



Focus

Radiography Enters the Digital Age

by William D. Meade

For years, scientists endeavored to create a reusable image format to use in place of radiographic film. Efforts were less than successful for most critical medical and industrial applications until advances in digital imaging technologies offered a viable alternative to film based inspection.

Why is Digital Radiography Important?

For more than fifty years, film based radiographic inspection has been used as a primary quality assurance tool to provide information about internal quality in the manufacturing of components and assemblies. Unfortunately, film based radiography is an expensive tool. The image medium (film) is a silver based technology that can only be used once. In addition, film technology requires photographic development that is both time consuming and involves the use of hazardous chemicals that must be discarded.

In contrast, digital radiography offers dramatically reduced exposure and processing times, lower recurring costs (no film or chemicals), and no chemical waste; all attributes that significantly cut costs. In addition, unlike film images, digital images can be enhanced for improved defect detection. Interpretation of digital radiography inspection results may even be fully automated in some cases. Digitized data also permits telecommunication of inspection results to and from remote sites as well as reducing costs to store.

Is Digital Radiography Really New?

Fluoroscopy. Digital radiography is not the first application of nonfilm radiographic inspection. The first nonfilm imaging device, the *fluoroscope*, was developed within months of

the discovery of X-ray by Wilhelm Röntgen in 1895. It consisted of a phosphor screen that would become illuminated when exposed to X-rays. The screen was placed in an enclosed viewing box to compensate for low brightness of the phosphors. The user observed it by peering into the opposite end (Fig. 1).

Image Intensifiers. The fluoroscope was widely used until the early 1950's when the *image intensifier* was invented. The image intensifier uses a photo cathode to convert light emitted by an initial phosphor screen into electrons which are then accelerated onto another phosphor screen. This process amplifies or intensifies the original image (Fig. 2). The amplified image is captured by a video camera and presented on a video display. The image intensifier continues to be widely used in industrial radiography although some limitations in sensitivity and resolution have

limited it primarily to noncritical applications. The fluoroscope and the image intensifier are not classified as digital radiography because their signal output is *analog* in nature, either providing direct viewing of a phosphor screen, or as a video presentation with real-time video camera output. Digital radiography devices accomplish the same function as the fluoroscope and image intensifier — the conversion of incident radiation into signal. However, in the case of digital radiography technologies, the signal output from the device is fully digitized data.

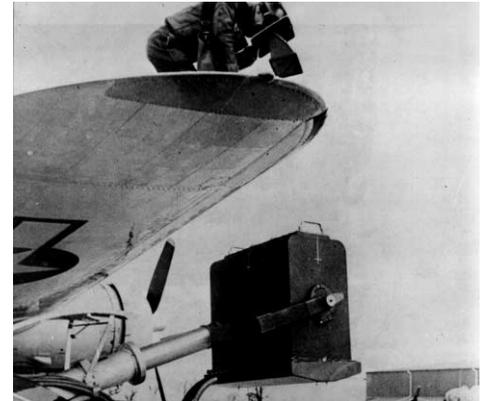


Figure 1. Radiographer uses fluoroscope to examine aircraft wing during World War II.

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Happy New Year and welcome to the first issue of *TNT*'s third year of publication. The new year is an appropriate time to introduce the exciting changes that have been incorporated into the *TNT* newsletter. First and foremost, *TNT* is a stand-alone publication! For the first two years of its production, *TNT* has been delivered as an insert in ASNT's *Materials Evaluation*. *M.E.* is the eminent NDT journal and as such has provided an invaluable association for *TNT*. However, from conception, this newsletter has had a separate identity and specific purpose — exclusively serving the NDT practitioner. You'll also find *TNT* has a very different look to go along with its new identity — a bright new design that implements full color.



As always, *TNT* is happy to hear from our readership. *TNT* and ASNT wish you a happy and prosperous new year.

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Tech Toon



"Either Fliegelhopper is protecting his dark adaptation, or he's taking those bongo drum lessons again."

Digital radiography encompasses multiple technologies. Some of these have existed for more than twenty-five years while others have only recently been established. Although these technologies have common advantages and disadvantages when compared to film radiography, there are unique differences to each method.

Linear Diode Array. The most widely utilized digital radiography detector is the *linear diode array*. Originally developed for use in *computed tomography* systems in the late 1970's, these devices have found widespread use in industries as diverse as food processing, industrial NDT, and security applications. In fact, anyone who has taken an airplane ride in the last few years has almost certainly had their baggage screened by a radiography system utilizing linear diode arrays.

Linear diode array detectors are typically composed of a *scintillation layer* (usually composed of a phosphor such as gadolinium oxysulfide) that is coupled to a single array of photodiodes (Fig. 3). Items to be inspected are moved at a constant velocity through a collimated X-ray beam. X-rays that penetrate the object cause the scintillation screen to emit visible light with the brightness a function of the amount of photons impinging on the screen. This light is converted into an electrical signal by the photodiodes and digitized by an image processor. Progressive lines of data are assembled to form a

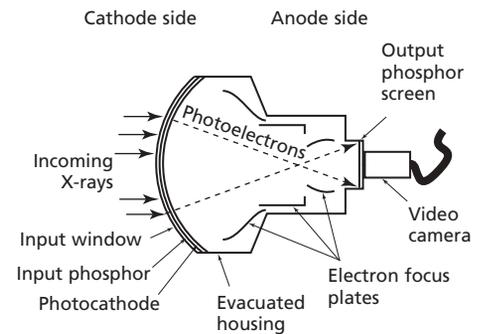


Figure 2. Diagram of image intensifier.

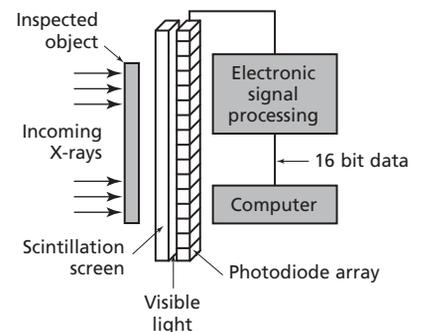


Figure 3. Diagram of linear diode array scanner and imaging chain.

traditional two dimensional image of the object undergoing inspection which is then displayed on a computer monitor.

Linear diode arrays have a distinct advantage over competing digital technologies in that they are scalable to almost any size. Arrays can be fabricated in lengths of a few inches to many feet. A disadvantage is that at high scan rates, resolution is often reduced and detection of very small features in a component or assembly may be limited.

Computed Radiography

Computed radiography, patented by scientists in the late 1970's, uses a *photostimulable luminescence screen (storage phosphor plate)* instead of conventional radiographic film. Like conventional film, the computed radiography imaging plate stores a *latent image* of the incident X-ray or gamma-ray energy. When the imaging plate is subsequently scanned by a laser beam of specific frequency, the phosphor releases light with brightness proportional to the degree of exposure. This light is simultaneously collected by a scanning photodiode array. The signal from the photodiode array is converted into digital values, processed for optimum viewing, and displayed as a two dimensional image on a computer monitor. The image stored on the plate is also erasable and the plate can be reused thousands of times.

The primary advantage of computed radiography is that the medium is flexible and highly portable and can be readily used as a direct film replacement. The disadvantage of this technology is that it requires an intermediate processing step to read latent information from the plate in order to display the image for interpretation. However, unlike film, this processing typically takes less than a minute and does not involve the chemicals or waste associated with radiographic film.

Flat Panel Detectors. *Amorphous silicon and amorphous selenium flat panel array detectors*, introduced in the late 1990s, were first developed for medical applications which then migrated to nondestructive testing. These devices consist of a very fine two dimensional array of thin film semiconductor based detectors referred to as *pixels* (picture a chess board with each square having a length and width about the diameter of a human hair). Each pixel collects and stores charge when exposed to X-rays. The primary difference between the two detectors is the way in which each collects the charge values. In amorphous silicon devices, the charge at each pixel is indirectly produced by the combination of a scintillating phosphor screen illuminated by the X-ray beam and the light converted to charge by a photodiode (Fig. 4). For amorphous

selenium detectors no scintillator is required since the selenium layer converts the X-ray photons directly into electrical charge. For both devices the stored charge values for each pixel are digitized electronically so they can be displayed as a two dimensional image on a computer monitor.

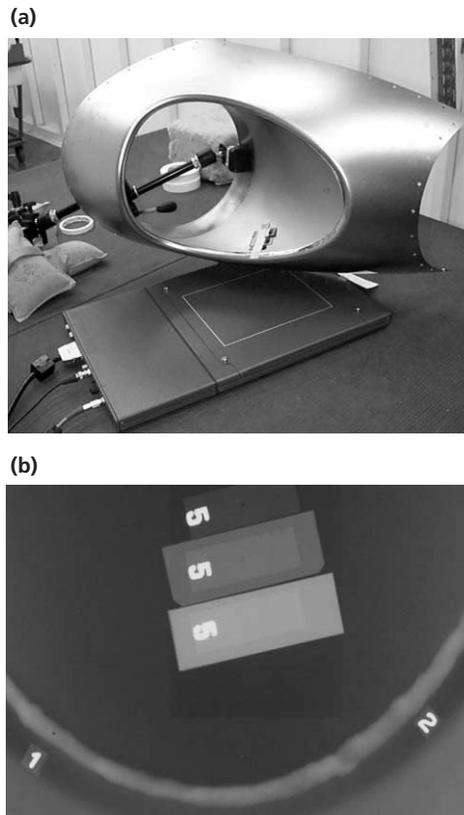


Figure 4. Flat panel detectors provide high contrast, wide dynamic range images that do not require intermediate processing. Photos show (a) amorphous silicon detector and (b) sample image of weld.

Flat panel detectors have common and distinct advantages. Because of their large area formats (up to 20 in. x 20 in.) they can image large areas quickly. Also, since they have the ability to obtain an image with no intermediate processing step, they are easily integrated with robotic manipulation systems. Both of these panels offer wide dynamic range and high contrast capability. A distinct advantage for amorphous silicon detectors is that they can create an image faster than amorphous selenium devices. In fact, some amorphous silicon flat panel detectors can create and read images at a rate fast enough to be used in live video (dynamic or real-time) imaging. Theoretically, amorphous selenium detectors offer higher resolution than amorphous silicon devices with equivalent pixel size since there is no scatter occurring during the conversion of the X-ray photons to signal. A disadvantage of these systems is that they are complex electrical

devices and care must be taken when handling them or using them in harsh environments.

Emerging Technologies

As with most digital technologies, digital radiography is a rapidly evolving field with new detectors coming to market each year. An example of recent technology is the *complementary metal oxide silicon (CMOS)* linear array. Similar to a linear diode array, the device uses a single column array of multiple elements, but with each element having its own discrete read-out amplifier. In order to protect the built in electronics from the effects of direct X-ray exposure, the elements are shielded and coupled to an X-ray sensitive scintillator via a fiberoptic bundle. The complementary metal oxide silicon elements convert the light signals transmitted through the fiberoptic cable into electrical signals that are converted to digital values for monitor display.

Like linear diode arrays this technology is scalable, with arrays ranging from a few inches to several feet long. However compared to conventional linear diode arrays, complementary metal oxide silicon linear arrays offer higher resolution and contrast sensitivity. As is the case in linear diode arrays, complementary metal oxide silicon linear arrays require relative movement between the detector and the object being inspected. As a result, imaging times are typically not as fast as amorphous silicon detectors, but are competitive with amorphous selenium.

Conclusion

Although digital detectors do not yet rival radiographic film in terms of spatial resolution, studies have shown that through proper use, many of these devices can equal, and in many cases exceed, the capability of film to image discontinuities in NDT applications. This imaging ability, along with appreciable economic and environmental advantages, has led to the use of this technology by many industries including food processing, petrochemical, marine, automotive, homeland security and aerospace. Radiographic imaging is fully a part of the digital revolution. It's only a matter of time before we find ourselves saying, "Remember when we used to use film?". **TNT**

Bill Meade is an NDI Specialist in the Materials and Process Technology department of Boeing Commercial Aircraft working on implementation of digital radiography for aerospace applications. His efforts have focused on comparing the reliability of digital radiography to established methods such as film based inspection. He holds ASNT Level III certification in radiographic, ultrasonic, and eddy current testing methods. Bill is a member of ASNT's Pacific Northwest Section in Seattle, Washington where he serves on the Board of Directors. He can be contacted at william.d.meade@boeing.com



FYI

Practical Contact Ultrasonics - Straight Beam Testing

by Jim Houf* and Bill Svekric†

What do thickness testers, sonar and fish finders have in common? All use sound to detect foreign objects in a sound carrying medium.

While fish finders and sonar are used in water and the majority of NDT straight beam inspections are performed in steel, all three applications can be calibrated to the degree of accuracy necessary to perform the required tasks. All use a zero degree (through-thickness) longitudinal wave sound beam to interrogate the part being inspected (in the case of fish finders and sonar, the part being inspected is water). All rely on the same principle — sound traveling through a uniform medium will reflect from the interface of that medium with a material having different acoustic characteristics.

Typical Applications

For NDT, the two most common applications of straight beam inspection are thickness measurement and verification of material quality. In both applications, the transducer is placed on the surface of the part using a liquid or gel couplant to couple the transducer to the part. Couplant allows the sound beam to cross the gap between the transducer and part. (For purposes of this article, it is assumed proper use of couplant is understood.) The sound beam

then travels through the test piece, reflecting from the backwall or any internal planar reflector and returns to the transducer. If equipment is properly calibrated, the distance that the sound has traveled to the backwall or reflector will be displayed either on a digital readout and/or oscilloscope or liquid crystal display screen. Newer instruments may use either single or dual element transducers.

For thickness testing performed using a digital thickness tester, the unit is calibrated so that the distance the sound beam travels to the backwall is displayed as a digital readout on a liquid crystal display. A basic digital thickness testing instrument consists of a small battery powered, handheld generating unit and a three to four foot coaxial cable with an integral dual element, delay line transducer that plugs into the unit. The generating unit has a digital liquid crystal display showing thicknesses in thousandths of an inch. Most units have a known thickness round steel block attached to the main unit that is used to standardize the system prior to use.

Dual Element, Delay Line Transducers

The dual element, delay line transducer has two crystals, one transmitter and one receiver set side-by-side at the back of the transducer assembly (Fig. 1). The sound carrying material

between the front face and the crystals (the delay lines) is divided longitudinally into two sections so that the transmitted sound travels down one side of the divider and returns up the other side to the receiver. The distance between the sending crystal and the front face (delay line) permits the near field effect to occur internally instead of in the part and also eliminates entry surface noise, permitting the inspection of thin materials.

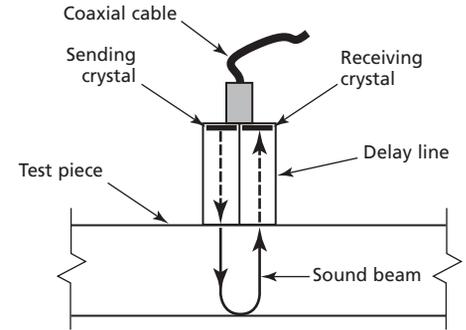


Figure 1. Schematic of dual element, delay line transducer.

Data Logging Units

Many units have data logging features that allow the operator to retain thickness readings for downloading to a word processor after inspections are completed. This feature can speed the inspection process significantly. One point of caution should be noted — periodic downloading is strongly recommended. The greater the amount of stored information, the greater the loss should the unit fail to work properly. The operator should check manufacturer recommendations for battery life and replacement procedures.

Standardizing Equipment Settings

- To operate a basic unit, the transducer cable is plugged into the unit and the unit is turned on.
- A drop of couplant is then placed on the built-in block on the unit and the transducer is coupled to the block to allow the unit system to standardize. Note this is not calibration, but is done to standardize the system. Since the thickness of the block is known, the unit software will adjust the digital readout to accommodate any changes in transmission characteristics caused by changes in the coaxial cable or transducer. Modern units may have a hidden transducer behind the block that lets the unit automatically adjust for transducer wear. If the reading from the block is not correct, remove the transducer, reapply couplant and try again. The reading must match the block thickness or the next step, calibration, cannot be done accurately.

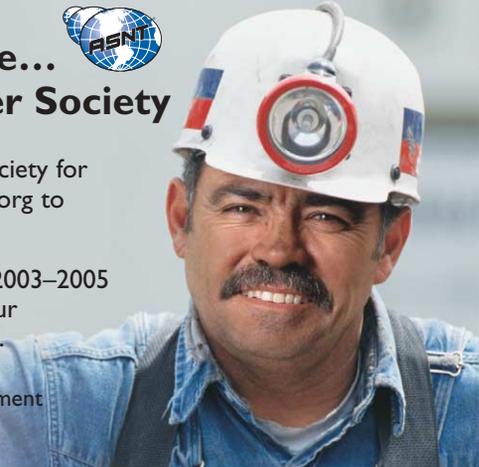
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Dried couplant or debris on the block surface can sometimes cause an inaccurate reading. In this case, clean the surface of the block and try again. Consult the operator manual for other options if this does not help.

Calibration

To calibrate the system once it has been standardized, place the transducer on a step wedge of acoustically similar material that covers the thickness range of the part to be tested. For the following example, a step wedge with five steps from 0.100 - 0.500 in. in 0.100 in. increments is used. The transducer is first placed on the 0.500 in. step and the readout is adjusted to match that thickness. The transducer is next placed on the 0.100 in. step and the zero control knob is used to set the readout for that step to 0.100 in. (Control functions vary from unit to unit and the appropriate operator manual should be referenced for the correct adjustment procedure.) The operator should then return to the 0.500 in. step and repeat the process until both the 0.500 and 0.100 in. readings are accurate. As a last step, check the readings from the 0.200, 0.300 and 0.400 in. steps. If the readout for each step is accurate, the unit is properly calibrated and the fixed markers or graticules on the screen directly below the baseline can be used to read the thickness (Fig 2). A significant advantage of the liquid crystal display screen presentation on a digital thickness tester is that the waveform often shows small discontinuities not large enough to cause the digital readout to change or that may only cause the readout to flicker back and forth between thicknesses.

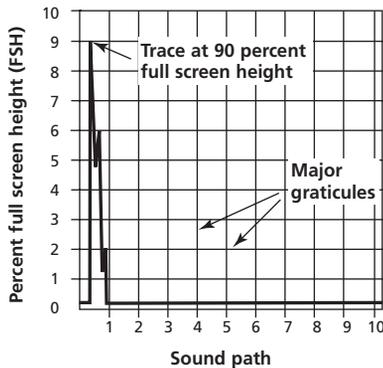


Figure 2. Liquid crystal display or cathode ray tube screen presentation for digital thickness tester showing major graticules.

Digital thickness testers with wave presentations are calibrated in a similar way, but there will be both a digital readout and a waveform presentation on a small liquid crystal

display similar to that found on a full size *flaw detector*. As with a flaw detector, the horizontal baseline represents the sound path to the reflecting surface, with the left side being near the transducer and the right side being farther away from the transducer. Permanent horizontal and vertical gridlines called *major graticules* are superimposed on the screen cover to allow the operator to determine the distance the sound has traveled (Fig. 2). The major graticules typically have five subdivisions or minor graticules to improve reading accuracy.

Performing Inspections

Once the unit is calibrated, inspection can begin. To take a thickness reading, place the transducer on the test surface at the first inspection point. This causes a thickness reading to appear on the digital readout screen. If the display remains constant, manually record the reading or press the save or store key to record that reading digitally. Move to the next inspection point and repeat the process. If the display reading flickers or fluctuates between thicknesses, the reading should not be recorded.

A reading may flicker for several reasons. If the transducer is not seated properly on the part due to surface roughness or a slightly curved surface, moving or rotating the transducer slightly to get a solid coupling to the part may correct the problem. On smaller diameter pipes or tubes, the transducer may rock side-to-side allowing the couplant under the edge of the transducer to cause higher or thicker readings than actually exist. This problem can often be corrected by making sure the divider in the transducer is oriented perpendicular to the axis of the pipe so that the major point of contact will include both sides of the transducer (Fig. 3).

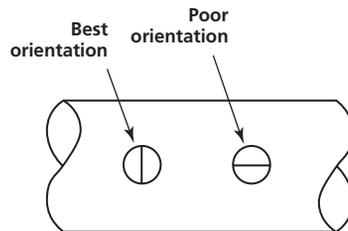


Figure 3. Dual element divider orientation on tubing or piping with small diameters.

Readings that flicker may be related to the part itself (rough or pitted backwall, multiple nonmetallic inclusions, or laminations in the part). If two reflectors such as the backwall and the edge of a lamination are sending approximately the same amount of sound back

to the transducer, the display may alternate between two thicknesses creating an unstable reading. In these instances, the digital unit with a waveform presentation can easily demonstrate the situation that is occurring.

Doubling is a confusing condition that can occur when doing thickness testing of materials that range in thickness from 0.040 - 0.080 in. in thickness. The sound bounces up and down twice in the part before detection by the crystal. The reading is twice or double the actual thickness (Fig. 4). Doubling should be suspected when the operator gets consistently thin readings that abruptly become almost twice that of the adjoining area.

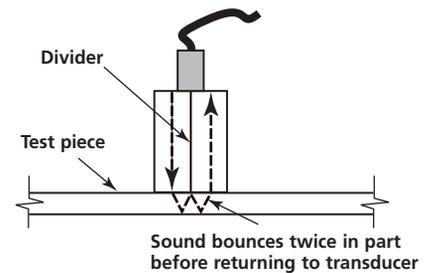


Figure 4. Diagram of sound path demonstrates doubling phenomenon that can sometimes occur when testing material thicknesses in the range of 0.04 - 0.08 in.

As an example, readings drop consistently to around 0.060 in. as the operator moves the transducer across the part. Abruptly, the readings double with the next reading taken as 0.115 in. and a succeeding reading at 0.110 in. This indicates that doubling may be occurring. At this point, the operator should substitute a transducer with crystals manufactured at a slight angle (*roof angle*) to help aim the sound beam more favorably.

When using a full *flaw detector* or scope, the operator must select the type of transducer (single or dual element), the diameter, and the frequency. Older scopes require the operator to match the frequency setting on the unit to the transducer frequency. Newer units may match the two automatically. When selecting transducers, keep in mind that some frequency/diameter combinations can result in near fields that are unacceptable for the proposed thickness range. If this is in question, the operator should check with his Level III. One advantage obtained by using a dual element transducer is the tendency of the unit to trigger from the *nearest* reflector, such as internal corrosion or pitting. Single element transducers tend to read the reflector with the *largest* surface area. For example, a deep farside pit with a small surface area may not be picked out from the larger backwall signal. As a result, single element transducers may result in thicker readings than what may actually exist at that

point in the part or may miss small reflectors as described in the example.

An advantage of using single element transducers is that coating thicknesses may be eliminated from the readings. This is done by reading the thickness value between the first and second backwall reflections. The same result may be obtained between the second and third backwall reflections if the display is difficult to read. Modern instruments have electronic gates that may be set to automate this process. The fact that coatings do not need to be removed saves time and eliminates the cost of coating removal and reapplication.

When a full flaw detector or scope is used for straight beam testing, setting the screen width and calibrating the instrument are one and the same. To set screen width, the transducer is first placed on a piece of acoustically similar material of known thickness such as a step wedge. Using two reflectors at a known distance, the UT operator then uses the *range* and *delay* controls to set screen width. The delay control shifts the entire screen display right or left without changing the distance between vertical traces. The range control expands or contracts the distance between vertical traces. (Consult UT reference text for technical explanation of range and delay.) These two control functions interact and it is necessary to alternately adjust each to obtain the desired screen presentation. Check the operator manual to confirm which knobs or touch pad keys control the range and delay functions for your machine.

To set up the screen width using a single element transducer, the operator can get two backwall reflections from the 0.500 in. step on

the screen and by spreading the screen with the range control and shifting the display to the left with the delay, can set the left trace (first backwall echo) on the number 5 graticule and the right trace (second backwall echo) on the number 10 graticule. Once the two traces are set this way, the full screen width is 1.0 in., with major graticules representing 0.1 in. and the scope calibrated for straight beam inspection from 0 - 1 in. (Fig. 5).

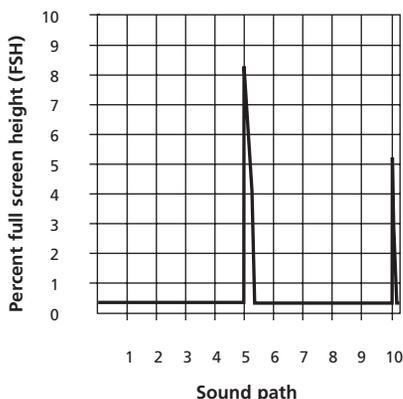


Figure 5. One inch liquid crystal display or cathode ray tube screen presentation from 0.5 in. step wedge.

The operator should next use the *gain* control to set the *amplitude* or *trace height* from the backwall echo from the test part to 100 percent of full screen height. Full screen height is used most commonly for backwall amplitude but operators should check their NDT procedure or job specification to determine exact requirements for the specific job.

Once the scope is calibrated and the amplitude set, the inspection technique is the same as for digital thickness testers, with the thickness being read from the horizontal graticules. When checking for laminations or inclusions, the depth of these discontinuities can be determined in the same manner. However, the governing specification may require acceptance or rejection to be based on amplitude of the resulting trace, the loss of backwall amplitude (*loss of back*) method or a combination of these two.

Amplitude can be read directly from the liquid crystal display or cathode ray tube screen, while *full loss of back* means the backwall trace drops completely off the screen. The specification may also call for a combination of the two methods and require rejection only if a reflector has a certain amplitude *and* causes a certain percentage of loss of backwall amplitude. An example of this would be a 40 percent full screen height reflector with a 50 percent loss of back.

Mapping

When a rejectable lamination or inclusion is found, the customer may want the operator to *map* the rejectable area. The most common method for mapping is to slide the transducer across the edge of the area where the signal first appears until the screen presentation meets the rejection criteria. The plate or part is then marked beside the center of the transducer. The transducer is then moved laterally until the same condition occurs and the plate is again marked. By repeating this procedure, the area of the defect can be outlined and mapped on the inspection report and on the surface of the piece being tested.

Conclusion

While this article is intended to provide information for the beginning UT operator, it may not be sufficient in some situations. If additional clarification is required, operators should consult their Level III. **TNT**

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INBOX

Q: Which industry uses laser NDT? What type of defects are found?

A: The term *laser method* may be confusing because several NDT methods use lasers. Lasers provide coherent (single wavelength, in-phase) electromagnetic radiation (for example, light or microwaves) at various wavelengths. When the wavelength is in the infrared part of the spectrum, it's considered a technique of the infrared and thermal method. Lasers are also used to generate and detect acoustic waves in several advanced techniques of ultrasonic testing. Ultrasonic laser techniques have been the subject of research for many years but are not widely used in industry.

Lasers usually operate in the visible part of the spectrum, and the best known group of laser techniques (shearography, profilometry, and holography) are used for surface testing. These three NDT methods all work by measuring variations on surfaces to find discontinuities such as impact damage, corrosion, and warping. The phrase *laser NDT* is sometimes used to refer exclusively to the shearographic and profilometric methods. Among other applications, shearography is used to detect dents on airplanes and profilometry is used to detect deposits in heat exchanger piping.

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PRACTITIONER PROFILE

Duane Schultz

Duane Schultz began working in NDT 17 years ago when the father-in-law of a former employer (an NDT lab owner) sent him to school on the contingency that if he passed — he wouldn't have to pay for it. Now he's got an NDT dream job working in Disneyland's Quality Control Department.

What kind of NDT have you done?

I started in a small lab with big volume in mag particle and penetrant. We did a lot of work for foundries — looking at forgings and castings mostly using mag particle and penetrant. Then I moved over to X-ray — manually processing the film. Mag particle and penetrant are actually what I do most now. From there, I went to a company working in aerospace where I picked up my first certification in eddy current. I also earned a Level I in ultrasonics as well as in X-ray. And I started getting into helium leak testing there.

What training and certification have you received?

I've gotten training from classes from previous employers that were recognized instructors in ASNT and formal training hours in NDT training programs. I currently hold a Level II in liquid penetrant and eddy current and I have an ASNT Level III in mag particle and liquid penetrant. My certification is third party through an outside consultant for Disneyland except for the Level III certification.

How is NDT applied at Disneyland?

Basically, for any ride here, there's a series of inspections that happen at different intervals — some monthly, some at three months, six months, a year, four years — it all really depends on that component's function. We determine what needs to be inspected and use the method called out by our engineers or the ride manufacturer. Some rides here are not manufactured by Disney but all the requirements are set by Disney to either meet or exceed those of the manufacturer. We work to procedures written by Disney engineers.

What methods are most valuable for your work?

Right now the two that I use most often are magnetic particle and liquid penetrant.

How many inspectors are there making inspections?

We have eighteen in our quality control department who are actually inspectors. We're working three shifts examining parts or making inspections out in the park. As far as NDT, there're six of us that handle mag or penetrant or both. We're QC technicians.

The rest are called QC inspectors, the difference being whether we are union or nonunion. Union employees perform the mag and penetrant inspections. Nonunion do dimensional, visual and first article inspections.

What are the structures you test?

From the track itself to everything that rides on the track — it all gets some form of inspection. Whether it's a visual inspection, a dimensional inspection or one of the two NDT methods. We mostly look for service discontinuities that could cause failure — cracks and other types of things resulting from use of the part.

What areas of NDT would you like to learn more about?

I'd really like to broaden my knowledge of eddy current. I do see a lot of applications for it here at Disney but it's not written into any of our books.

Do you have advice for those considering a career in NDT?

Each NDT method has its purpose, but they all help or augment one another. Where one leaves off, another one can pickup and overlap. So training should be broad-based. Also, keep an updated resume. It's a habit of mine and one that I would encourage others to develop. I keep an updated resume with all the people I've done training with. That's one of the reasons I got into Disney. A former trainer of mine was doing training at Disney. When they asked if he knew anybody, he gave them my resume.

Has membership in ASNT and your Section benefited you?

Yes, both are useful tools for networking and interacting with others. I've learned a lot by attending the meetings.

What are the best and worst parts of NDT?

The best part of NDT is a good find — something that's detrimental to form, fit or function. I guess the worst part is the end of the day because I have to stop until the next day.

What's the end goal for your career in NDT? Where do you see yourself at retirement?

I hope I'll still be here — I really enjoy what I do. **TNT**



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UT L I – Feb. 16 – 20, May 3 – 7, July 26 - 30
UT L II – February 23 – 27, May 10 – 14, August 2 - 6
Radiation Safety (IRRSP Prep) – January 19 – 23, March 29 – April 2
RT L I – January 26 – 30, April 5 – 9, June 14 - 18
RT L II – February 2 – 6, April 12 – 16, June 21 - 25
RT Film Interpretation – Dates TBD
ET L I – May 17 – 21, Dec. 6 - 10
ET L II – May 24 – 28, Dec. 13 - 17

Special Courses – Please call for details

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Radiography – Oct. 11 – 13 Penetrant – Oct. 14 - 15
Ultrasonic – Oct. 4 – 8 Magnetic Particle – Oct. 18 - 19

New NAS 410 MT & PT training requirements

PT Top Up (16 hrs), MT Top Up (16 hrs) Please call for next dates

All courses will run if payment is received two weeks in advance

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ASNT NDT Level III in UT, RT, ET, MT, PT and VT (Cert # KM 1485)
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