FOCUS
Replacing Film in a Modern Industry
by Wesley Soape

Converting to Computed Radiography
All too often, people come to me and say, “My company has allotted XX amount of money to get us into computed radiography. What is the best brand?” The first time I was approached with this question, I went into a long explanation of the many facets involved with converting to digital. I eventually answered the question, but only after explaining how complicated the transition is.

When I was asked that same question recently, I just said, “Hire a consultant” to the inquisitive individual. This may be because I had given that speech many times before and felt that it mostly fell onto deaf ears. It may be because I did not have time to go into all of the small details. Either way, it comes back to one simple concept: replacing film, the right way, with new technology, is extremely complicated.

Why is it so Complicated?
Anyone who knows me will tell you that I regard computed radiography simply as a film replacement (Figure 1). Yet, if it is simply a film replacement, then why is it so complicated?

When you replace film, you have to replace your standards. The average technician could shift gears from traditional film to computed radiography in a matter of minutes with some minor hands-on training. However, when it comes to any type of examination or technique within that examination there are always standards to follow.
The most prevalent standards are Digital Imaging and Communications in Medicine (DICOM) and Digital Imaging and Communication in Nondestructive Evaluation (DICONDE). These give the basic standards for equipment and software to follow. The most basic rule is that the image must remain in a raw state from formation to archival. Some machine and software combinations filter the image before delivering for review, which is not compliant of these standards. That is an evaluation that needs to be made first. Your client may accept pre-filtered images, though that segment is getting smaller and smaller. For most work, DICOM/DICONDE compliance is necessary.

If your client requires DICOM/DICONDE compliance, you will need to refer to something like ASTM E 2339 or ASTM E 2738 as accepted standards for compliance (ASTM, 2011; ASTM, 2013). ASTM E 2445 will give you the guidelines for performance evaluation and long-term stability, which is an important part of using any method or technique (ASTM, 2014). As a standard guide to computed radiography, you will need ASTM E 2007 (ASTM, 2010). Those are just a few ASTM International standards. If you use another evaluation standard, you will need to check into your applicable requirements.

There are also considerations with certification standards. You need to see how digital technology fits into your certification program along with a possible revamp of your own written practice. That could become a considerable task and expense, depending on the size of the company.

With the introduction and evolution of digital technology in our modern world of radiography, we have lots of standards with which to comply. Most of these standards go completely unnoticed by new and seasoned technicians alike, but clients are beginning to embrace these new standards, often before the service provider does.
Sensitivity Matters with Computed Radiography

The sensitivity level matters with computed radiography (Figure 2). Sensitivity is measured in microns (µm), or 1 millionth of a meter, in both the imaging plates and the scanner that creates the image. It is a physical measurement of width for each pixel on the image. Most weld-quality systems measure in the range of 50 to 100 µm, or 0.00005 to 0.0001 m. We use this same measurement for film, but film requires no attention to microns. The reason being is that the grain size is set. You can adjust the grain size by switching film, but that is the only adjustment. Computed radiography allows you to adjust micron size in multiple ways, ways we could never adjust with film (Figure 3).

Many technicians do not regard this number as important because they do not know what it means. Most people do not know that the lower the number, the finer the detail. When it comes to fine adjustments, this setting can make all the difference. Some situations may call for the micron settings to be as low as possible, while other situations will yield a better image at higher settings. In some cases, the extra noise that comes along with higher sensitivity can be detrimental. It depends on every possible variable you can consider. Should you need a unit with high sensitivity requirements, you will need to favor one that has those settings. These are all details that a consultant should be able to sort out.

Portability is an Important Consideration

With computed radiography, you can get a system that is as portable as needed and that meets your sensitivity needs. It is important to establish your specific needs. If the operation is in-house but you do perform fieldwork, do not limit yourself to a stationary unit that is ultimately going to make you less money. Odds are your company is looking at the utilization of that unit very closely in order to see whether it was worth the investment.

Large scanners are impressive to clients, but small scanners can go out to do jobs that net you more profit. If you tell your company at the end of the year that you need money to expand a program that is still in the red, you may not get approval. On the other hand, if you tell your company that the machine is always being pulled at from all sides for work, they may be willing to invest more money to expand on that newfound profit center. You want to have access to the most remote inspections where you would apply this technology. When you get started on applying this technology, you will want to try it on everything.

Phosphor Plates are Consumables

Contrary to what any salesperson tells you, phosphor plates are consumables. You cannot continue to use them over and over with no replacement or the quality will degrade along with the appearance. I have been told by the occasional individuals that their plates last longer than others, and that may be true. Whether that is useful is another matter (Figure 4).

It is not about how long these plates last, but how useful they are. A plate may last through 300 exposures without a scratch, but the image will be degraded from the first exposure. The common number that I hear is approximately 100 exposures until a plate begins to lose sensitivity. X-ray machines will shorten the life further than that. This means that each program needs to consider the cost of plates the same as the cost of buying film. These resources are not permanent and have to be renewed.

Finding the Right Consultant

Your consultant needs to be a good listener. He/she needs to listen to a walkthrough of your daily operations, know the materials for which computed radiography is required, understand configurations of equipment, and just generally understand
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** 结论 **

These are just a few of the key details to sort out for a film replacement unit. There are lots of other things to consider, with meeting your clients’ needs at the top of the list. Your end user needs to sign off on this technology in order for you to get paid, so keep them in mind for the entire process. Ultimately, in order to do something, you have to find someone who has successfully done it and knows the details. Hiring a consultant makes sense, but choosing the right one is important. Someone who can get you into the process and someone who can replace your film operations the right way may be two different people. The fact is that few people have been down that road and quality consultations could go a long way to help. I have personally seen the results of good and poor consultation and even compared it to no consultation. The differences in consistency are huge.

** 引用 **

Wesley Soape: ASNT NDT Level III in RT; Hellier NDT.

** 参考文献 **


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The main part of ultrasonic testing (UT) inspection of welded joints in construction is performed in accordance with AWS D1.1 code (AWS, 2010). Part F of Chapter 6 of this code provides instructions on how UT inspection should be performed. But there are some important aspects that are not explained in detail and their understanding is important for the correct performance of the inspection and interpretation of the results. Ultrasound weld inspection in accordance with AWS D1.1 is performed using the pulse-echo contact technique. Acceptance/rejection of weld imperfections is based on a comparison of the power of the ultrasound wave (amplitude on the screen of the UT scope) reflected from a standard/reference reflector—which is a 0.06 in. diameter side-drilled hole on the International Institute of Welding (IIW)-type calibration block—with the power of the ultrasound wave reflected from the inspected weld’s imperfection (obviously, the power of the initial sound wave impulse is the same in both cases).

The inspection process can be divided into three important steps.

1. Properly obtain the parameters of the reference reflector (calibration).
2. Adjust the parameters of the signal from the inspected imperfection to the parameters of the reference signal. This adjustment needs to take the following factors into account:
   a. A part of the wave energy, which is lost due to attenuation of the sound wave traveling from the transducer to the weld imperfection and back. This is the so-called distance amplitude correction (DAC) curve.
   b. The difference in the shape and surface conditions between the surface of the IIW-type calibration block and the scanning surface of the part to be inspected.
3. Compare the results received from Step 1 and Step 2 and evaluate.

The following is a review of the important points in each step. Step 2b will be explored in Part II of this article in the January 2016 issue of The NDT Technician.

Step 1: Calibration

Any UT scope that is working in pulse-echo mode actually measures only two parameters: the time needed for the ultrasound impulse to travel from the transducer to the reflector and back; and the energy of the reflected signal compared to the energy of the initial impulse.

All other data needed to evaluate the size and location of the reflector are calculated by the software of the UT scope on the basis of the data obtained from the calibration process. For example, the velocity of the sound wave is calculated from the wave travel times from the transducer’s active element to two fixed-distance reflectors on the IIW-type calibration block—9 and 4 in. on an IIW Type 1 calibration block. Determination of the transducer sound-path angle (which is found through calibration) allows for the calculation of the surface distance and depth of the reflector. Sensitivity calibration gives the sound wave energy reflected by the standard reflector (incident sound wave energy is constant during calibration and inspection). Therefore, the accuracy of the data during UT inspection strictly depends on the accuracy of the calibration process.

In addition, two important aspects related to sensitivity calibration should be pointed out due to their significant effect on the attenuation of the sound wave.

- The thickness of the couplant layer should be approximately the same during calibration and inspection. This means that the pressure put on the plastic shoe of the search unit should be the same during calibration and inspection.
- The difference between the temperature of the calibration block (during calibration process) and the temperature of the
inspected detail (during UT inspection) should not exceed 25 °F. For example, the difference in the reference level (reflection from a 0.06 in. diameter side-drilled hole) obtained from an IIW calibration block at 60 versus 100 °F is 2 to 2.5 dB. The use of a temperature gun is recommended to determine the temperature of the calibration block (during the calibration procedure) as well as the inspected area (during inspection).

Step 2a: Adjustment for Attenuation

A typical DAC curve for mild steel (ASTM A709, grade 50) and a standard search unit with a 70° angle is shown in Figure 1 (ASTM, 2011). For simplifying reasons, AWS D1.1 approximates the DAC curve using a straight line with a slope of 2 dB/in. and assumes that the near zone is located within the first inch of the sound-path distance. This approximation, named “attenuation factor” (subdivision 6.26.6.4 of AWS D1.1), means that the attenuation of the wave energy (decreasing amplitude on the screen) is 2 dB for each inch of sound-path distance, and the near zone is located within the first inch of the sound-path distance.

This assumption leads to the following important consequences. First, it means that (in terms of amplitude and length) a discontinuity cannot be evaluated if the sound-path is less than 1 in. In other words, the first leg of a 70° search unit cannot be used for inspecting a weld from the scanning surface up to a depth of 0.342 in. For example, for the inspection of a weld with a size

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TO THE EDITOR

Good Afternoon,

I’m a Level II technician at GE Composite Operation in Batesville, Mississippi. I just wanted to let you know that Bryan Lancon’s article on “Circumferential Scanning in Ultrasonic Inspection” [The NDT Technician Vol. 11, No. 1, 2012, pp. 1–4] is the best I’ve seen for breaking down/understanding skip distance and discontinuity depth.

If you have any more practice problems or literature that I could practice and learn from I would very much appreciate it. In my line of ultrasounds I don’t get to practice that much. Most of my time I’m running a 12-axis, dual gantry, squirter system inspecting composite laminates, bonds, and metal to composite bonds.

Thank you for your time,

Craig Owens
NDT Level II/Quality
UT, RT, ET, PT
GE Aviation

The NDT Technician welcomes reader feedback. E-mail the editor: tkervina@asnt.org.
of 5/16 in. with a 70° search unit, the first leg cannot be used, but rather the second and third legs are used. It is a common technician’s mistake to inspect complete joint penetration joints with a weld thickness of 5/16 in. using the first and second legs only.

Second, due to different deviation of the real attenuation (DAC) from a straight line with a slope of 2 dB/in. (the “attenuation factor”) for different values of the sound-path, indication ratings (as defined in 6.26.6.5 of AWS D1.1) from the same reflector found using the first leg (from Face B, Figure 2) or the second leg (from Face A, Figure 2) can differ significantly. For definitions of Face A, B, and C, see Table 6.7 of AWS D1.1 (AWS, 2010). As an example, take a 1/16 in. diameter hole drilled in the middle of a 1.25 in. thick flat bar (see Figure 2) parallel to Face A and Face B.

Reflections from this hole are equal if one uses the first leg from Face A and Face B. The amplitude of these reflections as well as the amplitude of the reflection of the second leg from Face A lie well on the DAC curve. This means that in all cases there are reflections from reflectors of the same size, but different results when using the “attenuation factor.” Reflection from the same side-drilled hole gives an indication rating of +1 dB when using the first leg (from Face A or from Face B), which is a rejectable (Class A, Table 6.2, AWS D1.1) indication regardless of length, but when using the second leg from Face A, one gets an indication rating (from the same reflector) of +6 dB, which is an acceptable indication regardless of length (Class D, Table 6.2, AWS D1.1).

This deviation is not the only limitation for using the second leg. To get correct results when using the second leg the following requirements need to be satisfied.

- The surfaces of Face A and Face B should be strictly parallel.
- The roughness of the surface on Face B should be small in comparison with the sound wavelength to avoid significant scattering of sound energy on the surface of Face B (more detail will be given in Part II of this article).

The refraction of the sound energy on the surface of Face B should be significantly lower in comparison to the reflection. For example, the presence of any liquid (water, oil, and even couplant) on the surface of Face B could pervert the results of the inspection when using the second leg.

Summarizing all of the preceding and the fact that the acceptance criteria in Table 6.2 and Table 6.3 in AWS D1.1 by default were found using the first leg, the following is recommended: complete covering of the weld and the heat-affected zone (HAZ) should be done using primarily the first leg, wherever possible. This means that butt joints should be scanned from Face A and Face B from both sides of the weld (see joint configurations in Table 6.7 of AWS D1.1); corner and T-joints should be scanned from Face A, Face B, and (possibly) from Face C. The second and third legs should be used only if the sound-path of the first leg is less than 1 in., or if some part of the weld and the HAZ cannot be covered by the first leg. For example, if there is no access to Face B in a butt joint, then the second leg should be used for inspection of the top part of weld.

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**REFERENCES**


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Christopher A. Black is the recipient of the Lou DiValerio Technician of the Year Award for 2015. This award is made annually to an individual demonstrating exceptional merit as an NDT technician or in service to the Society. Pacific Northwest Section Director Kathy Ferguson said, “I have had the pleasure of serving with Chris on the board of directors for the past five years.” Black is a Level III/Certified Welding Inspector and lead NDT inspector for Boeing. He is also the owner of CBI International. Pacific Northwest Section Secretary Emery Roberts added, “He actively mentors individuals in NDT and teaches classes at Clover Park Technical College.” Black received his CWI recertification from Renton Technical College. He studied business at the University of South Dakota and received NDT certifications from Quad City Testing Laboratory, Inc. and Hellier. He is certified to Corporate and ASNT NDT Level III in PT, RT, UT, and MT.

Q: How did you begin your career in NDT?
A: I began my NDT career in 1977. My brother owned Quad City Testing Laboratory in Davenport, Iowa for 39 years. He was also the ASNT national president in 2001. I was 17 when I was introduced to NDT. A couple of years later I started out as an industrial radiographer working in refineries, on pipelines, and on water towers mostly inspecting welds.

Q: Can you tell us about your certifications and training? Did most of it come about as on-the-job training?
A: Most of my certifications and training came from working on the job, which can be very different from classroom training. With both I think it makes for a better inspector; the theory of each method is understood more with actual on-the-job experience.

Q: Describe the work you do. What goes into a typical workday?
A: My everyday responsibilities include being the lead NDT inspector at Boeing, performing NDT work on the planes, doing paperwork, and answering questions that the manufacturing and engineering people may have.

Q: Is your work focused on a particular field?
A: My work is focused primarily on aircraft airframe and power plant inspections and also ground handling tooling structures.

Q: What kind of structures/materials are you testing?
A: The structures and materials range from airframe structure to engine fan blades and composites. These materials are made of high temperature alloys such as nickel-chrome-molybdenum, reinforced carbon fiber, 15-5 PH corrosion resistant steel, and carbon steel.

Q: What codes and/or standards must you be knowledgeable of?
A: The codes and standards I must be familiar with include: Boeing process specifications, many aerospace standards, military standards, and many industry codes like the AWS [American Welding Society] and ASME [American Society of Mechanical Engineers] codes.

Q: What kind of indications are you looking for?
A: The types of indications I look for are cracks, pits, corrosion, and welding flaws like lack of fusion and porosity.

Q: Tell us about your work in training NDT personnel.

Q: What characteristics do you think define a good NDT technician?
A: I think some of the characteristics of a good NDT technician are being organized, good writing skills, and having a hands-on approach.
Q: How did you decide to start your own business?
A: I started my NDT business as a consultant because I was getting many phone calls about NDT. And I knew many other longtime Level IIIIs in the industry were retiring and that there was a need.

Q: How has NDT changed during your career?
A: Some of the changes that have occurred in my career have been the advancement in the UT, ET, and RT technologies, for example, phased array UT and digital RT. It reminds me of Star Trek compared to the UT equipment I started using that was the size of a small suitcase at the time.

Q: What do you consider the growth areas of NDT—methods, industries?
A: I think the growth areas are in every industry sector, not just aerospace. And I believe the methods that are growing very fast are the UT, ET, and RT technologies.

Q: What are your professional goals?
A: My professional goals are to grow my business as an NDT consultant after I retire.

Q: What is the most rewarding aspect of your work?
A: The most rewarding aspect of my work is knowing my job and performance are important to the people that fly every day and that I have helped other employees succeed and do well in their job assignments.

Q: What is the most difficult part of NDT?
A: The most difficult part of NDT is working in bad environments like confined spaces, very cold or hot climates, and at remote sites in hostile countries around the world.

Q: What is the best way for a technician to advance his or her career in NDT?
A: The best way for someone to advance their career in NDT is to stick with it, be a good listener, learn as much as they can, keep up on advancing NDT technologies, and never give up on themself.

Q: How has ASNT membership/Section involvement benefitted your career?
A: ASNT membership/Section involvement has benefited my career by interfacing with people and companies associated with the NDT industry.

Q: How are you involved in your Section?
A: I am involved in the Pacific Northwest Section of ASNT as a director and work with the technical colleges so they can advance their NDT programs.

Q: How can practitioners become involved in their ASNT Section?
A: Practitioners should attend as many Section meetings as possible to interface with others in the industry for their personal advancement and to keep up to date with industry changes and trends.

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Across
6. A storage _______ traps X-ray induced charge carriers in the color centers of such materials as europium activated barium fluorobromide.
9. A fluorescent _______ consists of a phosphor material deposited on a substrate.
11. The characteristic _______ expresses the relation between the exposure applied to a photographic material and the resulting photographic density.
12. A _______ is the lightproof container that is used for holding radiographic film in position during the radiographic exposure.
16. The _____ level is the integer number representing the brightness or darkness of a pixel or, as a composite value, of an image composed of pixels.
17. Metal in sheet form less than 0.15 mm thick.

Down
1. One example of a digital detector is phosphors deposited on amorphous _______ thin film transistor diodes.
2. Repetitive pattern whereby a directed element follows the path of a series of adjacent parallel lines, taking them successively in turn, always in the same direction, stopping at the end of one line and beginning again at the start of the next line.
3. Interaction of radiation with matter such that the direction of travel after scattering is over 90° and often close to 180° to the original direction of travel.
4. An exposure _______ is a graph showing the relation between material thickness, kilovoltage, and exposure.
5. Unit for measurement of radiation intensity.
7. Radiography can be performed in a variety of techniques based on the imaging system type, source-to-_______ geometry, and operational speed or motion.
8. Radiographic testing technique in which gamma rays, X-rays or neutrons are used to produce an image on a video or screen display as opposed to a latent image on a film.
10. An _______ is a gelatin containing a radiation sensitive silver halide compound.
13. _______ scattering is the reduction of energy of an incident photon by its interaction with an electron. Part of the photon energy is transferred to the electron, giving it kinetic energy, and the remaining photon is redirected with reduced energy.
14. Zircon _______ is a highly absorptive material used as a blocking or masking medium for drilled holes, slots, and highly irregular geometries to reduce scattering during radiography.
15. Non-SI unit for measurement of the quantity of radioactivity, corresponding originally to radiation from atomic disintegrations from 1 g of radium.