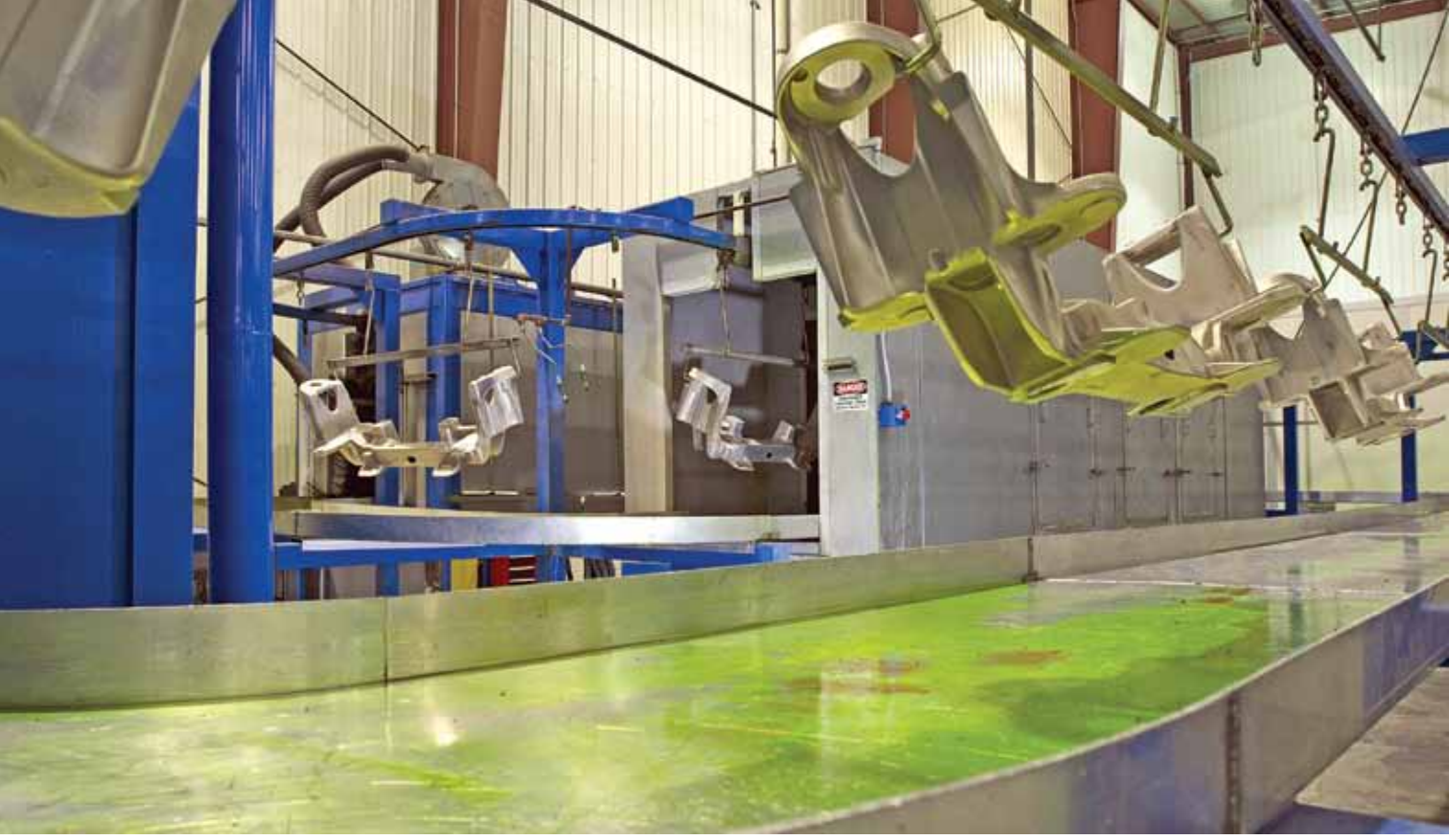


Building Nondestructive Know-How

Customer requirements for nondestructive testing increasing? Maybe it's time to bring it in-house.

Shannon Wetzel, Managing Editor

Nondestructive testing (NDT) can be a benefit to both you and your customer. Your customer receives the reassurance that the castings supplied will stand up to the rigors of the end-use application. You maintain a final checkpoint to make sure castings aren't being sent out only to be returned by the customer due to defects revealed during machining. In-house NDT can help you catch potential casting issues that can be corrected before a whole order has been completed.

When customers are particularly concerned about porosity defects, for instance, David Howell, senior casting specialist at AlumAlloy Co. Inc., Ontario, Calif., recommends they pay for x-ray inspection on at least a sample of the first lot.

"If the first 10 castings x-rayed show signs of trouble, then we can re-gate and re-rig the mold," Howell said.

Although testing will add to the final part cost quoted to the customer, x-raying at least a small percentage of castings can help save time and money in the long run.

"Many times porosity is discovered at the machine shop," Howell said. "Without testing, a metalcaster can't prove a casting is good until it is machined, and then the cost of machining, as well as time, may be lost."

NDT comes in many forms. The simplest methods—visual and dimensional inspection—are incorporated in most metalcasting facilities. Other methods, such as radiography (x-ray), ultrasonic, magnetic particle and dye penetrant, require larger investments in equipment, floor space and personnel. For metalcasting facilities casting the occasional part that requires testing, working with an outside testing service makes the most sense. For metalcasters thinking of bringing these tests in-house, several things should be considered before taking the plunge.

Is it worth the time and money?

Performing in-house testing can shorten turnarounds, reduce transportation costs and allow staff to quickly evaluate results. But establishing a testing program requires investment in equipment, training and retention of qualified personnel. Justifying the expense will depend on the amount of testing required. "If it is something that will be a long repeat business, and the space and equipment are available, it is probably worth it," said Tim Duffy, Level III ASNT quality inspector for Waukesha Foundry, Waukesha, Wis. "If it is just a small or one-time job, I would use a lab."

Do you have a quality system in place and the available personnel?

NDT hinges on proper quality procedures. Most customers likely will audit your testing procedures to ensure they are adequate. Some manufacturers require certification through Nadcap, an independent organization that audits and certifies NDT facilities. These audits and company certifications can add to the cost of performing in-house NDT.

"One of the biggest hurdles to nondestructive testing is setting up a program to certify personnel and maintain their certification," said Mark Pompe, director of technology for West Penn Testing, New Kensington, Pa.

Certified testing personnel are graded on three levels. Level 1 personnel are only qualified to perform certain calibrations and tests but are not skilled at interpreting the results. Level 2 personnel can set up and calibrate equipment, conduct the inspection according to procedures, interpret, evaluate and document results and train. A proper NDT program must also employ a Level 3 inspector, who has the qualifications to write techniques and procedures, interpret codes, standards and specifications, and designate the particular NDT methods, techniques and procedures to be used.

"Finding trained personnel to hire is difficult, and the training/qualification time is lengthy," said John McGoldrick, technical director for Hodge Foundry, Greenville, Pa., which performs ultrasonic, magnetic particle and dye penetrant testing in-house. "For instance, training takes approximately one year to achieve a Level 2 status in ultrasonic testing, four months for magnetic particle and three months for dye penetrant."

What types of castings generally require NDT?

Castings used in applications with high wear or pressure, such as nuclear power, offshore oil, power generation, chemical and petroleum processing, aerospace and military are prime candidates for NDT.

"Anything where the cost of the failure of the component exceeds the cost to test it would be a typical application," Pompe said.

Every metal casting houses discontinuities within its walls, and castings with tighter specifications on the acceptable size and frequency of discontinuity will typically require some sort of NDT.

Which NDT methods should you bring in-house?

While various methods of nondestructive testing can measure mechanical properties, chemical composition, casting soundness or maximum service loads, a single test that encompasses all these factors does not exist. A combination of nondestructive methods may be required to document the soundness and quality of a casting. Some of the more common methods include dye penetrant, magnetic particle, ultrasonic and radiographic.

When determining which methods to bring in-house, consider the scope of testing, the ability to perform the testing, and the standards and methods required.

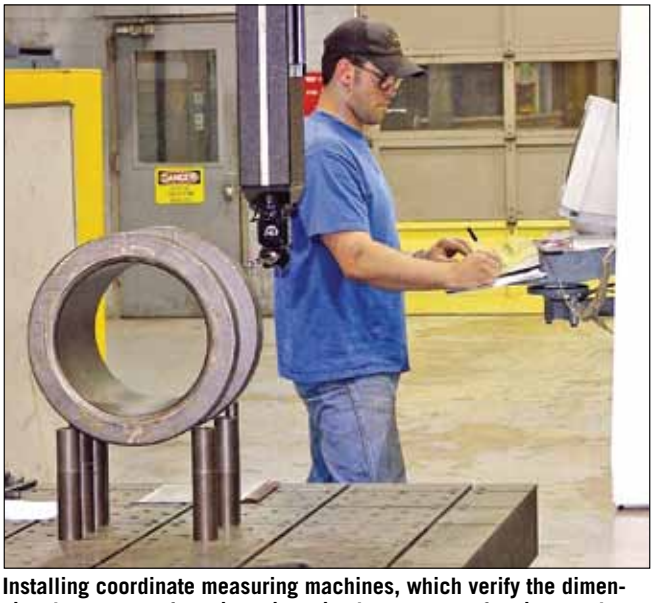
According to McGoldrick, magnetic particle and dye penetrant are fairly simple methods that can be easily implemented, if requested by the customer.

Dye penetrant testing, or liquid dye penetrant testing, is used on both ferrous and nonferrous material to detect tiny cracks, pores or other surface glitches that are hard to see with the human eye. In this method, a colored dye solution is applied to the surface of the casting. The dye, which is suspended in penetrating oil, will find its way into the surface defects. A special developer then is applied to clearly indicate the defects.

In general, dye-penetrant techniques identify defects on the surface of the casting and do not detect internal porosity or shrinkage that is not open to the surface.

Although considered one of the simplest tests to bring in-house, a designated area will still be needed. Waukesha Foundry houses its liquid penetrant testing in a specific area with dip tanks and drain areas, water washing equipment, pressure gauges and fans and dryers.

Magnetic particle inspection is quick, inexpensive and sensitive to defects, particularly shallow (0.003 in. [0.0076 cm]) surface cracks and other lineal indications. It detects small cracks on or near the surface of ferrous alloys that can be magnetized (basically any ferrous alloy except austenitic material). A high-amperage, low-voltage current is passed through the casting, which establishes a magnetic field. Cracks and defects have magnetic properties different than those of the surrounding material, so their presence interrupts the magnetic field, causing distortion. Small magnetic particles show the path of the flux line, which spreads out in order to detour around the distortion, thereby indicating the shape and position of the crack or void.



Installing coordinate measuring machines, which verify the dimensional accuracy of castings, is a simple start to performing nondestructive testing.

Ultrasonic testing uses high frequency acoustic energy that is transmitted into a casting. Because ultrasonic testing allows investigation of the cross-sectional area of a casting, it is considered to be a volumetric inspection method.

"Ultrasonic testing is more

involved, and there should be enough demand to make the long training period worth the effort," McGoldrick said.

The high frequency acoustic energy used in ultrasonic testing travels through the casting until it hits the opposite surface or an interface or defect. The interface or defect reflects portions of the energy, which are collected in a receiving unit and displayed for the analyst to view. The pattern of the energy deflection can indicate the location and size of an internal defect, as well as wall thickness and the nodule count of ductile iron.

Leak testing determines whether air can penetrate through the casting wall.

Radiography testing will require the largest investment of time and money, but when done correctly, it is the best nondestructive method for detecting internal defects, such as shrinkage and inclusions.

"Unless one has a great deal of work requiring radiography, it is best left to others," McGoldrick said.

In this method, a casting is exposed to radiation from an x-ray tube. The casting absorbs part of the radiation, and the remaining portion of the radiation exposes radiographic film. Dense material withstands the radiation penetration, so the film is exposed to a lesser degree in those areas, giving the film a lighter appearance. Less dense materials allow more penetration and correlate to darker areas on the film. Any hole, crack or inclusion that is less dense than the casting alloy is revealed as a dark area.

The radiographic image serves as a permanent record of the casting quality that can be reviewed by multiple personnel. Casting thickness and density will limit the range of inspection possible, depending on the energy level of the radiation.

Radiographic inspection also can be performed with digital images capable of being viewed on a video screen. Computerized axial tomography (CAT scanning) also is being used to develop 3-D computer imagery to inspect a casting's soundness.

Waukesha Foundry actively pursues the types of parts that require NDT, so it performs liquid penetrant, magnetic particle and radiography in-house, where space and personnel have been dedicated. A large area enclosed with 2-ft.- and 4-ft.-thick walls is supplied for radiography. Here, the company has the capability to perform x-ray inspection on up to 6 in. of steel.

When is testing best left to outside contractors?

"It is best to involve the experts when internal knowledge is uncertain," McGoldrick said.

NDT testing generally is less expensive when performed by internal personnel, but outside testing centers have a broader range of services and knowledge. When a testing requirement moves out of your facility's comfort zone, these centers are good resources. Because of its expense, required space and associated safety issues due to radioactive materials, radiography is often left to an outside contractor.

"For radiography, there is a minimum clearance zone around the source which can be extensive and may require operations to shut down temporarily for the safety of employees or neighbors," McGoldrick said.

When searching for an outside testing facility, look for an accredited organization, either through Nadcap or an industry-specific organization, depending on the application.

"You want to look for someone that has experience testing the types of parts you are casting and is familiar with the industry," Pompe said. ***MC***

For More Information

"Putting the Brakes on Leakers with PCRI," *F. Pirrello, J. Silkauskas and J. Schwarz, MODERN CASTING, July '05, p. 29-34.*