the NDT Technician

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FOCUS

Nondestructive Testing Detects Altered Baseball Bats

Daniel A. Russell*

Corked Wood Baseball Bats

The history of the game of baseball is peppered with interesting stories of attempts to break the rules. Managers have been caught stealing signs; groundskeepers have altered the playing conditions of the field to the advantage of the home team; pitchers have used petroleum jelly, mud, emery boards, or thumbtacks to alter the surface of the baseball; and Major League Baseball players like Albert Belle, Norm Cash, Graig Nettles, and Sammy Sosa, have used corked bats.[1,4]

Major League Baseball rules dictate that a bat must be made from a solid piece of wood. A corked bat has a hole drilled into the barrel that is about 1 in. (25 mm) in diameter and about 8-10 in. (0.20-0.25 m) deep. The hole is filled with tightly packed cork or rubber superballs and capped with a wooden plug sanded and painted to disguise its presence.

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The prevalence of corked bats in Major League Baseball is not known because players are caught only when the doctored bat breaks, revealing the cork interior. For example, in 1974, New York Yankees' Graig Nettles shattered his bat, sending several superballs bouncing around home plate. In 1987, Houston Astros outfielder Billy Hatcher's bat broke and one of the pieces ended up in the hands of Chicago Cubs third baseman Keith Moreland, who promptly showed the exposed cork filling to the nearby umpire. The most recent example occurred on June 3, 2003 when the bat swung by Chicago Cubs centerfielder Sammy Sosa shattered and the umpire who picked up the barrel fragment saw the exposed cork filling.

A physics analysis of the bat-ball collision concludes that corking a bat does not provide any performance advantage to a hitter,[2] but cannot determine whether or not a wood bat has been corked. There are, however, several nondestructive methods for detecting corked bats.

X-rays and CT scans. Pete Rose was frequently accused of using corked bats during his 1985 chase of the all-time hits record, but no broken bats ever exposed cork. Several of Rose's bats from 1985 are now in private collections. Recent X-ray scans of two of these bats show that they were indeed corked.[3]

Following the Sosa corked bat incident in 2003, the Major League Baseball commissioner's office ordered that X-ray scans be taken of the rest of Sosa's bats, including several that had been sent to the Baseball Hall of Fame after the 1998 home run record breaking season. The X-rays of all 76 of Sosa's other bats came back negative; the bat that broke during the 2003 game was the only one found to have been corked.

Sosa's 2003 corked bat fragment was eventually purchased by Grant DePorter, CEO of the Harry Caray Restaurant Group, and a doctor friend used computed tomography (CT) to scan the bat.[4] The CT scan images in Fig. 1, clearly show the

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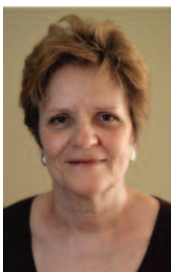
FROM THE EDITOR

A great deal of physics and engineering go into the design of baseball bats, especially the new aluminum and composite bats. Unfortunately, some bats are altered after manufacture to enhance their performance. Dan Russell teaches graduate level courses in acoustics and vibration at



The Pennsylvania State University. One of his research areas focuses on the physical properties of bats. Dan describes the role of NDT in his article "Nondestructive Testing Detects Altered Baseball Bats."

"How Sensitive is a Bubble Test — Really?" Gerry Anderson explains that bubble leak tests are very sensitive when done correctly and he outlines the means to achieve the best results.

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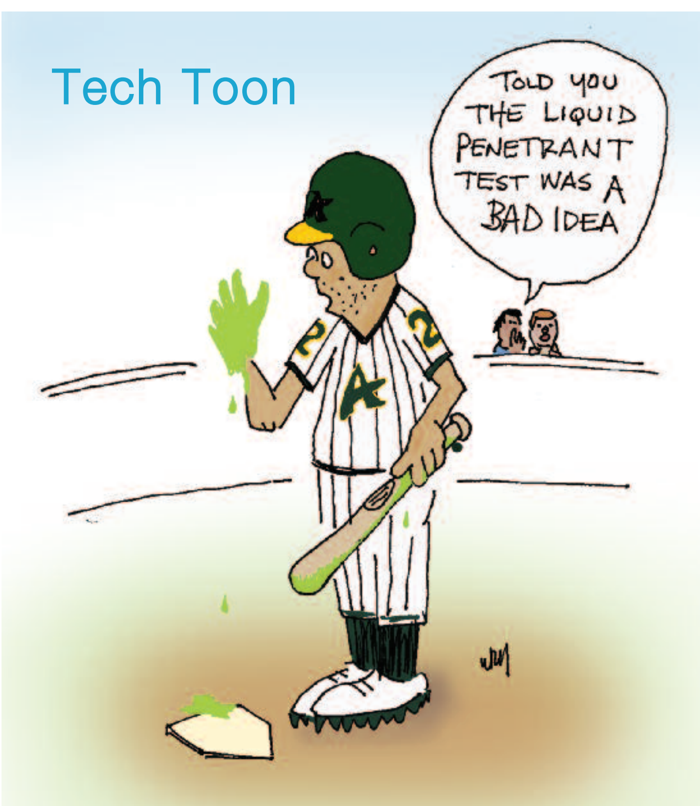

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hole filled with cork as well as the mismatch in the grain between the barrel and the wood plug used to fill the hole.

In August of 1987, just weeks before the Billy Hatcher incident, Major League Baseball commissioner Peter Ueberroth had asked experts at the National Institute of Standards and Technology to perform a quick study of several nondestructive methods for detecting the presence of illegal cork in a hollowed out wood bat.[5] The study found that CT scans provided the clearest image quality and were the best at detecting corking. However, the study concluded that standard medical X-ray scans were the quickest and most practical, especially since many professional ball parks have in-house X-ray machines for diagnosing player injuries.

Ultrasonic Scanning. The 1987 NIST study also explored ultrasonic tests, but found that it was difficult to conclude

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(b)

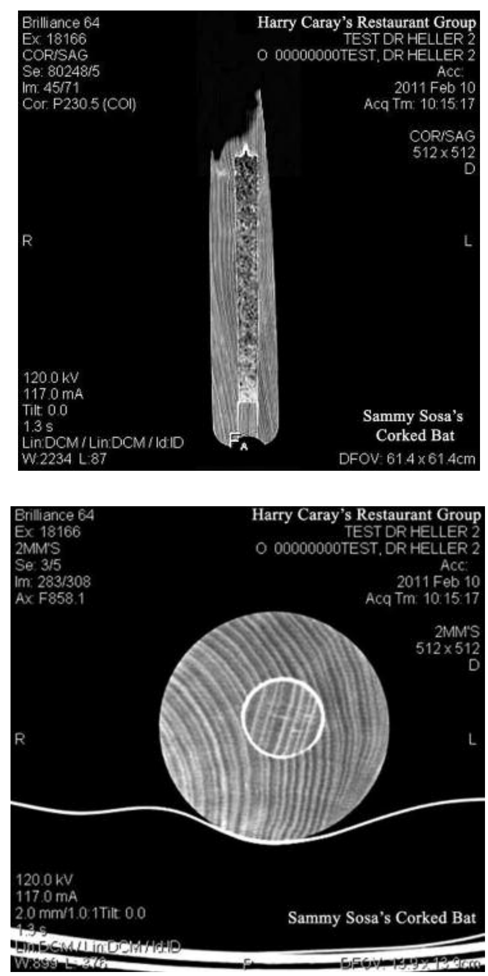

Figure 1. Computed tomography (CT) images of corked bat used in 2003 by Sammy Sosa: (a) side view of bat fragment and (b) end view of bat showing wooden plug. Reprinted with permission of Dr. Richard Heller and Harry Caray Restaurant Group.

with certainty whether a specific reflected signal was due to the presence of cork or the imperfections in the wood grain. However, a recently published study used a pair of 100 kHz narrow-band contact transducers (receiver and source) to measure the signal strength transmitted through three 4 in. (102 mm) thick blocks of sample wood: with and without cork filled holes.[6] The signal transmitted through the hollow block suffered an attenuation of 15.2 dB compared to the solid block. The corked block resulted in 9.6 dB of attenuation. Clean signals require a layer of liquid between the transducer and the bat barrel surface, something prohibited by Major League Baseball rules. The device has not yet been brought to market, but the technique shows promise.

Doctored Metal And Composite Softball Bats

The problem of illegally altering wood bats in Major League Baseball is certainly newsworthy when it happens, but it does not occur with great regularity. The opposite is true in amateur slow-pitch softball, where the illegal modification of bats is much more prevalent but does not often make the news.[7] The bats used for men's amateur slow-pitch softball are manufactured almost exclusively from aluminum or composite materials, and the barrels of these bats are hollow. The collision between a softball and a hollow bat barrel gives rise to the so-called *trampoline effect* in which the hollow barrel compresses as a spring, temporarily storing the energy from the collision and then returning almost all of that energy to the ball as the barrel elastically recoils to its original shape.[8] Careful design of the barrel wall thickness and material properties allows the trampoline effect to be tuned, maximizing the efficiency of the bat-ball collision to the extent that hollow aluminum and composite bats can be designed to produce batted-ball speeds that are significantly faster than are possible with a solid wood bat.

Governing bodies, such as the Amateur Softball Association or the United States Specialty Sports Association have implemented performance standards to regulate bat performance either by placing an upper limit on the batted-ball speed or by limiting the coefficient of restitution between bat and ball. Bat performance is measured following an ASTM test protocol[9] which fires balls at approximately 150 mph (240 km/h) toward a stationary bat and uses measurements of the bat and ball speeds before and after the collision to determine the coefficient of restitution of the bat. Knowledge of the inertial properties of the bat allows for calculation of the batted ball speed. Measurement of bat performance in the laboratory is time intensive and expensive, and requires specialized ball cannons, light gates, bat pivot devices, and computer hardware for data collection and processing.[10]

Almost as soon as bat performance standards for softball were adopted, players discovered that they could significantly improve the performance of a bat by modifying it to increase the trampoline effect. So-called *bat doctors* sprang up around the country, offering to cleverly repaint banned high-performance bats, add or remove mass in the barrel or handle of the bat to change the swing weight (moment-of-inertia), or the more drastic modification of removing the end-cap and using a lathe to shave the inner wall of the barrel.[11] Governing bodies have imposed heavy penalties and fines against players caught using illegally altered bats, but the detection of altered bats in the field of play has presented a challenge.

While X-ray machines may exist in most Major League Baseball stadiums, they certainly do not exist in a portable form at the thousands of amateur softball parks across the country. Even if they were available, X-ray scans could not be used to detect the modification of aluminum bats, and X-ray scans would not easily detect evidence of shaving in a thin-walled hollow composite bat.

Ultrasonic measurement techniques would seem to be the preferred method for detecting alterations in hollow softball bats since ultrasonic sensors are frequently used to measure the thickness of hollow metal, plastic and composite pipes. However, knowing the barrel wall thickness would detect modification only if one knew the original wall thickness and manufacturers are unwilling to make this information publically available. Reflections from the air gaps between the thin layers of a double-walled aluminum bat, or from the different layers of composite and resin in multi-walled composite bats could lead to errors in thickness measurements.

The difficulty in detecting illegally altered softball bats is exacerbated by the fact that it is possible to improve the performance of a composite bat without actually changing the thickness of the barrel walls. A currently popular technique for improving the performance of a composite bat is to use one of several accelerated break-in methods.[12] It is well known that the performance of composite bats improves with use as the layers of composite materials gradually delaminate with use and the bat wall softens, increasing the trampoline effect. A quick search of the web will reveal a small industry for rolling and pressing bats to accelerate the break-in process. Awareness of this phenomenon led the Amateur Softball Association to begin rolling bats prior to certification testing for compliance with their performance standard, and also caused the National College Athletics Association in 2009 to ban composite bats from use in college baseball after a large number of certified composite bats were found to exceed performance standards when tested following the College World Series that year. However, approximate estimates of performance may be obtained

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indirectly from vibration frequencies and stiffness values.

Hoop Frequency. A hollow softball or baseball bat exhibits a number of vibrational modes involving radial oscillations of the cylindrical barrel. The fundamental mode shape with the lowest frequency is termed the *hoop-mode* of the bat. Modeling this vibrational hoop mode using a simple mass-spring approach captures the essential physics of the bat-ball collision.[8] Experimental results for softball and baseball bats have shown that the frequency of this hoop mode may be used as a fairly accurate predictor of the performance of a bat.[13,14] Figure 2 shows the measured batted-ball speeds for a variety of aluminum single-walled and double-walled, titanium, and composite softball bats plotted as a function of the hoop mode frequency. The data shows that bats with lower hoop frequencies tend to produce higher batted-ball speeds. The Amateur Softball Association requires that the laboratory measured batted-ball speed fall below 98-mph, suggesting that a bat with a hoop frequency lower than 1300 Hz would exceed this performance limit.

The hoop mode frequencies in Fig. 2 were obtained through experimental modal analysis, a test procedure in which a hammer with an instrumented force gage provides an impulse to the barrel of the bat and the resulting vibration response is measured with an accelerometer. The frequency response function (the ratio of acceleration to force as a function of frequency) for a combination of impact and measurement locations along the length of the bat may be used to obtain the vibrational mode shapes, corresponding natural frequencies, and damping rates by curve fitting the data with modal analysis software. A typical setup for measuring the vibrational response of a softball bat includes power supplies for hammer and accelerometer as well as a two-channel analyzer to capture the frequency response function. While suitable for laboratory testing, this experimental setup is not conducive to field tests.

An ongoing project hopes to develop a hand-held device to measure the frequency of the hoop mode using a microphone and a programmable dedicated microchip to sample, filter and process the signal, and compare the measured frequency to a reference value. Such a device would not be able to detect whether a bat had been illegally modified, but it

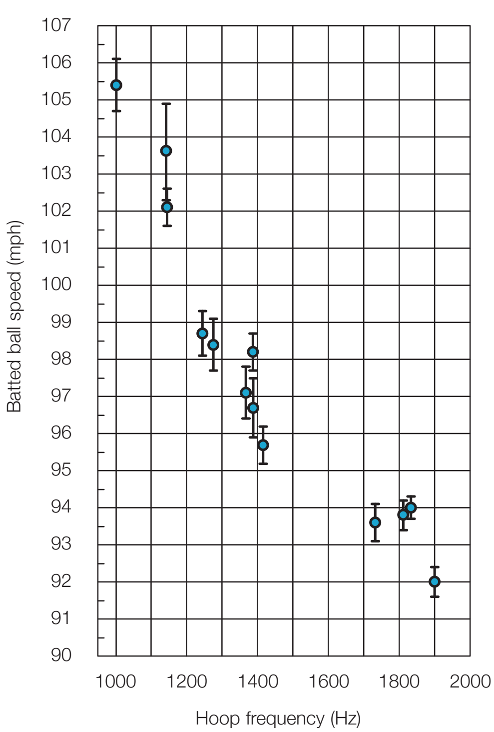

Figure 2. Batted-ball speeds for collection of softball bats showing increases in performance as hoop frequency decreases.

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(b)

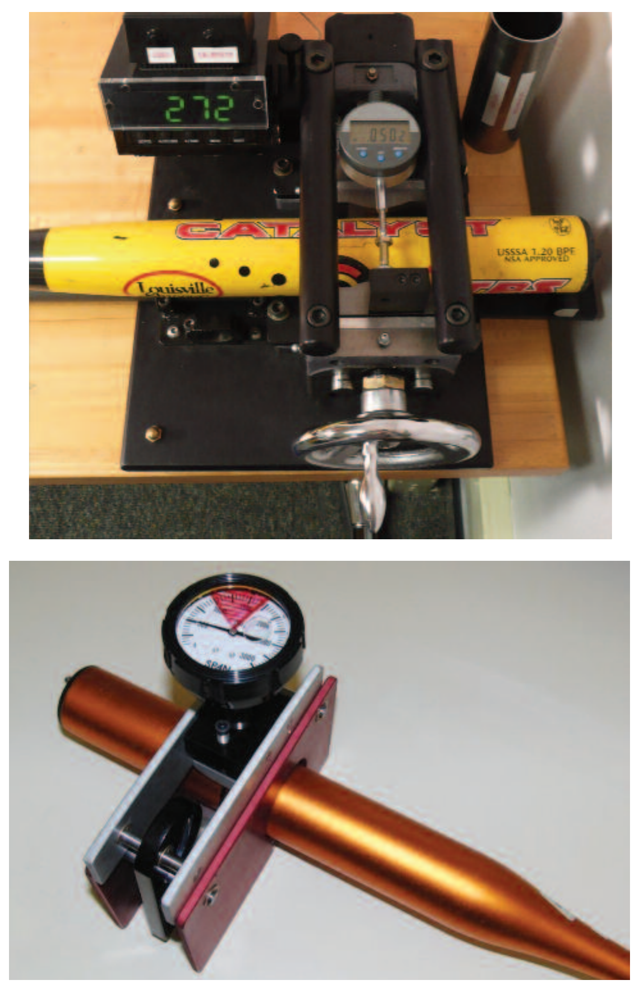

Figure 3. Barrel compression testers measure barrel stiffness of hollow composite or aluminum softball bats: (a) setup for laboratory testing and (b) portable device.

could predict whether or not the bat might exceed the required performance limits.

Barrel Stiffness. Another approach to measuring the elastic *springiness* of a hollow bat barrel involves the static stiffness of the barrel. Experimental data relating performance to barrel stiffness, as measured using a compression tester in the laboratory, follows a trend similar to that shown in Fig. 2; lower values of barrel stiffness result in higher batted-ball speeds. In 2004, the Sporting Goods and Manufacturing Association commissioned the portable barrel compression tester for field use (Fig. 3a). The force in pounds required to compress the barrel by 0.05 in. (1.27 mm) is used to calculate the barrel stiffness. This device was used to police bats at a 2004 national slow-pitch softball tournament sponsored by the United States Specialty Sports Association. Five hundred bats were tested and 75 bats were removed from play due to excessively low stiffness values.

A more portable (requiring no electricity) and simpler to use barrel compression tester was recently developed by the Sports Science Lab at Washington State University (Fig. 3b). Bats for which the pressure gage reading falls in the red zone are not stiff enough to be legal. The stiffness values from this portable tester do not completely correlate to values measured in the laboratory with a compression tester, but a portable tester like this could indicate whether a bat might be suspect of having been tampered with, or at least whether it might exceed performance limits.

Further research in these areas is ongoing. Available data suggests the correlation between performance and laboratory measurements of hoop frequency or barrel stiffness for specific softball bats that are known to have been altered is not yet close enough for reliable field detection of illegally altered bats using portable devices in the field, but results are encouraging.[15]

Conclusion

Nondestructive test methods may be used to detect baseball and softball bats that have been illegally altered. X-ray scans and ultrasonic testing can easily detect corking in a wood bat. Measurements of the hoop frequency of barrel vibrations and/or the static stiffness of the barrel can identify hollow aluminum and composite softball bats that may exceed performance limits due to illegal modification.

References

1. "Biggest Cheaters in Baseball." Web page. Bristol, CT: ESPN (2007; accessed June 2012).
2. Nathan, A.M., L.V. Smith, Warren L. Faber and D.A. Russell. "Corked Bats, Juiced Balls, and Humidors: The Physics of Cheating in Baseball." *American Journal of Physics.* Vol. 79, No. 6. Melville, NY: American Institute of Physics (June, 2011): p 575-580.
3. Petchesky, B. "This is Pete Rose's Corked Bat" web page. New York, NY: Gawker Media (June 2010; accessed June 2012)
4. Telander, R. "The Inside Story of Sammy Sosa's Corked Bat." Web page. *Chicago Sun-Times*. Chicago, IL: Sun-Times Media Group (16 February 2011; accessed June 2012).
5. Schramm, R. "NIST and the American Pastime: A Real Corker." Web page. Gaithersburg, MD: National Institute of Standards and Technology (May 2001; accessed June 2012).
6. Gamache, P., A. Galante, G. Seben, and A.J. Elbirt. "Validating Baseball Bat Compliance." *Sports Engineering.* Vol. 10. London, United Kingdom: Springer (2007): p 57-164.
7. Dougherty, C. "Softball, Hard Questions: On America's Other Diamonds, Players Try Doctored Bats; How Bobby Buggs Got an Edge." *The Wall Street Journal Online,* New York, NY: Dow Jones (20 May 2005)
8. Nathan, A.M., D.A. Russell, and L.V. Smith. "The Physics of the Trampoline Effect in Baseball and Softball Bats." *Engineering of Sport 5,* Vol. 2. Sheffield, United Kingdom: International Sports Engineering Association (2004): p 38-44.
9. ASTM F2219-05, *Test Methods for Measuring High-Speed Bat Performance.* West Conshohocken, PA: American Society for Testing and Materials (2005).
10. Smith, L.V. "Progress in Measuring the Performance of Baseball and Softball Bats." *Sports Technology.* Vol. 1, No. 6. Hoboken, NJ: John Wiley (2008): p 291-299.
11. Russell, D.A. "Why is Doctoring (Painting, End-Loading, or Shaving) a Bat Illegal?" Web page. State College, PA: Pennsylvania State University (2008; accessed June 2012).
12. Russell, D.A. "Do ABI Techniques Really Work?" Web page. State College, PA: Pennsylvania State University (2009). (accessed June 25, 2012).
13. Russell, D.A. "Hoop Frequency as a Predictor of Performance for Softball Bats." *Engineering of Sport 5,* Vol. 2. Sheffield, United Kingdom: International Sports Engineering Association (2004): p 641-647.
14. Sutton, A.D. and J. A. Sherwood. "Using Vibrational Analysis to Investigate the Batted-Ball Performance of Baseball Bats." *Procedia Engineering.* Vol. 2, No. 2. New York, NY: Elsevier (2010): p 2687-2692.
15. Smith, L.V. and C.M. Cruz. "Identifying Altered Softball Bats and Their Effect on Performance." *Sports Technology.* Vol. 1, No. 4-6. Hoboken, NJ: John Wiley and Sons (2008): p 196-201.

How Sensitive is a Bubble Test — Really?

Gerald L. Anderson*

Factors Influencing Sensitivity of Bubble Testing

The basic principle of the bubble test consists of creating a pressure differential across a leak and observing bubbles formed in a liquid medium located on the low pressure side of the leak or pressure boundary. The sensitivity of the bubble test technique can be influenced by factors such as:

- pressure differential acting across the leak;
- viscosity of pressurizing tracer gas;
- test liquid used for bubble formation;
- contamination such as paint, dirt and oil on inside or outside surfaces of object being tested;
- ambient weather conditions (such as rain, temperature, humidity or wind);
- lighting in test area;
- test equipment; and
- test personnel technique and attitude.

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Properties Affecting Leak Detector Solution Performance

- *Surface tension* affects the speed and size of bubble formation. Lower surface tension solutions form many small bubbles and the reforming of new bubbles. Higher surface tension solutions slowly form very large bubbles that are slower to break, but usually do not reform new bubbles.
- Good *wetting action* and a large *contact angle* are the result of lower surface tension. Poor wetting action and a small contact angle are the result of higher surface tension.
- *Viscosity* affects the size of bubble growth. Lower viscosity solutions produce smaller bubbles. Higher viscosity solutions produce larger bubbles.
- *Evaporation rate* controls the amount of test area that may be covered with leak detector solution before the final inspection. It is desirable therefore to limit the evaporation rate to be able to cover a larger test area. Evaporation rate is also temperature dependent with an increase in temperature causing an increase in evaporation rate and vice versa.

Techniques for Attaining Required Bubble Test Sensitivities

As long as the pressure differential can be maintained, the bubble test technique can be used. However, the sensitivity of a leak testing procedure must be adequate to permit detection of all leaks of a certain size and larger so that all detected leaks can be repaired. The hole or crack that constitutes the physical leak is usually characterized for size of leak by the amount of gas passing through it as leakage. The sensitivity of a bubble test can be increased by:

- increasing the time allowed for bubble formation and observation;
- improving conditions for observing bubble emission and
- increasing the amount of gas passing through the leak.

Improving Bubble Test Sensitivity by Better Observational Capabilities

The actual sensitivity of a specific leak test procedure can be improved by an increase in observational ability. An increase in observational ability could be attained by the following means.

- Position test surfaces optimally for visual inspection.
- Improve lighting to highlight bubble emission clearly and use clean translucent immersion liquids.
- Increase time for bubble formation and observation by test operators.
- Eliminate false bubble indications (caused by boiling, entrained air or contamination of inspection liquids, for example).
- Decrease surface tension of the detection liquid that causes more and smaller bubbles to appear.
- Reduce pressure above the inspection liquid, which makes the individual bubbles larger.

- Select test site and time to provide optimum ambient conditions, such as temperature, wind and lighting conditions.
- Use leak detector solutions that are fluorescent and colored for increased contrast with different test surfaces.

Factors affecting operator comfort and ability to see bubble indications must also be considered. Tests might be postponed until proper test conditions can be attained.

Each of these aids to sensitivity enables the test operator to detect the bubble emissions from smaller leaks or to separate the indications for closely adjacent leaks more readily and so improve leak detection reliability.

Increasing Bubble Test Sensitivity by Raising Tracer Gas Flow Rate

Increase in sensitivity resulting from improvements in leak test procedures are typically attained by raising the rate of flow of tracer gas through the existing leaks. The increased amount of gas flow through the leak passageway may be attained by a change in the properties of the gas (lower gas viscosity). Alternatively, the quantity of gas passing through the leak could be increased by applying a higher pressure differential across the leak. This higher differential pressure could be achieved by a higher level of internal gas pressurization of the vessel or component under test, by heating the gas within a sealed component to increase its pressure or by reduction of the pressure acting through the test liquid on the low pressure side of the pressure boundary. These techniques increase the sensitivity of the test procedure to which the components are subjected. They may also result in more easily observed bubble indications that improve the reliability and speed of bubble testing.

Sensitivities Attainable with Liquid Film Bubble Testing

The actual sensitivity attained in bubble testing depends on the control and selection of leak test conditions that influence factors affecting sensitivity. Sensitivity also depends on the selection of the test technique. The liquid application technique (solution film technique), in which a thin film of liquid is applied and bubbles form in air (like soap bubbles floating on water), is typically used only for leak detection and location. A leak is a physical hole; the gas passing through it is leakage. Service requirements or specifications for testing may require that any detectable leakage be taken as cause for rejection or for repair of leaks.

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In this case, it is not necessary to measure actual leakage rates to determine the disposition of the test items. The sensitivity of the liquid application technique of bubble testing is adequate for locating leaks with leakage rates in excess of 10^{-5} Pa·m^3·s^{-1} (10^{-4} std cm^3·s^{-1}). The solution film procedure is widely used on large pressurized systems that cannot be immersed in detection liquid. The technique is ideal for quick detection of large to moderate size leaks (10^{-2} to 10^{-4} Pa·m^3·s^{-1} or 10^{-1} to 10^{-3} std cm^3·s^{-1}) at very low costs (Fig. 1).

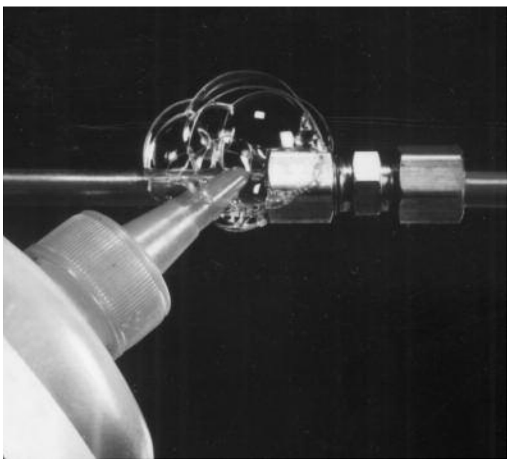


Figure 1. Liquid film bubble testing.

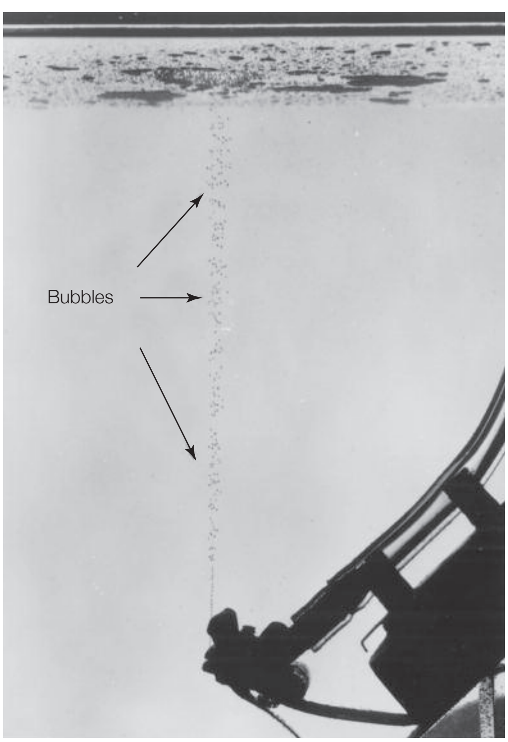


Figure 2. Immersion bubble testing.

Sensitivities Attainable with Immersion Bubble Testing

In bubble testing by the immersion technique, test sensitivity depends on operating conditions and selection of both the tracer gas and the test liquids (Fig. 2). Other factors can also change the test sensitivity actually attained. With certain combinations of tracer gases and detection liquids, sensitivities of 10^{-8} Pa·m^3·s^{-1} (10^{-7} std cm^3·s^{-1}) have been attained with calibrated leaks operating under laboratory conditions. Under excellent industrial immersion bubble testing conditions, maximum sensitivity of bubble testing is in the range of 10^{-5} to 10^{-6} Pa·m^3·s^{-1} (10^{-4} to 10^{-5} std cm^3·s^{-1}).

Operator Training and Motivation to Maintain Bubble Test Sensitivity

The sensitivity of bubble testing is hard to define because it also depends on the observation and alertness of the leak test operator. Practically, under excellent industrial test conditions, there is no question that leakage of 10^{-6} Pa·m^3·s^{-1} (10^{-5} std cm^3·s^{-1}) can be observed by the immersion bubble testing procedure. However, it is a different matter when operators do not know that a leak exists and have to examine a long weld seam for a possible bubble. Conceivably, they might not wait long enough for the bubbles to form or they might fail to look carefully after sufficient time at every portion of every area where a potential leak might exist. Thus, optimum bubble observation conditions and continuing training and motivation of bubble test operators to achieve and maintain their best observational capabilities are essential if the reliability and sensitivity of bubble testing are to be ensured.

Effects of Test Pressures on Bubble Formation

Because a minimum pressure is required to form a bubble in a liquid, bubble testing sensitivity depends on the pressure differential acting across a leak. Bubble testing sensitivity increases with an increase of pressure across a leak. Sometimes, it is possible for the operator to estimate that a certain rate of leakage is observed because a bubble of a particular volume is being observed. However, this type of leakage rate estimation can be inaccurate on very small leaks because of the finite solubility of the tracer gas in the bubble test liquid. It is theoretically possible for a small leak to exist where the tracer gas from a capillary leak dissolves in the test liquid so fast that no leakage bubble indication is visible. Special techniques that serve to increase the pressure differential across leaks can be used to increase bubble testing sensitivity.

Bibliography

1. ASTM E 515, *Standard Practice for Leaks Using Bubble Emission Techniques.* West Conshohocken, PA: ASTM International (2011).
2. Marr, J.W. *Leakage Testing Handbook.* Report No. CR-952. College Park, MD: National Aeronautics and Space Administration, Scientific and Technical Information Facility (1968).
3. *Nondestructive Testing Handbook,* third edition: Vol. 1, *Leak Testing.* Columbus, OH: American Society for Nondestructive Testing (1998).

PRACTITIONER PROFILE

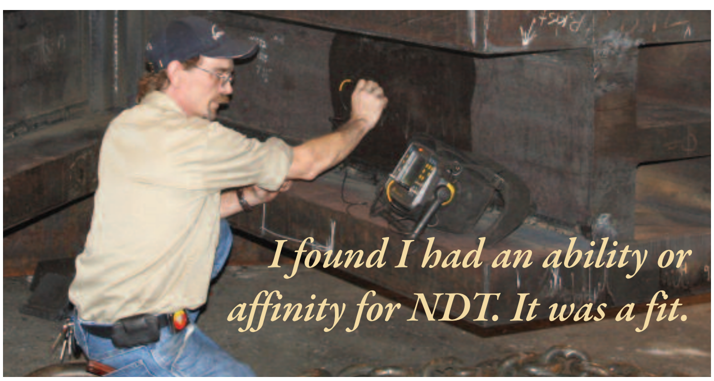
Robert E. Campbell, Jr.

Bob Campbell really knows how to pack a lot into a workday. Not only is he responsible for the training of his employer's NDT personnel, he also maintains the documentation of their training and certification. In addition, he monitors their work all while conducting inspections himself. He tells us that knowledge is key to using codes and specifications as tools to facilitate working procedures instead of as limiting factors.

Bob Campbell has been selected as ASNT's Lou DiValerio Technician of the Year award winner for 2012. This award recognizes an individual that demonstrates exceptional merit either as an NDT technician or through service to the Society.

Q: How did you first become involved in NDT?

A: In early 1990, I found myself in Northern Virginia seeking a new career. I picked up the paper one morning and saw an ad looking for an NDT technician trainee. I



had some indirect experience with NDT while in the military. So, I did have some knowledge of it and understood the basic principles. And, as part of my military training, I also had some experience with radiation detection instruments. I found I had an ability or affinity for NDT. It was a fit. And, it was an opportunity to make some decent money. The work was interesting and the environment I was working in — government office buildings in the northern Virginia or D.C. Metro area — were interesting too. In 1993, I was involved in the radiography of the Statue of Freedom that stands on top of the United States Capitol dome. The statue was originally put up in sections but they brought it down as an entire 19-foot unit. They lifted it with a helicopter and set it down between the Supreme Court building and the Capitol to do the restoration work. We radiographed the internals — corroded rivets and missing pieces that had fallen off.

Q: Can you tell us about your NDT training?

A: The biggest percentage of my training has been OJT — on the job — backed up when and where required with coursework; schools for radiographic interpretation or ultrasonic testing with equipment manufacturers. At some level, all of the companies that I've been involved with have used *SNT-TC-1A* guidelines..

Q: What certification do you currently hold?

A: I am certified by my employer as a Level II in MT, RT and UT, with limited procedure specific phased array. I am an AWS Certified Welding Inspector. I hold ASNT ACCP Level II certification in VT and am certified as an ASNT IRRSP Radiographer. In addition, I have Virginia DOT Level II certification in RT and UT and I have Level III certification as a NACE coating inspector.

Q: Tell us about your working environment.

A: We're a fabrication shop. We take raw pieces of steel — I-beams, channels, and in some cases, large pieces of just rolled plate — and, based on the designs, cut it to length and weld it into the different configurations that steel mills can't produce. We do structural steel for buildings and bridges and we've developed a specialty in that many of the projects that we take on are projects that are outside of the norm — the National Marine Corps Memorial and Museum in Quantico, VA for example. We also did the initial steel package for the Freedom Tower in New York City. We fabricated approximately 80 columns — weighing on the order of about 700 lbs per linear foot — that were the first pieces of steel to go back in when they started rebuilding. These are foundational columns, sunk down into caissons and, in some cases, all the way down to bedrock, that are now supporting the entire structure.

Q: What NDT methods do you use to inspect these structures?

A: Visual inspection is the biggest, most prevalent, day in and day out, pretty near 24/7, method that we use. Everything gets visually inspected. Once it's passed visual inspection, then it depends upon the code and the client's requirements and specifications. Ultrasonic testing is probably our second most used NDT method.

Q: And you also do training, is that correct?

A: Yes, that's another big part of my responsibilities. I ensure that we have adequate personnel to perform all of the different inspections here in our two shops. I also make sure that all training is up-to-date and that all certification is documented. In addition, I monitor the work that's being done and at the same time, perform work myself. I'd say that 70 to 80 percent of my work is hands on. We do a pretty substantial amount of magnetic particle inspection and many of our clients, especially the department of transportation folks, will also require radiography of the finished completed welds.

Q: What are the indications you look for?

A: Any that are deemed detrimental to the intended use of the structure. We rely heavily on visual inspection prior to welding to minimize or prevent problems later on in the inspection process and in the life of the structure. For fillet welds, it's usually VT and MT for surface indications such as undercut, porosity and inclusions. When it comes to full and partial penetration joint designs, RT and UT are the primary methods used. It's mostly porosity, lack of penetration, slag inclusions and cracks that we are looking for there.

Q: Are the welds on these structures automated or manual welds?

A: Although we use a lot of manual welding — I've got probably 40 guys outside my office door right now welding by hand — we are using more and more automated and robotic welding in an effort to increase efficiency and to keep us competitive.

Q: What are your biggest challenges in NDT?

A: I'd say it's mostly the parts themselves. When you go into the code and specification books and even when you go for training, you're typically dealing with relatively small and very generic applications for your different NDT methods. When that gets translated into an actual production piece out here, the little ¾ in. (19 mm) thick by 6 in. (152 mm) wide block that you spent 3 hours testing with ultrasonics in school, is now a piece of steel that will support a major building and it's 3 in. (76 mm) thick and 3 ft. (0.9 m) wide. There's a lot that classroom training just cannot give you when it comes to practical application.

Q: So, an ability to adapt is important?

A: An ability to adapt within the parameters of your code. It's important to know your codes and specifications and to use them as the tools they are intended to be instead of perceiving them as a list of restrictions.

Q: What codes and standards apply to your NDT work?

A: *SNT-TC-1A* is the basis for most of our NDE certifications. Next would be the AWS D1.1 *Structural Welding Code Steel* and the AWS D1.5 *Bridge Welding Code*. Beyond that, it's up to the client and the needs of their project.

Q: What part of your work do you enjoy the most?

A: If we were to put it in terms of an NDT method, I would say RT. It's really an intangible but I guess it's just the whole idea that I can use a tiny source that zips out from a tube or a unit that plugs into a wall to pass a beam of energy through a piece of steel that you can't blast through with a canon. I can tell a welder, "Look, it's right here." And, when he finds it, it makes it all worthwhile.

Q: Has ASNT membership benefitted your career?

A: Yes, when I go to the meetings, there's always something to be gained. I'm currently a member of ASNT's Old Dominion Section. It's an active Section and when I sit in those meetings, not only am I there with my vendors but I'm also there with some of my clients. And, sometimes regulatory agencies come in to do demonstrations or presentations for us. So, when an issue comes up out here on the shop floor, I've already developed a rapport with the people that have the solutions.

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the NDT Technician

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ASNT exists to create a safer world by promoting the profession and technologies of nondestructive testing.

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INBOX

Q: *We are an Eastern European NDT company with Level II personnel certified in accordance with* SNT-TC-1A *and we wish to have them certify to Level III. Our questions are:*

1. *Must the Level III administering the examinations hold an ASNT Level III certificate or can we use an* SNT-TC-1A *Level III?*
2. *Can the Level III be certified under another program (such as EN 473)?*
3. *Does the Level III have to be employed by our company or can we use an outside service?*
4. *If we can use an outside service, do we have to have a written practice?*
5. *Can our company certify these people after they pass the examinations even if we don't have a Level III on staff?*

A:
1. Holding an ASNT Level III certificate is not mandatory. As long as Level IIIs have met the *SNT-TC-1A* guidelines for certification to Level III they can train, qualify and certify other NDT personnel in those test methods in which they are certified.
2. Yes, as long as the use of Level IIIs from other programs is described in your company's written practice.
3. Paragraph 8.1.5 of *SNT-TC-1A* permits the use of outside examination services as long as your company has determined that those services meet the requirements of your written practice. The written practice must be approved by a Level III, so if one is not on staff, you may wish to contract with an outside service until such time as your personnel are certified to Level III.
4. Yes. Regardless of who administers the qualification examinations, a company performing NDT must have a written practice to be compliant with *SNT-TC-1A*.
5. Yes. In fact, *only* the employer can certify NDT personnel to perform NDT work on their behalf regardless of who administers the examinations.

Respectfully,
James W. Houf,
Senior Manager, ASNT Technical Services Department

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