THE NDT TECHNICIAN

A Quarterly Publication for the NDT Practitioner

TNT Focus: Evaluation of Indications

by Edward E. Hall

Proper evaluation of indications when performing *magnetic particle testing* and *liquid penetrant testing* can be challenging. The evaluation of indications is deceptively simple but the best test techniques are useless if the evaluation is not performed properly. Magnetic particle and liquid penetrant testing are commonly used for the location of surface discontinuities which can be much more detrimental to the service of finished parts than internal discontinuities. Therefore, it's critical that the evaluations be conducted correctly.

Sizing an indication.
American Society for Nondestructive Testing.

Proper Preparation

Several things must be considered prior to evaluating indications. The inspector must be confident that (1) the proper system tests and calibrations were performed, (2) the test method was properly conducted and (3) he or she is properly prepared to begin the evaluation.

Being properly prepared involves a review of all pertinent codes and specifications related to the evaluation. Knowledge of the material type and the manufacturing processes performed, as well as testing methods and quality requirements for the parts, will give the inspector an idea of the anomalies that can be expected. Fluorescent methods require dark adaptation of the eyes. Codes and specifications will vary in these requirements depending on exposure to various types of lighting prior to inspection. Of course, dark adaptation is not necessary when evaluating indications produced using visible magnetic particle or liquid penetrant testing methods. It is helpful to gather devices needed for sizing the indications. These may include magnifiers and various measurement tools.

Categories of Indications

Consideration must be given to the basic categories of indications (false, nonrelevant, and relevant). False indications are normally produced by a contaminant on the part surface. Nonrelevant indications are often the result of part geometry or parts touching or rubbing against other parts during the testing process. The ability to distinguish relevant from nonrelevant or false indications will determine inspector efficiency.

Liquid Penetrant Indications

Liquid penetrant indications can be easier to evaluate than those produced

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TNT Tips: Penetrant Dye Removal

After penetrant dwell time comes the job of removal — not a bad job on smooth surfaces, but tough on rough or irregular surfaces. The old lint free rag just doesn't get it.

When you encounter the problem areas often found on as-welded surfaces, machined parts with sharp inside corners, or parts with depressions or pits, try this. Clean the part using the normal method and then finish the problem areas with a commercially available cotton swab or with a cotton swab on a toothpick. If you run into an inspector or customer who finds this method unacceptable, place the lint free rag on the part and use the swab to push it into the problem area.

This method also helps in precleaning and removing water following water washable or post emulsification operations. Lint free paper towels can be pushed into tight spots better than thicker items.

George R. Henke
Napa, California

Cotton Swab and Nonaqueous Developer

In recent years, many companies have replaced solvents such as acetone, trichloroethane, and carbon tetrachloride with alcohol for various reasons. While alcohol is less flammable, does not present as severe a hazardous waste disposal problem, and doesn't have the toxicity associated with more volatile solvents, neither does it evaporate as quickly. This can be annoying when performing penetrant inspections.

Standard practice when confirming indications detected with color contrast penetrant systems is to remove a suspect indication with a solvent moistened wipe, allow the solvent to evaporate, and reapply developer to the area. A discontinuity indication will generally reappear as the developer dries, confirming the indication. If a low volatility solvent such as alcohol is used,

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Tech Toon

"Ya know — early crack detection could have prevented all this."

Readers are invited to submit ideas. Send your humorous NDT experiences to Tech Toon.

from magnetic particle testing. Properly processed and dried parts will result in indications that remain the same as when initially formed. However, small linear indications can begin to appear rounded as developer dwell time increases making them look more like a rounded indication. Therefore, it is important to observe the indication *bleed out* as it develops. The longer developer remains on the part, the more the penetrant diffuses into it.

Generally speaking, linear indications will appear as a jagged line and rounded indications will be round or nearly round. An indication appearing to be a very straight line is often found to be the result of part geometry or the interface of mating pieces in an assembled part. Using the following techniques to evaluate these indications will usually eliminate confusion for the inspector.

Applying Solvent and Developer

To evaluate questionable indications, lightly dampen a clean cotton swab with a solvent approved for use with the penetrant system. There is always a question as to the exact meaning of the phrase *lightly dampen*. This is best determined by the surface being tested. When working with rough surface castings, and looking for gross porosity and cracks, the swab will need to contain more solvent. However, you cannot use a saturated or *wet* swab when inspecting a smooth, machined surface for very fine cracks. This may flood the area of interest and require retesting. To correctly dampen the swab, saturate it and then lightly roll or blot it on a clean cloth or absorbent paper to remove excess solvent. Wipe the indication in one direction only and rotate the swab as it passes over the indication. Observe the indication for penetrant bleed out as you perform this operation. Apply the developer using the appropriate *dwell time*. It is difficult to observe formation of indications when using dry powder developer in a dusting box. However, you may have the opportunity to watch an indication redevelop when using a *nonaqueous wet developer*. This will aid in proper sizing should the procedure require measurement of the actual discontinuity.

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TNT Tips: *Continued from page 1*

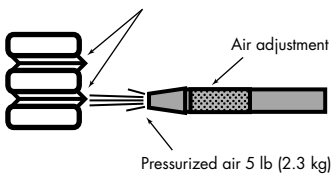
evaporation time is significantly increased. I find that spraying nonaqueous developer onto a cotton swab and wiping the indication saves time. It removes the indication, cleans the surface, and reapplies developer in one step.

Carrier and Particulate Pooling

Many times when testing splines of shafts or grooves on a gear, the accumulation or pooling of magnetic particles and carrier make the interpretation more difficult.

I find that by using an air nozzle with about 5 lb (2.3 kg) of air pressure, the carrier can be removed while the particles stay intact on the indication. The indication jumps out, making it much easier to interpret.

John Morris
Houston, Texas



Pressurized air used to clear excess carrier pooling along shaft splines.

Some specifications require measurement of penetrant bleed out. If the indication reappears, evaluate it in accordance with provided acceptance criteria. If it is of sufficient size to be rejected, mark it and record it on your test report. If the size of the indication is within the acceptable limits, the part is acceptable and the evaluation is complete. Should the indication fail to reappear, examine the area with magnification allowed by the procedure or specification in the proper white lighting. Retest the area if a visual indication is present and consult your Level III for additional input.

Magnetic Particle Indications

Indications produced by magnetic particle testing will create some different

challenges for the inspector. Magnetic particle testing will locate subsurface discontinuities as well as surface discontinuities. Subsurface anomalies such as internal keyways, splines and notches will produce broad, fuzzy indications. An indication breaking over the edge of the part shows evidence of depth. However, sharp edges and corners can create leakage fields resulting in nonrelevant indications. This increases the difficulty of the inspection and can hamper the evaluation. Nonrelevant indications can often be caused by geometry of the part, magnetic writing when parts touch, or by close proximity to the magnetic field source. Also, most procedures recommend application of magnetizing force as the particles are applied to the test object (continuous method). This presents no problem when working with parts having low permeability and high retentivity. It is even possible for particles to be applied after the magnetizing force has been removed and still produce an adequate test for evaluation (residual method). Highly permeable parts with low retentivity tend to have the indications washed away or distorted if incorrectly timed when applying particles and magnetizing force. It is very important to remember the rules concerning adequate coverage. When using a central conductor bar, the coverage will be four times the bar diameter. When using a coil, the part length must extend 6 to 9 in. (15 to 22 cm) on each side of the coil. Overlap your shots for complete coverage and demagnetize and retest when there is doubt concerning the adequacy of the inspection. *Dry powder* magnetic particle testing can be easier to use in many applications. Powders used for magnetic particle testing come in different colors to better contrast with the color of the surface to be inspected. Dry powder particles are typically large with good mobility and thus will tend to "dance" on the surface of the part during application of the magnetizing force. The particles are attracted to the leakage field produced by the discontinuity and will take the form of the anomaly. Excess powder can be blown away from the area of interest as magnetizing force is applied leaving only the indication. Measure the indication in accordance with the acceptance criteria to determine acceptability.

Conclusion

Indications resulting from magnetic particle and liquid penetrant inspections can take many shapes. Indications may form as a line or be shaped as a Y, X or star. They can also be round, oblong or oval in shape. A series of aligned dots can indicate a very tight crack. It is even possible to see checkerboard patterns. Some indications may be intermittent. All relevant indications must be evaluated according to the acceptance criteria from codes, specifications, procedures, drawings, shop plans and/or work instructions provided with the parts. Consult your Level III or lead inspector with questions regarding the interpretation of test results.■

Ed Hall is vice chair of the Technicians Advisory Committee in the Technical Publications Division, Technical and Education Council (ehall3@san.rr.com).

FROM THE EDITOR:

Here's a recent topic posted on ASNTnet. "What's the best method for finding Level I Technicians?" The individual was looking for entry level NDT/NDE personnel to fill immediate positions. *The NDT Technician* is building a new internet recruiting database that will provide that exact information — listings of NDT practitioners of all levels that work on a contract basis arranged by NDT and PdM qualification and experience, alphabetically by name and by geographical area.

The *NDT Contract Employee Listing Service (NDT CELS)* will reside on the *TNT* web page at **www.asnt.org**. Until January 1, 2003, it is offered free of charge. The ASNT Web site is the eminent internet address for NDT and receives more than 7000 weekly visits. If you work in NDT on a contract basis and would like to be included in the free listing, return the *NDT CELS* application available at ***www.asnt.org/Publications/The NDT Technician*** or contact the *TNT* editor.

Work in NDT can take often take the NDT practitioner to an interesting locale, be it the site of an unusual application here in the US or a typical application in far removed areas such as the South Sea island described in this issue's *Practitioner Profile*. If you know a practitioner who uses NDT in interesting circumstances — we would like to hear from you. We'll share it with *TNT* readers.

Put your ideas into print. Make *TNT* content relevant to your NDT practice. Contact us at ASNT.

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TNT Practitioner Profile: Steve Johnson

Steve's vocation as an airplane mechanic working in Papua, New Guinea is a means to an end. He shares in the efforts of his employer, Wyckliffe Bible Translators, to provide literacy to the natives of New Guinea who have no written language. Steve and his employer also work to provide basic community services such as first aid posts and clean water resources. He is an avid woodcarver and enjoys hiking with his wife and four sons in the rugged terrain of Papua, New Guinea.

You are currently working in NDT in Papua, New Guinea?

Yes, that's correct. that's where I work four years out of five. I'm working with a company called Wyckliffe Bible Translators. My primary job is as an aircraft mechanic. We maintain a fleet of eight aircraft — one helicopter and seven fixed wing. My family and I are actually here in Seattle on furlough for a year. We came back to the US in June and we'll be returning to New Guinea in May of 2002. I'm temporarily working for Caliber Inspections and building time toward certification in magnetic particle, liquid penetrant, eddy current, and eventually, ultrasound thickness testing and radiography.

Do the training and certification you obtain here in the US directly benefit your work in New Guinea?

Yes, we actually ran into an urgent need for increased training in NDT last year, especially eddy current. The Australians produced the air worthiness directive, which is a requirement for maintaining an airplane in airworthy condition. The directive requires spar replacements on all twin engine aircraft at certain time frames. It also requires the retirement of those airplanes at two wing spar lives. You can continue flying that airplane if you produce another form of inspection criteria that meets the review administrators requirement to maintain airworthiness. We have one aircraft approaching the end of the second wing life. Nineteen of those inspections are eddy current inspections and we had no one qualified to do the tests at that time.

So, without someone certified in NDT to determine if the plane met requirements, that plane was out of commission?

Yes, essentially, scrapped. That makes it worth going out and paying for the training and testing instrumentation to maintain the aircraft. There's three of us that actually do NDT. As aircraft mechanics, we are trained in the US to be able to do magnetic particle and liquid penetrant. Two of the guys have actually received certification in Papua, New Guinea and I am preparing for that.

How did you first start working in NDT?

I started working as an aircraft mechanic in 1993 for a small airline in Seattle doing a tiny bit of NDT. As an aircraft mechanic, we have to keep crankshafts, landing gear and a number of critical items throughout the airplane inspected. I began doing little inspections here and there on my mechanics license. I realized that wasn't going to be an acceptable certification for me in the future. So, I decided to go through and get certified in NDT.

Would you describe New Guinea for us?

Most of the country is tropical but I live at about 5000 feet where it's fairly mild. You get everything from tropical rainforest or jungle down on the coastlands to the kind of grassland up where I live. There are highlands even further above that. I've gone hiking at 12 500 feet. There's a mountainous region throughout the center of the island. It starts from about 2000 to 3000 feet above most of the low coastal areas. Most people live in the highlands and aviation is the primary means of getting around. We have five or six provinces connected by one two lane road that goes from the coast all the way into the Indonesian border to the west and right now they are still finishing that at the far end of the road. I'm thinking of Highway 99 in Seattle or the Blue Ridge Parkway in North Carolina. Picture that as the major thoroughfare.

If someone were considering a career in NDT and wanted to travel to countries like New Guinea, what methods would you tell them to train in?

Magnetic particle and penetrant would be the primary ones used. The oil industry would use radiography. Behind that would be ultrasound and probably eddy current.

How does the cost of living in New Guinea balance with an income in NDT?

That's a really good question — a difficult one. I think there's probably less than a dozen nondestructive testing personnel in the country. It's a pretty small working group but growing. I guess I can speak from what I perceive and what I know of in the aviation industry. I think expatriates have a very good or at least moderate lifestyle and typically an employer of expatriates will provide them with a return ticket to their home country at least once a year.■

TNT Inbox:

Q: I lost my ASNT membership card. How can I get another?
A: You can call the folks in Member Services at ASNT headquarters (800) 222-ASNT. Ask for Mary Rapp X217 or Ruth Dheel X216.

Q: Do I always have to demagnetize a part after magnetic particle testing?
A: Not if the next operation is a heat treat at or above 1390 degrees F° (1028 K°).

Q: What is a common NDT method to determine coating thicknesses?
A: Eddy current inspection.

Q: Who determines if a borderline indication is acceptable or rejectable?
A: Those decisions are normally made by your Level III.

Q: Are penetrameters always required in radiographic testing?
A: Your technique sheet will determine that for you.

Q: Do I need a college degree to become a Level III?
A: No, but you will need to have additional experience as a Level II.

E-mail, fax or phone your questions for the *TNT* Inbox to the editor.

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