17th World Conference on Nondestructive Testing, 25-28 Oct 2008, Shanghai, China

Digital Comparisons in Oil & Gas

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Abstract

Conversion of radiographic inspections from film to digital x-ray detectors has many benefits including increased detection capability, higher productivity, and simplified operations. However, successful conversion requires consideration of both technical and financial factors. The outstanding imaging performance of both DXR flat-panel detectors and computed radiography systems provides the required sensitivity equivalent to film for many applications. To determine if a digital solution is economically justified, GE Inspection Technologies routinely provides total cost of ownership projections for specific customer applications. These projections include factors such as productivity gains, detector wear out for applicable detector models, service contract options, and elimination of unnecessary chemical handling. This paper discusses the factors involved in these conversions and presents some example applications from the Oil & Gas industry.

Keywords: digital X-ray, X-ray imaging performance, X-ray flat panel detectors, computed radiography

1. Introduction

As the demand for oil and energy continues too grow, the Oil and Gas industry continues to feel the challenge for old infrastructure to produce at higher utilization rates, and for expedient new infrastructure construction. This demand taxes the non-destructive testing (NDT) industry, which ensures that these assets operate with structural integrity and to preserve safety for both humans and the surrounding environment.

Unfortunately, there is a shortage of qualified NDT technicians, and the aging work force combined with the expected demands will result in even more strain in the years to come. Faster inspections, which are more accurate and repeatable, can improve inspector efficiency to aid in closing the gap. Digital radiography provides such benefits in a variety of ways. This paper will highlight the potential benefits, and provide some application examples where digital can provide significant productivity.

2. Benefits of digital radiography

Digital radiography techniques usually provide both direct cost savings as well as cycle time reduction, improving both the inspector’s productivity and the asset owner’s profitability. The most obvious benefit is the reduction of the consumables associated with film use. This includes film, chemicals, and chemical disposal. Eliminating chemicals is not only better for the environment, but also the need to store and manage the transportation and processing. This is even more significant for offshore work where space is constrained and transporting materials is expensive.

Digital radiography enables productivity at the job site throughout the entire process. Using radiography instead of other modalities such as ultrasonic can reduce time by leaving insulation intact. Digital techniques frequently require significantly lower dose than film. This allows a reduction in the exclusion zone, either from lowered kV/mAs settings with x-ray sets or from use of reduced activity sources, so more work can continue in surrounding areas. This directly allows additional production or a reduced outage cycle. Alternatively, adequate image quality can be obtained with exposure times up to 90% faster than film in many applications, allowing the job to be finished faster. The wider latitude of digital solutions requires fewer shots, since a single exposure can replace what may have taken multiple films in examinations requiring wide latitude. It is also more forgiving of exposure variation, resulting in fewer retakes.

Not only can you gather your images faster, but you can also process them quickly and onsite. Unlike conventional films that must be processed before interpretation, digital images can be ready for review almost instantaneously. Digital Radiography (DR) uses a detector to convert the x-rays directly to a digital image and provides an instant image. Computed Radiography (CR) uses a phosphor plate to capture the image and then uses a laser to measure the stored image for processing into a digital display. Scanning a plate takes only approximately 1-2 minutes.

The fast access to images allows an inspector to review the image and make an instant decision at the site. Live decision making allows you decide to do immediate maintenance, turn a system back on, or even to take another exposure while the area is prepared for radiographic inspection. It is very costly to have to return to a site because an exposure needed to be reshot.

Digital data also provides improvements to analyzing images versus film usually resulting in improved probability of detection (POD). Zooming, filtering, grey leveling, electronic measurement are all tools that can be used to help make a determination about the item being inspected. In addition, application specific tools can be utilized to improve accuracy of results, reduce the time of manual measurement, and improve the repeatability and reproducibility of results both within a single inspector and between multiple inspectors.

Storing film requires climate-controlled space, and stored films can later be difficult to locate and share. Digital data allows images to be archived on servers, CD, DVDs, and with redundancy. In addition, these images can be shared globally via electronic mail. It is important to take into account how to access the data and search for images. Choosing a non-proprietary data format like DICONDE will provide many benefits. DICONDE data is an extension of the medically accepted standard DICOM, and ensures that data will be available in a supported format for years to come. In addition, the file format includes meta-data about the image such as date, location, part, site, exposure technique, study status etc. These user-defined fields are then searchable for locating old images. Older formats such as .jpg, .tif, or .bmp are flat images allowing you to only search by file name, making it cumbersome to locate and distinguish archived images.

3. Choosing the right digital solution

When selecting the right digital solution for your application you must consider the factors above to maximize your benefits. The first step in the process is finding the right image quality. Once you've established a technology that provides sufficient POD and meets any required standards you can begin to analyze environment. It is critical that you package the technology in a method that is suitable for the area of use and intended application. A simple rule of thumb is that for jobs where you need to bend around an object, have tight access, or requires high energies CR is often the best solution. If you are doing repeatable applications, in high throughput environments, or require premium image quality DR is often the preferred choice. Finally, workflow needs to be considered. Deciding the ideal throughput or cycle time will provide the proper set-up and layout of the solution. At this point a financial assessment can be done to quantify the expected financial improvements provided by a digital solution. You can perform a return on investment or calculate it down to a cost per shot to easily compare with film.

4. Application Examples

Corrosion in the Oil and Gas industry is one of the largest contributors to unforced outages and safety concerns. This can be attributed to many reasons and affects pipes both internally and externally. One of the main external sources of wall loss is known as Corrosion Under Insulation or CUI and has been a major issue for the upstream and downstream Oil & Gas industry decades. One of the principle methods for the detection of CUI is to remove the insulation and perform visual and ultrasonic inspection. This method however, is extremely costly and takes a long time to complete. Often after the insulation is removed no corrosion is present, the insulation then has to be replaced.

Figure 1. Typical insulated pipe structure

An alternative technique to the mechanical removal of the insulation is profile radiography using the tangential method. Historically using analogue film this technique requires a film be placed behind the pipe and the source, typically Iridium 192, positioned on the opposite side of the pipe (see diagram below). The image is then processed and a calculation made as to the extent of the remaining pipe wall thickness. Over the past 5 years this analog technique has been replaced with Computed Radiography where an Imaging Plate replaces the film, while the source remains the same.

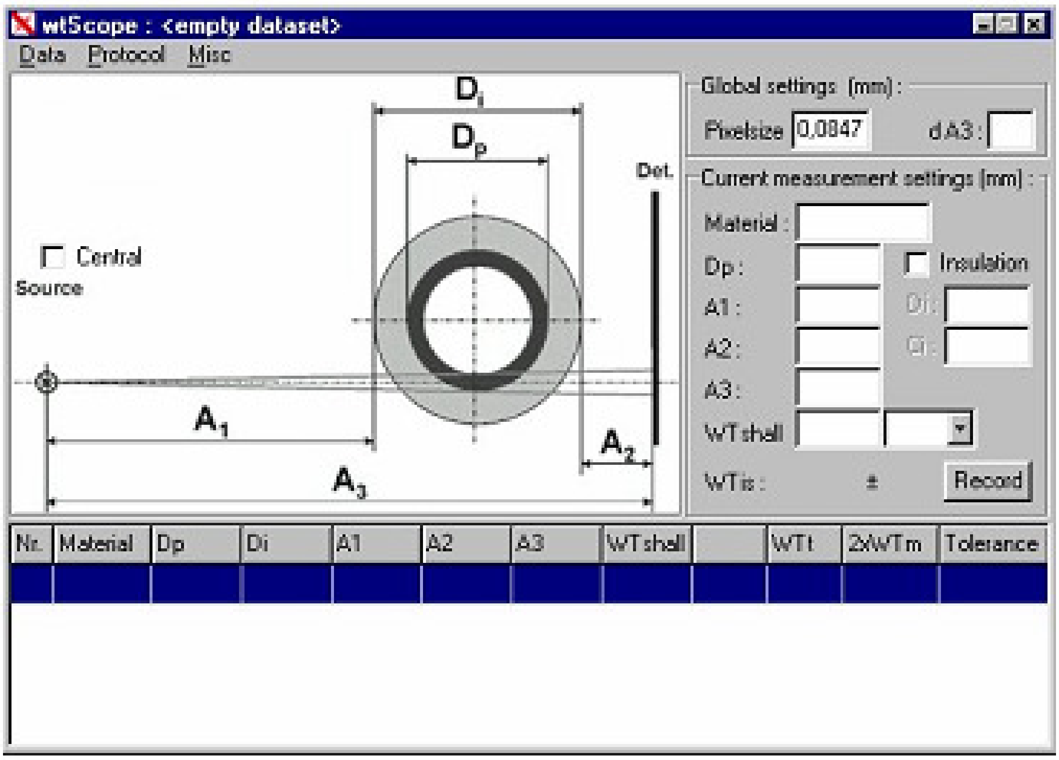

Figure 2. Technique example for tangential radiography

Some key advantages of using a digital technique instead of an analogue technique for corrosion inspection are listed below:

1. Reduced exposure time, typically 80% to 90% less than film
2. Increased dynamic range, enabling multiple thickness to be inspected in one shot
3. Zero chemicals to transport and dispose
4. Accurate and reliable wall thickness measurement using automated wall thickness algorithms
5. Digital data storage for long term use and data on demand accessibility for periodic review and comparisons
6. Reduced re-shoots due the inherent dynamic range of the system
7. Savings on consumable costs as the Imaging Plates are reusable

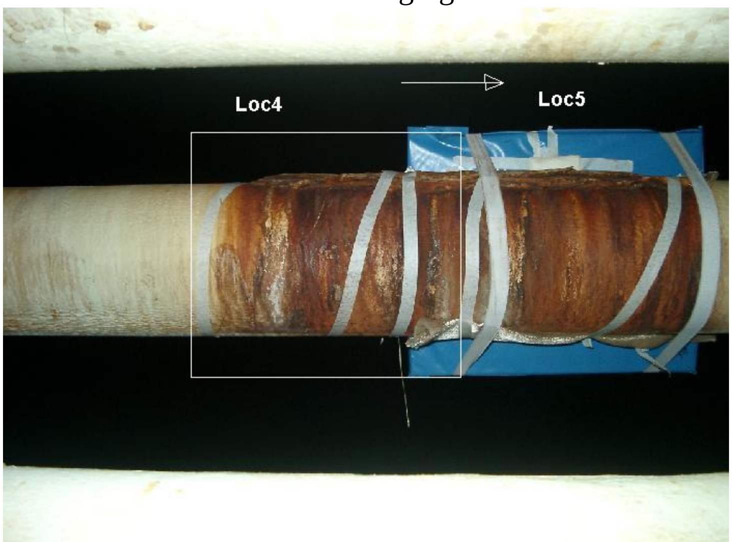

Figure 3. Pipe with scaling and wall loss

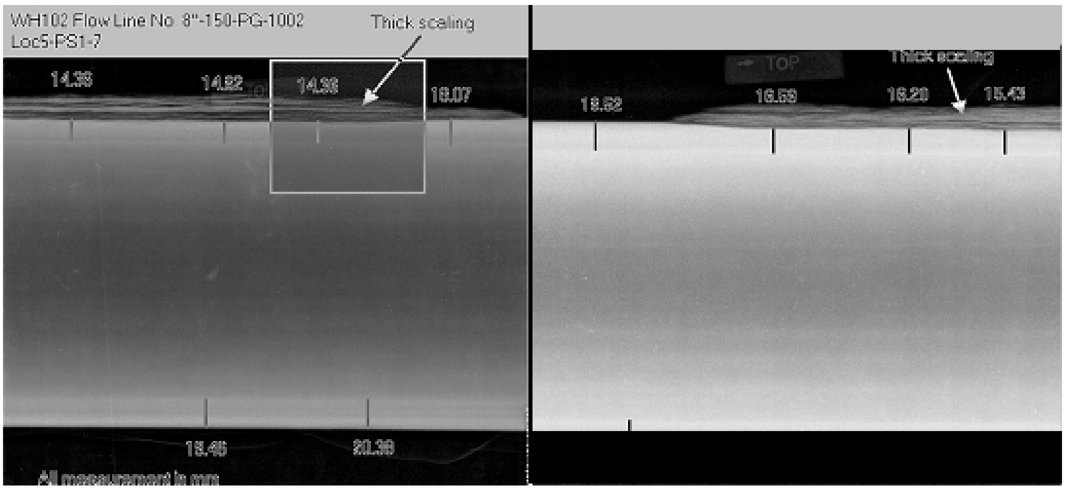

Figure 4. Corresponding digital images show the scaling and remaining wall thickness

CR is now widely used for profile radiography with the primary purpose of detecting and sizing wall thickness reductions caused by corrosion. The CR method is extremely convenient for offshore applications where the transportation of darkrooms is a costly and time-consuming task. In both upstream and downstream process plants, CR is being used on stream as part of the day-to-day inspection activities providing first class data to the plant engineers to help provide the asset integrity demanded by the regulators and asset owners.

In addition, DR methods are also becoming more common in field applications. The superior image quality, fast exposure times, and instant or real time images provide an attractive alternative to CR and film. This can be the ideal solution for above ground cross-country pipeline inspection; where often times miles of pipe requires inspection. This technology provides the added benefit of being integrated with a robotic crawler to optimize productivity and safety.

5. Conclusions

Digital radiography continues to grow in popularity because of the operational, environmental, and financial benefits. Digital images provide further advantages versus film with regards to measurement, sharing, storage, and retrieval.

When selecting the appropriate digital solution for a specific application, it is important to verify that the image quality is sufficient. Once this is established, the ideal solution should be determined by tailoring the solution to the operational and environmental factors to provide the best return on investment.