray film on circumference of drum, lead markers are placed to label areas in case any rework is required if defects are detected on the processed film later.
5. Leave the bunker, perform X-ray exposure and re-enter the bunker to remove film from drum.
6. Repeat from (3) on a new weld and begin developing the newly exposed film in a separate darkroom next to the bunker.

With the aforementioned customer requirements in mind, DÜRR NDT’s local dealer was responsible for proposing the complete turn-key solution to the customer – this automated solution combines the technology and expertise from three different international companies: DÜRR NDT GmbH (Germany), X-RAY WorX GmbH (Germany) and BOSELLO HIGH TECHNOLOGY srl (Italy).

X-RAY WorX provided a micro-focus rod anode X-ray source with a customized head. BOSELLO designed and provided a CNC-controlled manipulation system to move the drum, with the weld centered between the X-ray tube and the DDA. The X-ray projection is carefully controlled to a specific magnification in order to reach the basic spatial resolution requested by the customer (based on material and weld thickness).

DÜRR NDT provided the software integration solution for the multi-manufacturer system which allows the viewing and analysis of the segmented digital weld images for sentencing by Level 2 and 3 X-ray inspectors.
The image transfer from the bunker to the inspector PC workstations uses the DICONDE (Digital Imaging and Communication in NDE) standard which guarantees a future-proof solution in terms of image format stability and interoperability with software and tools from different vendors.

The DICONDE standard achieves this by defining methods for how data from NDT inspection equipment is shared, stored and transferred. The data format itself also allows additional tags and attributes to be stored within an image such as the acquisition date, inspector name, material type, etc. which is useful for later archiving and retrieval. The software solution provided by DÜRR NDT is fully DICONDE-compliant and allows the viewing of all available image metadata.

The DICONDE standard also allows this current solution to be easily interfaced with a DICONDE-compliant digital work order management system or a picture archiving system (PACS) in the future if required.

Furthermore, a DÜRR NDT CR scanner (HD-CR35) was also installed to provide ultra-high resolution inspection capability in cases where this is required if the material thickness is below a certain value. As the inspection techniques for this application are based on the 2013 ISO 17636-2 standard (“Non-destructive testing of welds – X- and gamma-ray techniques with digital detectors”), penetrated thicknesses of 1.5 mm and below require a minimum basic spatial resolution (BSR) of 40 µm – the HD-CR35 exceeds this requirement and is certified by BAM (Federal Institute for Materials research and Testing) down to 30 µm. For any resolution requirements below 30 µm, the DÜRR NDT DR7 digital detector is more suitable as it can achieve a 25 µm basic spatial resolution.

This above-mentioned fully-automated solution can be described as follows:

1. Transport drum to X-ray bunker.
2. Mount drum on a special turntable which is able to rotate and adjust the drum height (so that the weld can be aligned with the source-to-detector axis).
3. Start CNC program for specific drum type. This program will x-ray all welds – single images are automatically stitched together by the image acquisition software.
4. After the entire drum is automatically inspected, all stitched weld images are transferred to a network folder and automatically imported by the DÜRR NDT software for viewing and analysis.
This fully automated solution has been in operation for over two years and has successfully reduced the inspection burden associated with examining numerous large welds of a single complex part - the time now associated with examining 11 welds has dropped from the length of a shift (8 hours) to merely 1.5 hours.

With this end-to-end solution, aerospace turbine manufacturers can implement a state-of-the-art digital X-ray inspection process which offers full data management and integration using industry standards such as DICONDE and ISO 17636.

As demonstrated, any inspection workflow where conventional x-ray film is used to perform weld inspection during the manufacturing process can benefit from huge time and labor savings by utilizing a fully-automated solution. An additional benefit is the seamless digitization of the inspection data which allows further analysis for part optimization and future development purposes.

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