WLD 204
Non Destructive Testing I
Magnetic Testing

Welding Technology

Portland Community College

NSF -ATE Project

Advanced Materials Joining for Tomorrow's Manufacturing Workforce

INDEX

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MAGNETIC PARTICLE INSPECTION (MT)

Magnetic particle inspection is a method for locating surface or near surface discontinuities in metals that have strong magnetic properties, such as iron and steel. These metals are said to be ferromagnetic. Both surface and shallow subsurface discontinuities set up a flux leakage in the magnetic field that can be revealed by applying magnetic particles to the surface.

Method

There are four basic steps involved in the performance of a magnetic particle inspection:

(1) Cleaning. Each item should be free from grease, oil, or dirt that may interfere with the inspection. The precleaning does not have to be so exacting as for the liquid penetrant method.

(2) Magnetizing the part. This can be done with a permanent magnet (such as a horseshoe magnet), with an electromagnet, or by passing an electric current through the part.

(3) Apply the particles. Once the part has been magnetized, the magnetic particles are applied either as a dry powder or suspended in a liquid. The particles will be attracted to any leakage field, thus giving an indication of the discontinuity that disrupted the magnetic flux.

(4) Interpretation of the results. The inspector must view the magnetically held particles and make a decision as to the location, size, and shape of discontinuities present. The results are recorded for future use. The pattern of particles is sometimes transferred to pressure sensitive tape by pressing the tape down onto the pattern and peeling off the tape with the particles embedded in it.

MT Systems

Some of the factors that determine the detect ability of discontinuities are the magnetizing current, the direction and density of the magnetic flux, the method of magnetization, and the material properties of the weldment to be tested. Either alternating (ac) or direct (dc) current may be used to generate a magnetic field. Magnetic fields produced by dc are far more penetrating than those produced by ac. This means dc will detect discontinuities deeper in the test material.

Magnetism is a physical phenomenon exhibited by ferromagnetic materials such as lodestone and magnets, and is inseparably associated with moving electricity. Typical examples are (1) the permanent horseshoe magnet that attracts a nail, (2) the electric coil of an electromagnet which attracts steel plate, and (3) the magnetic field around a welding cable which attracts steel grinding dust.

The magnetic field is visualized in terms of magnetic lines of force. The bar magnet with its north-south poles exhibits these lines (see Fig. 1-1)

MAGNETIC FIELD CHARACTERISTICS

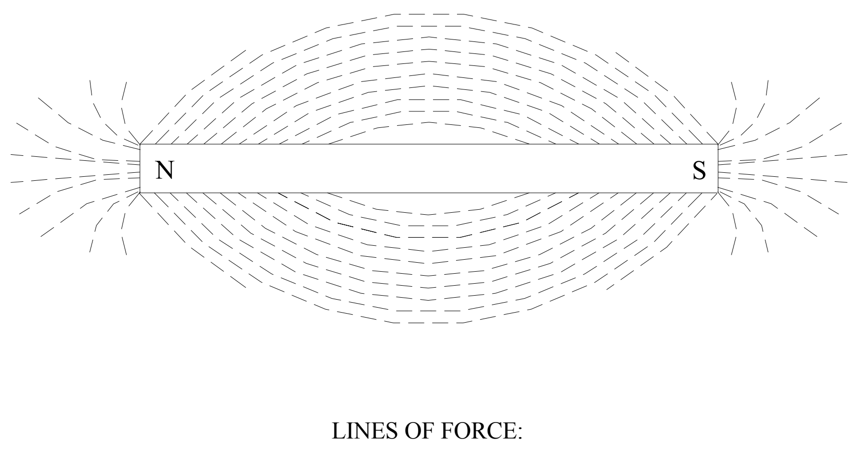

Fig 1-1

The term "magnetic flux" is used to mean the same thing as lines of force. If iron particles (a ferromagnetic powder) are sprinkled over a glass plate or sheet of paper above a magnet as in Fig. 1-1, the particles will collect along the flux lines as shown. Within the magnetic piece itself, the lines are intensely concentrated. However, if there is a crack in the surface, there will be a distortion of the magnetic field there and an accumulation of particles at that crack site, as sketched in Fig. 1-2. Field distortion or leakage occurs at a crack or other discontinuity in a part being inspected. The difficulties arise in magnetizing the part.

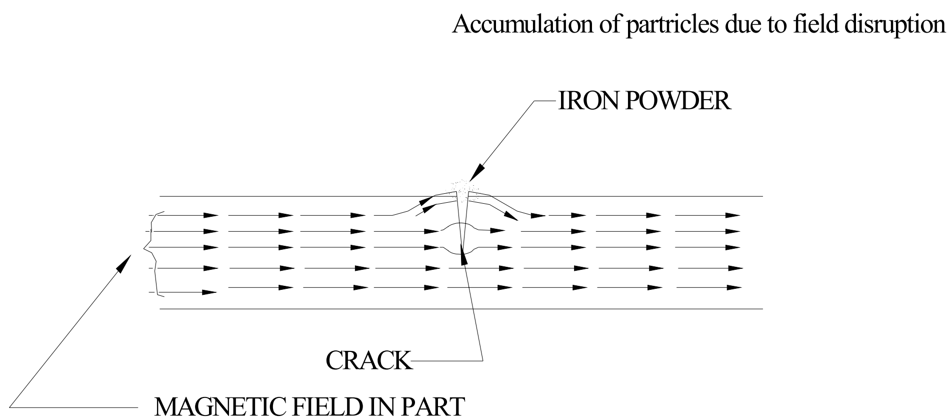

Figure 1-2. Principle of indication

A permanent magnetic yoke (special horseshoe magnet) or an electric magnetic yoke can be used to produce the lines of force. The lines of force travel between the poles through the ferromagnetic part. A discontinuity in the part aligned across the flux field will produce an indication (see Fig. 1-3).

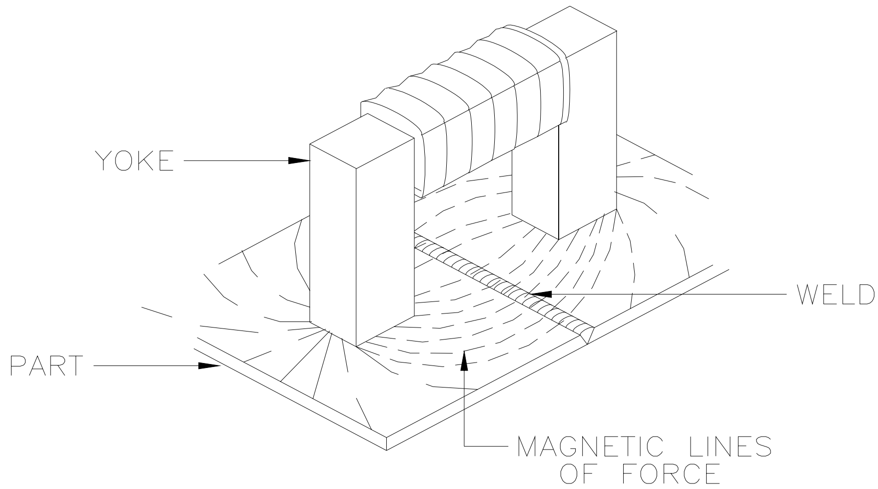

Figure 1-3.

The part may also be magnetized using an electric current. If a ferromagnetic part such as a bend specimen is placed in a coil of wire that has direct current flowing through it, the part will be magnetized with a north pole on one end and a south pole on the other end. The lines of force travel through the part from pole to pole. When magnetic particles are dusted over the part, any transverse discontinuities that run across the lines of force and so disrupt them create a pile-up of particles, thus revealing their presence. This is referred to as longitudinal or length-wise magnetization to produce a north and south pole in the part. Defects that run lengthwise of the piece will not be detected (see Fig. 1-4).

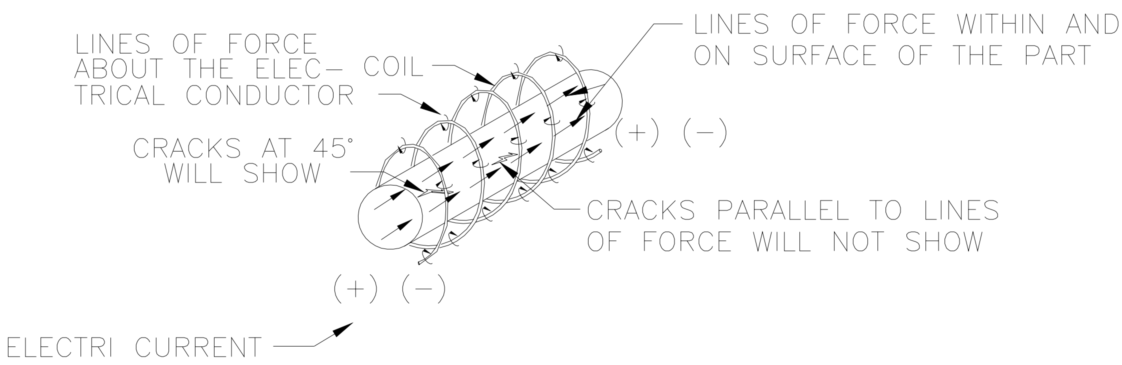

Figure 1-4 Longitudinal magnetism

On the other hand, if the electric current is passed directly through the part, the lines of force travel around the part. This is referred to as circular magnetization and reveals cracks or discontinuities that are lengthwise of the part (see Fig. 1-5). No north or south pole created.

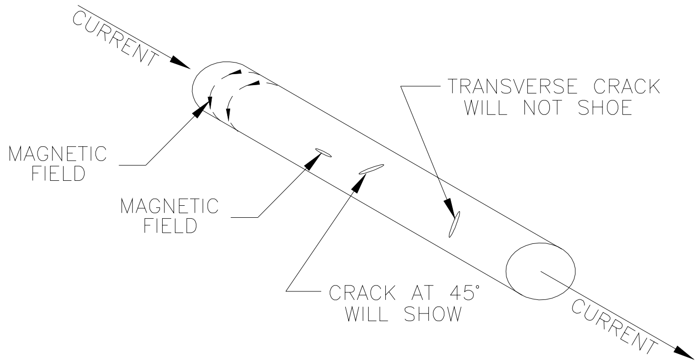

Figure 1-5. Circular magnetism

To detect both longitudinal and transverse cracks, it may be necessary to use both longitudinal and circular methods of magnetization. This means that the part would be magnetized in one manner and inspected, and then magnetized in the other manner and inspected.

Once the part is magnetized, the iron particles are applied. This can be done by dusting with dry particles or by a liquid bath with particles in suspension.

As a modification of this process, prods can be used to magnetize the part. This is done by pushing the prods tightly against the part, then turning on the current. The electric current flows from one prod to the other producing a flow of current causing a magnetic field. Discontinuities that run perpendicular or across the lines of force give the best indications. Normally, the prods should not be located more than 6 inches apart (see Fig. 1-6).

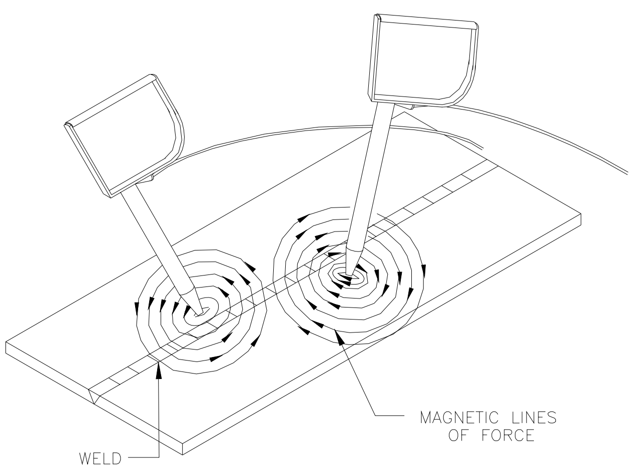

Figure 1-6

Advantages

1. Compared to examination of liquid penetrant testing, MT will reveal discontinuities that are not open to the surface. Cracks filled with carbon, slag, or other contaminants are not detectable by liquid penetrant inspection, but can be detected with MT.
2. Magnetic particle inspection is generally faster and more economical than liquid penetrant inspection.
3. Less cleaning is required.

Disadvantages

1. MT inspection applies only to ferromagnetic materials in which the deposited weld metal is also ferromagnetic. It cannot inspect non-ferromagnetic material such as aluminum, magnesium, or the austenitic steels.
2. Difficulties may arise when inspecting weldments where the magnetic characteristics of the deposited weld metal differ appreciably from those of the base metal or where the magnetic field is not properly oriented. Sound joints between metals of dissimilar magnetic characteristics may create misleading magnetic particle indications.
3. Handling the test equipment in the field may be time consuming and expensive.
4. MT is not reliable for finding deep-seated discontinuities. Deep-seated discontinuities are discovered by other inspection methods such as radiography and ultrasonic; you should use those methods, plus sectioning of a test sample, to qualify the magnetic particle procedure if it is to be depended upon for subsurface inspection.
5. Major crack dimensions must be on the order of 0.5 mm.
6. Surface roughness may distort the magnetic field.

Inspector magnetizes weld with cross yoke, inducing magnetic fields in two directions. Magnetic particles reveal transverse and longitudinal discontinuities.

Know your welding NDT - Magnetic Particle Testing

Magnetize a weldment, then dust it with magnetic particles to reveal surface and near-surface defects

Developed to locate defects in ferromagnetic metals and alloys, irons and steels except for austenitic types, magnetic particle testing (MT) requires three steps:

1. Magnetize the part.
2. Apply fine soft-iron particles to the surface of the workpiece.
3. Examine the surface for accumulations of particles which outline discontinuities.

Weld inspectors use much MT, especially for stress-bearing welds in bridges, buildings, offshore rigs, and other code-controlled structures. Because MT is a convenient, inexpensive way to find surface defects, fabricators often use it to pinpoint substandard joints during construction. Example: MT via hand-held yokes verifies crack-removing adequacy of air-carbon arc gouging when preparing the second side of a joint or making repairs.

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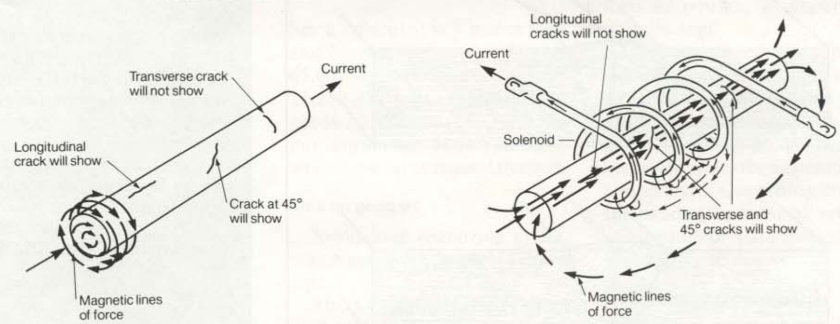
PRINCIPLES OF MAGNETIC PARTICLE TESTING



To magnetize a part, the technician runs current, ac or dc, through the part (left) or a coil (right). The current induces in the part magnetic lines of force that run at right angles to current flow. Surface and near-surface discontinuities interrupt the lines of force, producing flux leakages at the surface that attract magnetic particles to outline discontinuity shapes. Circular lines of force detect longitudinal discontinuities (left); longitudinal lines of force detect transverse discontinuities.

How MT works

To reveal a defect, the magnetic field must run through the part so that the defect cuts across the lines of magnetic force. Doing so, force lines leak out of the surface, creating a field that attracts iron particles.

To locate longitudinal defects in a bar, the inspector magnetizes it by running electric current, either dc or ac, through the bar to create circular lines of force at right angles to the bar axis. He finds transverse defects by running current through a coil that surrounds the bar so that the circular current creates longitudinal lines of force.

To locate defects running at different angles, as often happens in weldments, the inspector runs current in more than one direction. The usual procedure is to run currents at right angles, to cover all orientations. Each succeeding magnetization cancels out the effect of the preceding one.

Magnetizing a part

The inspector magnetizes a testpiece by one of two methods, continuous or residual. For continuous magnetization, he keeps the current running while he applies the particles; this method satisfies for testing low-retentivity alloys such as low-carbon steels. The residual method, applying particles after turning the current off, works best for high-retentivity alloys—usually the harder the steel, the higher the retentivity.

The inspector selects dc or ac according to the defects he seeks. Looking for subsurface defects, he will use dc, which penetrates the part. Alternating current gives a skin effect, which limits it to location of surface defects.

Whether he uses ac or dc, the inspector usually works from 60 Hz line current. Portable generators may serve in the field. Permanent magnets can be used for MT, but fields are usually too weak to locate subsurface welding defects.

When using single-phase ac, the inspector has a further option for dc: half-wave or full-wave rectification. Used for inspection with prods and dry particles, single-phase half-wave dc gives maximum sensitivity to subsurface discontinuities, because the pulsations of each half wave agitate the magnetic particles, as does ac. Single-phase and three-phase full-wave rectified ac give smooth dc outputs, virtually without pulsation. Transformers step down line voltage to low values, keeping sparking at contact points to a minimum while magnetizing the part at high amperages.

The inspector chooses the particle application method according to the situation. Large parts, such as weldments and forgings, generally call for dry-particle inspection, for convenience. Wet particle inspection, which often requires a tank with stirring and pumping equipment, works well for production-line inspection, where the operator examines many small components of similar dimensions.

Choosing equipment

AWS D1.1, *Structural Welding Code—Steel,* permits wet and dry MT inspection, conducted as spelled out in ASTM E709-80, *Standard Recommended Prac-*

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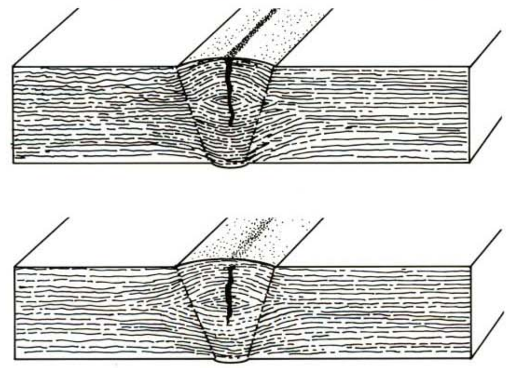

Surface cracks give sharp powder patterns that cling tightly and build up heavily; the deeper the crack, the heavier the powder buildup. Subsurface cracks produce broad, fuzzy patterns; powder adheres loosely.

tice for Magnetic Particle Examination. For dry MT examination, weld inspectors can use portable power supplies small enough to carry in a pickup truck. Operated from a 120-volt electrical outlet, they generate as much as 700 amps, ac or dc. To examine large weldments, operators use generators with outputs to 20,000 amps; these deliver dc or half-wave ac.

Suppliers of NDT equipment, such as Magnaflux Corp. (Chicago) offer MT kits, which include current-carrying prods, yokes, and coils. With the kits come powders in different colors (gray, red, black, and yellow); the operator selects the shade that contrasts most sharply with the surface being examined.

Gray powder works well on dark surfaces, suiting it to most MT jobs on weldments. Yellow powder also gives good contrast on dark surfaces, while black and red powder satisfy for examining lighter surfaces. Black powder contains more iron particles than the others, making it the most sensitive type.

Dusted on magnetized parts by rubber bulbs, squeeze bottles, or air-powered guns, dry powders adapt readily to shop and field inspection with portable equipment. They also withstand temperature extremes, finding application from subzero temperatures to 600 F.

Wet suspensions, made by mixing dry or paste concentrates with oil or water, find use on automatic production-line systems. Black, red, and fluorescent powders stand out on surfaces of tested parts, revealing indications clearly. Fluorescent particles, which glow a bright yellow-green under black (ultraviolet) light, give maximum contrast.

Compared to dry powders, suspensions are more sensitive to fine cracks, because particles are much smaller. Application temperature range is narrower though—low temperatures freeze oil and water suspensions, while high temperatures evaporate water and ignite oil, creating a hazard.

Running a test

Testing large weldments and structures, the technician inspects convenient sections, say 6- to 8-inch lengths of a long weld. Using prods or yokes, he magnetizes sections in a variety of directions to pick up defects lying at different angles. With each shot of current, he carefully dusts the magnetized area with dry powder, giving it just enough velocity to settle lightly on the surface. Particles float gently to flux leakages that relate to discontinuities without contacting other areas of the surface. Light puffs of air blow away particles that fall on the surface, leaving indications for evaluation.

Labor savers help

The technician can use magnetic leeches, strong permanent

MT AMPERAGES

How much current do you need to magnetize a part for MT? Start with guidelines presented in ASTM E709, *Standard Recommended Practice for Magnetic Particle Examination.*

Using circular magnetization by coils or wraparound cables:

- To locate surface and near-surface discontinuities, use dc, full-wave or half-wave rectified, from 700 to 900 amps per inch for parts to 5 inches in diameter; 500 to 700 A/in. for 5- to 15-inch diameter parts; and 100 to 300 A/in. for parts more than 15 inches in diameter.
- To detect surface discontinuities by ac, use currents approximately 50 percent of those listed for dc examination of parts of the same size.

Using localized magnetization via prods or yokes:

- Use 90 to 110 amperes of magnetization current per inch of prod spacing for stock less than 3/4 inch thick; 100 to 125 A/in. spacing for thicker parts.

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magnets fitted to probes. Leeches cling to the test surface, holding probes in place, so the technician can dust on the powder and examine indications easily.

Built with two pole pieces set 6 to 8 inches apart, yokes adapt to one-man operation. The technician positions the yoke with one hand, applies powder with the other.

MT technicians also inspect with coils, either fabricated to specific diameters, or made up of several turns of heavy cable for magnetizing large weldments. The part being magnetized should be at least three times as long as it is wide, giving a length (L)-to-diameter (D) ratio of 3 or greater. To calculate the ampere-turns (AT) needed to magnetize a part, use this formula:

$$AT = \frac{45{,}000}{L/D}$$

Say a weldment is 8 inches long and 2 inches in diameter. Divide 45,000 by 4 (8/2), and you get 11,250 AT. A five-turn coil then needs 2,250 amps (11,250/5). To cut amperage requirements, wrap more turns around the part.

Tips for good MT

Avoid long energizing cycles, which can overheat parts at prod tips.

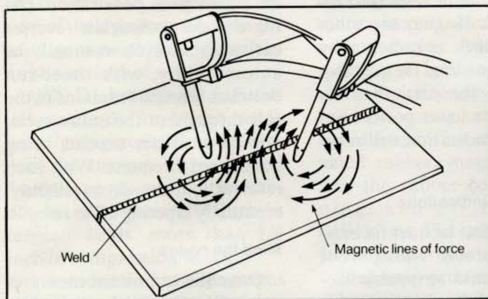
Also keep prod spacing from 3 to 8 inches—less than 3 inches collects particles in circles around prods; more than 8 inches results in low field strengths.

Determine magnetizing strengths of yokes by measuring lifting power—ac yokes should lift at least 10 pounds, dc yokes at least 40 pounds, at maximum pole spacings.

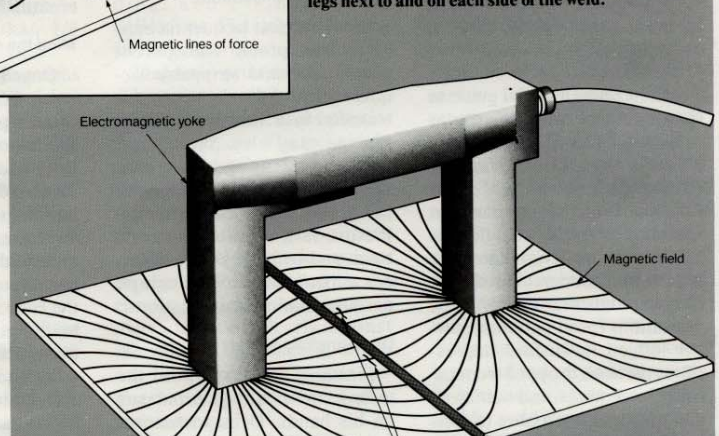
Clean and smooth tips of prods before firing the current, to avoid localized overheating. High magnetizing currents can burn workpieces at contact points, heating them well above the austenitizing temperature. Quenching, by the surrounding base metal, creates small zones of hard martensite, which can start cracks.

Interpreting indications

To interpret MT indications correctly, the inspector needs, besides good eyesight and adequate illumination, a background in NDT technology and fabrication practices. He should know material and production history of the



MT prods, placed 6 to 8 inches apart, examine areas of large weldments, locating longitudinal and transverse discontinuities. Electromagnetic yoke imposes a magnetic field to detect discontinuities parallel to a weld. To find discontinuities across a weld, rotate the yoke about 90 degrees to place yoke legs next to and on each side of the weld.



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part being inspected. Also useful is knowledge about conditions that contribute to metal failure, as well as experience in NDT of parts similar to the one being inspected.

Starting his interpretation, the inspector measures lengths of magnetic particle indications, which duplicate discontinuity sizes. He pays special attention to surface defects, which constitute stress raisers. In tension-bearing joints of bridges and buildings, stress raisers can start cracks.

Cracks open to the surface, typified by weld undercut, build up sharp linear indications—the narrower the crack, the higher the buildup.

Incomplete fusion and **penetration,** subsurface discontinuities, appear as broad lines, straight and continuous or intermittent. Powder clings weakly, owing to the low strength of flux leakage.

Surface **porosity** shows up as rounded and elongated clusters, scattered randomly. Subsurface porosity is nearly impossible to detect by MT.

Inclusions appear as isolated, irregular, or elongated clusters, occurring singly, in lines, or as feathery streaks.

ASTM offers a useful guide to the appearance of MT indications in ASTM E125, *Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings.* It includes photos that show indications of weld discontinuities (porosity, incomplete penetration, undercut, weld inclusions, and crater cracks); false indications (prod patterns, powder lodged in surface depressions, particles dropped from cables, chisel marks, and wrinkles); and magnetic anomalies (adhering scale, magnetic writing, high external magnetic field, junction of different-permeability metals, and powder buildup at sharp corners).

Beware of false marks

Inspectors must watch out for false indications and magnetic anomalies. Particles adhering to sharp corners, ridges, and surface irregularities may indicate excessive magnetization. Constrictions in metal path through which the flux must pass crowd out the flux lines, producing leakages that attract magnetic particles. Magnetic particles sometimes outline grains in large-grained stock, because the boundary and the grain interior have different magnetic properties. Indications reveal junctions between weld metal and base metal for the same reason. Dendritic segregation, carbide segregation, and banding in steel also cause misleading MT indications.

When the inspector suspects a false indication, he resorts to additional tests. He may use other NDT tests, such as radiography or ultrasonic testing. He may also demagnetize the part, then remagnetize at a lower power level to see if the indication will reappear.

Recording MT indications

Sprays of clear lacquer fix indications in place. Transparent plastic tape and strippable lacquers pick up indications for transfer to a notebook. Technicians may also photograph tested parts, using either conventional lighting or black light, for fluorescent indications. Picture-in-a-minute cameras, black-and-white or color, offer a convenient way to photograph parts containing MT indications.

Demagnetizing a part

Finishing his inspection, the technician has a magnetized part on his hands. Demagnetization sometimes becomes necessary when the part is MT-checked before welding or between passes; magnetic fields may deflect the arc, causing arc blow. Residual magnetism also disturbs subsequent machining by attracting chips, which can clog tool bits.

To demagnetize a part, subject it to a continually reversing current that gradually diminishes to zero. Each reversal cancels out the effect of the previous cycle, producing a weaker field, so that magnetization eventually disappears.

Small parts demagnetize readily by passing them through a coil energized by alternating current, usually 60 Hz line current. As the part gets farther and farther from the coil, the induced ac ebbs, reducing the magnetism within the part. Alternatively, the technician places the part within the coil, then gradually reduces the current.

Demagnetize large parts with dc, which gives penetration. Using dc, the technician reverses each current cycle manually or automatically, with timer-run switches. The part remains in the coil throughout the entire cycle, one reversal per second being considered adequate. With each reversal, current drops slightly, eventually tapering off to zero.

Mind the codes

Once the technician measures MT indications and determines their significance, he uses the *Structural Welding Code,* AWS D1.1-83, to evaluate the weld. The code provides rules for buildings, bridges, and tubular structures. Stating that MT technicians shall use procedures and techniques given in ASTM E709, the code stipulates that welds in buildings and bridges must be free of cracks and restricts sizes of other discontinuities.

In buildings, welds containing individual discontinuities 3/32 inch or greater in the large dimension are unacceptable in these instances:

- The greatest dimension is larger than 1/2 of the effective throat, 2/3 the weld size, or 3/4 inch.

- The discontinuity is closer than three times its greatest dimension to a groove weld subject to primary tension stresses.
- A group of such discontinuities is in line such that:

(a) the sum of the greatest dimensions of all such discontinuities is larger than the effective throat or weld size in any length of six times the effective throat or weld size. (For shorter welds, the permissible sum of dimensions reduces proportionally.)

(b) the space between two adjacent discontinuities is less than three time the greatest dimension of the larger of the pair of discontinuities being considered.

The code rejects building welds having discontinuities that are smaller than 3/32 inch if the sum of their greatest dimensions adds up to more than 3/8 inch in any linear inch of weld.

AWS D1.1 spells out individual standards for bridge welds undergoing tensile and compressive stresses. Porosity and fusion-type discontinuities cannot be more than 1/16 inch in tension welds, more than 1/8 inch in compression welds.

The code also provides graphs showing weld quality requirements for discontinuities in tension and compression bridge welds, as tested by MT and radiography. Using them, the technician measures the discontinuities, then uses the graphs to determine weld acceptability.

What's new in MT?

Technicians have lamented the lack of an accurate way to measure field strength on a part surface, necessary to assure that enough flux lines exist to produce leakages adequate to reveal defects. To fill this need, Magnaflux engineers have devised a 7-pound magnetization indicator. Model MPL-101, equipped with an eddy-current probe, determines when a part has enough magnetization for MT inspection. It works with ac and dc magzation and on circular and longitudinal fields.

Another Magnaflux item is the portable MT power supply, Model P-70. Built for field use, the 35-pound unit runs off line current, 115 or 230 V, and puts out 750 amps.

Tiede Corporation offers, through its American agent (Transmares Corporation, Carteret, N.J.), hand-operated cross yokes for inspecting welds in large structures. The yokes magnetize in two directions to pick up defects running at different angles.

New MT techniques include these:

Magnetic-rubber inspection uses room-temperature-curing rubber impregnated with magnetic particles. Adapted to inspection of hard-to-get-at areas and complex shapes, the method calls for coating surfaces with a liquid suspension of the impregnated rubber, magnetizing, curing the rubber coating, stripping, and evaluating the indications. The stripped coating serves as a permanent record.

Magnetic printing requires a magnetizing coil (the printer), magnetic particles, and a plastic-coated test piece. The technician sprays the cleaned surface of the part with a coating of white plastic, starts the current, places the printer next to the test surface, and dusts the magnetic particles on the surface. Impelled by the current, particles move to outline discontinuities clearly against the white plastic coating, which can be sprayed with a clear lacquer and stripped for a permanent record.

Magnetic painting employs a slurry of magnetic particles, which the technician brushes on the part surface. Magnetization reveals dark indications sharply against a silver-gray background.

Underwater MT inspection, used for examining ship hulls and offshore structures, requires clean surfaces. Technicians generally use fluorescent particles to reveal defects in black light, magnetizing with ac applied via prods, coils, or yokes.

The Magfoil method, developed by Henrichs & Walther GmbH, a West German firm, simplifies underwater MT by recording discontinuities as the diver-inspector finds them. Flat packets of flexible foil hold magnetic particles and a white carrier solution in separate partitions. At the test site, the diver squeezes the packet to mix particles with the carrier, fits the packet on the surface, and magnetizes the area. After a preset time, usually about 3 minutes, the diver strips off the Magfoil and sends it topside for evaluation.

Multidirectional magnetism promises to speed MT examination of large, complex weldments. As practiced by Newport News Shipbuilding Company, the method requires 6,000 to 20,000 amps dc, applied through contact grips or coils of wraparound cable. During tests, supervised by L.J. O'Bryan of the Newport News (Va.) yard, technicians checked magnetization setups with a field strength indicator to make sure that areas of concern carried the required amount of flux. Trying both dry and wet MT, the yard found that the latter worked best because it covered large areas rapidly and eliminated the extra time needed to blow excess powder from indications.

Magnetic particle testing costs little, and indications are simple to interpret, making it a reliable tool for weld inspection. It complements radiography and ultrasonic testing—MT finds and outlines surface defects, while RT and UT locate and measure interior flaws. ■

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PCC MT HW 1 **Name: _______________**

1. The temperature at which ferromagnetic materials lose their magnetic properties is called:

a. magnetic point
b. Curie point
c. non-magnetic point
d. none of the above

2. From the list below, select the one that is not a magnetic inspection method:

a. magnetic painting
b. magnetic particle inspection
c. magnetic printing
d. no correct answer, all are magnetic inspection methods.

3. At which steps, are discontinuities caused during processing which may be detrimental to the use of the part detected?

a. final inspection
b. in-process inspection
c. receiving inspection
d. none of the preceding

4. If a crack on the surface of a magnetic material is to be found it must:

a. not be filled with foreign material.
b. be of a certain size and shape.
c. cause a magnetic leakage field.
d. all the preceding.

5. What is the group that publishes a guide for employers in establishing qualifications and certifications of personnel required to perform magnetic particle inspection?

a. M.T. Society
b. ASTM
c. U.S. Department of Defense
d. ASNT

6. What is another term for magnetic line of force?

a. flux.
b. lux
c. Mag-na-lines
d. all the preceding

7. A part may be magnetized by which type of magnetic field?

a. circular
b. longitudinal
c. all the preceding
d. none of the preceding

8. The continuous method of magnetic particle inspection is used on what type of material?

a. all materials
b. only aluminum
c. Low-carbon steel
d. only materials with high retentivity

9. Which type of current would you select for subsurface discontinuities?

a. direct current
b. alternating current
c. high frequency
d. any of the preceding

10. Magnetic lines of force flow:

a. from north to south.
b. from south to north.
c. a and b are both correct.
d. only in magnetic material.

PCC MT HW 2 **Name: ______________**

1. Half-wave current, used in magnetization with prods and dry magnetic particles, provide the highest sensitivity for discontinuities that are:

a. open to the surface.
b. parallel to the surface.
c. wholly below the surface
d. intergranular in nature.

2. An electromagnetic yoke usually consists of what type of core material?

a. non-magnetic material
b. soft iron
c. tool steel
d. aluminum

3. What type magnetic field is induced in a part by a magnetizing coil?

a. longitudinal
b. circular
c. field that looks like the coil that produced it
d. a non-leakage field

4. How many amper-turns would be required to produce 70,000 lines per square inch of flux density in a round part, 10 inches long and 2 inches in diameter?

a. 25,000
b. 700,000
c. 45,000
d. 1 6,666

5. If the flux density of the surface of a 3 inch solid non-magnetic current carrying conductor is 100,000 lines per square inch, what would be the value six inches from the conductor?

a. 33,333
b. 600,000
c. 50,000
d. 200,000

6. As in problem 5, if the conductor carrying direct current was a solid ferromagnetic material and not non-magnetic, the flux density would be higher at the surface do to:

a. magnetic cross-fire.
b. the material permeability.
c. current flowing on outer side of bar.
d. magnetic current enhancement.

7. If a central conductor is used to magnetize a hollow cylindrical ferro-magnetic part, where will the flux density be the maximum?

a. surface of conductor
b. center of conductor
c. center of the hollow part
d. inner surface of the hollow part

8. What type of magnetic field is produced using contact prods?

a. circular
b. longitudinal
c. depends on size of part
d. all of the preceding

9. When the induced current method is used for inspecting a part, the magnetizing field is produced by:

a. direct current.
b. the up-side of the down current.
c. current caused to flow in the part by an alternating magnetic field outside of the part.
d. none of the preceding.

10. Permeability can be defined as:

a. H divided by B.
b. the ration of material density to magnetizing force.
c. B divided by H.
d. U times L over D ratio.

PCC MT QUIZ 1 **Name: ____________**

1. Ferromagnetic material is:

a. strongly attracted by a magnet.
b. capable of being magnetized.
c. both a. and b.
d. not capable of being magnetized

2. The permeability of a material describes:

a. the ease with which it can be magnetized.
b. the depth of the magnetic field in the part.
c. the length of time required to demagnetize it.
d. the ability to retain the magnetic field.

3. Why are magnetic particles available in different colors?

a. For color contrast with the part surface.
b. To enhance the detection of indications.
c. For both a. and b.
d. Different colors are used with different magnetic flux values.

4. Which of the following can be magnetized?

a. Iron
b. Nickel
c. Cobalt
d. All of the preceding

5. Which statement is true when related to magnetic lines of force?

a. They never cross.
b. They are most dense at the poles of a magnet.
c. They seek the path of least resistance.
d. All of the preceding.

6. The magnitude of the residual magnetic field in a specimen is dependent on:

a. the l/d ratio (length to diameter).
b. the strength of the applied magnetizing force.
c. the right hand rule.
d. the left hand rule.

7. A circular field may be induced into a specimen by which of the following methods?

a. Direct induction (head shot)
b. Direct induction (prods)
c. Central conductor
d. All of the preceding

8. An electrical yoke produces:

a. a longitudinal field.
b. a circular field.
c. alternating fields.
d. a swinging field.

9. A magnetic particle build-up from a discontinuity is strongest when the discontinuity is oriented:

a. 180 degrees to the magnetic field.
b. 45 degrees to the magnetic field.
c. 90 degrees to the magnetic field.
d. 90 degrees to the current flow.

10. The flux within and surrounding a magnetized part or around a conductor carrying a current is known as:

a. saturation point.
b. magnetic field.
c. ferromagnetic.
d. paramagnetic.

PCC MT QUIZ 2 **Name: ___________________**

1. Sub-surface discontinuity indications usually appear:

a. sharp and distinct.
b. sharp and wide.
c. wide and fuzzy.
d. high and loosely held.

2. Which residual field is most difficult to demagnetize?

a. Longitudinal
b. Circular
c. Vector
d. Bimodal

3. Which brings out surface indications most clearly?

a. AC
b. DC
c. Pulsed DC
d. DC with surge

4. Inspecting a part by magnetizing, removing the current flow, then applying the medium is called the:

a. continuous method.
b. wet method.
c. residual method.
d. dry method.

5. False indications are caused by magnetic particles being held to the part by which of the following means?

a. Gravity
b. Mechanical
c. Both a. and b.
d. None of the preceding

6. The point at which the magnetism in a material cannot be increased even though the magnetizing force continues to increase is known as the:

a. salient pole.
b. saturation point.
c. residual point.
d. remnant point.

7. The strongest magnetic field in a coil is at the:

a. outside edge.
b. inside edge.
c. center.
d. end.

8. What equipment is used to determine if a part has been demagnetized?

a. A magnet on the part
b. A field meter
c. A survey meter
d. Careful observation for clinging magnetic particles

9. Coercive force:

a. describes the means by which the magnetic particles are suspended in the liquid when using the wet method.
b. describes the magnetizing force used with the continuous method.
c. represents the reverse magnetizing force necessary to remove the residual magnetism in a material.
d. is not a term used in magnetic particle testing.

10. Demagnetization:

a. may be accomplished by heating a material above its Curie Point.
b. is always necessary.
c. can be performed only with AC.
d. can be performed only with DC.

PCC MT QUIZ 3 **Name: _________________**

1. Residual magnetism may be beneficial as an aid:

a. in the deposition of weld metal.
b. in interpretation and evaluation of indications.
c. in demagnetization.
d. All of the above.

2. What type of magnetization uses the formula: Ampere-turns = \45,000\ L/D

a. Circular
b. Longitudinal
c. Parallel
d. Vectored

3. A prime consideration when selecting a powder to be used as a magnetic particle medium is to select a powder that:

a. provides a high contrast to the surface being tested.
b. provides a low contrast to the surface being tested.
c. will adhere to the surface being tested.
d. requires a high demagnetization current to remove it.

4. When testing a bar with an LD ratio of four in a ten-turn coil, the required current would be:

a. 45,000 amperes
b. Unknown; more information is needed.
c. 18,000 amperes
d. 1125 amperes.

5. When adding concentrate to any wet magnetic particle suspension liquid it is common practice:

a. to add powder directly to the suspension liquid.
b. to make a small, slurry-like test mixture of the powder.
c. both of the above.
d. neither of the above.

6. Which of the following can cause non-relevant magnetic particle indications?

a. Joints between dissimilar metals
b. Brazed joints
c. Roughing tool cuts on surface
d. All of the above

7. The accumulation of particles at a site on the part surface, collected at and held to the site by the magnetic leakage field, is called:

a. a discontinuity.
b. a defect.
c. an indication.
d. magnetic writing.

8. Half wave rectified AC (HWDC) is used for detection of:

a. surface defects only.
b. subsurface defects only.
c. surface and subsurface defects.
d. none of the above.

9. Which of the following is a commonly used technique for preserving MT powder patterns?

a. Clear lacquer
b. Transparent tape
c. Photography
d. All of the above

10. Of the following discontinuity categories, which one is considered most detrimental to the service life of an item?

a. Subsurface inclusions
b. Subsurface porosity and voids
c. Cracks open to the surface
d. All of the above

PCC MT QUIZ 4 **Name: ________________**

1. For which of the following would the wet fluorescent technique be preferred over the dry technique?

a. When the parts are large and bulky
b. When increased speed and sensitivity are desired
c. When it is desired to use the fluorescent lighting provided in many plants
d. When the parts being inspected are to be field welded

2. Of the following, which is not a valid reason for demagnetization of parts after magnetic particle testing?

a. If the part is to be radiographed after magnetic particle inspection, residual magnetism may interfere with the electromagnetic radiation spectrum.
b. Residual magnetism may attract chips or small particles in service, causing galling or mechanical wear.
c. Residual magnetism could interfere with the operation or accuracy of instruments placed on or near the part during service.
d. Residual magnetism can disturb the welding arc path on parts to be welded.

3. An important factor that must be considered when selecting a method of magnetization is:

a. location of inspection station
b. alloy, shape, and condition of the part
c. permeability of the part
d. B and C above

4. What happens to a magnetic material when it reaches its Curie temperature?

a. It becomes paramagnetic.
b. It becomes diamagnetic.
c. It becomes nonmagnetic.
d. It becomes radioactive.

5. To examine a part 5" long and 2” in diameter using a 5-turn coil and head-stock magnetic particle machine, what amperage should be used for longitudinal magnetization?

a. 3600 amps
b. 3000 amps
c. 10,000 amp-turns
d. 4500 amps

6. When a magnetic field is created in a part with prods spaced 6 inches apart, the field is a:

a. solenoid field.
b. longitudinal field.
c. distorted circular field.
d. residual field.

7. Which of the following discontinuities occur as a result of the rolling process?

a. Blowholes and pipe
b. Laminations
c. Fissures
d. All of the above

8. Which of the following discontinuities occur as a result of the forging process?

a. Pipe
b. Laps
c. Laminations
d. All of the above

9. If an indication is formed when using the residual method as well as the continuous method, it is most likely:

a. very deep and tight.
b. very shallow and open to the surface.
c. a relevant indication.
d. a non-relevant indication.

10. Banding is a common term used to describe:

a. field strength relative to the poles of a permanent magnet.
b. a method of mounting cylindrical objects on a bench system.
c. the appearance of powder patterns at laminations found in heavy plate material.
d. powder patterns created by using excess amperage.

Magnetic Particle

Answer each of the following questions in the space provided, on the back of the page you are working on or on a separate sheet of paper. The answers should be brief but complete.

1. In a bar magnet, what direction do magnetic lines of force travel?

2. What is a magnetic field?

3. Explain what is meant by the statement "We live in a magnetic field".

4. If we were to cut a bar magnet in half, what would we have?

5. Is it true that magnetically materials are only attracted to north or south poles of a magnet?

6. What creates flux leakage in a part that is magnetized?

7. Would you expect a north and south pole to exist at any and all places where flux leakage occurs?

8. How do flux lines travel in a horseshoe magnet?

9. Do all ferromagnetic materials contain some iron?

10. Are all bar magnets made of ferromagnetic materials?

11. What magnetic material classification are lead and bronze?

12. Are all paramagnetic materials strongly attracted by a magnetic field?

13. Would tool steel have a high or low permeability?

14. Is the following statement true "all permanent magnets are the result of residual magnetism"?

15. What happens to the flux density in a material if the magnetizing force is increased beyond the saturation point?

16. Under what testing or inspection condition is a virgin curve developed?

17. Do strong permanent magnets have high or low retentivity?

18. Why does a material with low permeability require a high coercive force?

19. If we want to make an electromagnet for picking up heavy objects and move them, would we use as the core a material that has a fat or thin hysteresis curve? (Explain your answer)

20. What direction do electrons flow in a circuit and how does this differ from conventional current flow?

21. What is the relationship of the magnetic lines of force and the current that produces them?

22. Why is it more important to know the general direction of a magnetic field in a part than it is to know where the north or south poles are located?

23. Any time electrical current flows through a conductive material what type of magnetic field is established within the material?

24. How does a circular magnetic field differ from a longitudinal magnetic field?

25. What is the correlation between the current flowing in the part, to the crack that will be revealed by the magnetic field that is created by the current flow?

26. Why would a crack that is parallel to a magnetic field not cause a magnetic particle indication?

27. For a ferromagnetic steel bar that is circular magnetized, the flux density will be greatest at what location in the part?

28. What are the two main advantages of using a central conductor to magnetize hollow parts?

29. When using a central conductor, why is it important for the objects being tested to rest on the conductor?

30. How many times would a hollow round part 2” in diameter need to be rotated and inspected if the central conductor is 3/4”in diameter?

31. What is the difference between amount of flux developed by a coil and flux density?

32. What determines the strength of the magnetic field produced in a coil?

33. For longitudinal MT inspection using a coil, where is the magnetic field the strongest?

34. What does effective length of magnetic field in an article mean to us if we are testing a 36" long part that is many times longer than the coil is wide?

35. If the 36" part in the preceding problem were tool steel, how many coil shots would be needed to inspect it?

36. Why would undercut cause an indication?

37. How does the technician apply the magnetic particles to the test surface while conducting the test for wet magnetic particle test?

38. Using a yoke system one would find discontinuities that are oriented in what direction in relation to the current in the yoke's coil?

39. What are the advantages of using alternating current for magnetic particle inspection?

40. Why is DC selected when looking for subsurface discontinuities?

41. What are the advantages of using HWDC for MT inspection?

42. What document contains information about current (amperage) requirements for a particular magnetic particle test?

43. On your first try, would it be best to use a high or low current setting if you are not sure of the current setting? Why

44. If the current requirements for circular magnetization are 1000 amperes per inch of thickness, how much current is required to inspect a rectangular bar 3"x5”?

45. Using a central conductor that is 5/8" in diameter the following three items are to be inspected: 2” sleeve, 1 1/2" nut and 1" do-dad. The test current is 800 amperes per inch. Describe how the test is to be conducted, how many different current settings are to be used, and how many shots (time the current is turned on and a part or portion of the item inspected)?

46. What is the maximum spacing recommended when doing MT using the “Prod Method"?

47. Find the current required to inspect a part that is 22 cm thick when using a prod spacing of 16 cm.

48. Using the proper equation, find the ampere-turns needed for longitudinal magnetization of a part 3/4" in diameter and 10 inches long?

49. If the coil we are using has 6 turns, find the current required to test the part in problem 50.

50. What is meant by the term "liquid vehicle"?

51. Why is it important for magnetic particles to have a thin hysteresis loop?

52. Why would red magnetic particles be selected over black particles for a particular job?

53. How much is 1 ml in good old American units? (not in book)

54. How is a centrifuge tube used to maintain the quality of a test system?

55. To assure the sensitivity of a wet magnetic particle inspections system, which is more important pre-cleaning or post-cleaning and why is this so?

56. Using the "Betz test ring" in a sensitivity test which hole can be found using 600 amperes of direct current?

57. Which current type is most sensitivity to subsurface discontinuities?

58. Why are dry particles more sensitivity when testing for subsurface discontinuities?

59. Discontinuities located at the surface produce what type of indication?

60. List six causes of non-relevant indications?

61. When is it recommended, to demagnetize a part and re-inspect with lower current values?

62. What is the difference between non-relevant indication and false indication?

63. List at least 3 things about MT indication of grinding cracks that make them recognizable from the indications of other cracks?

64. Where do hot tears usually occur in a casting?

65. Under what conditions, can a lamination be detected using magnetic particle inspection?

66. If you had a choice of AC or DC to inspect a part for fatigue cracks, which would you select and why?

67. What is the main difference between the wet and dry continuous methods?

68. What type of materials can be inspected with the residual method?

69. Using circular magnetization why can we not get an indication from a discontinuity that is located at the center of a round test object?

70. Why would using a welding machine to develop the needed current possible cause a problem when using the prod method?

71. Could a part be demagnetized using circular magnetization? Explain answer.

72. Under normal testing procedures if a part had been inspected using circular magnetization and it is important to demag it, what should be the first step after inspecting with the circular field?

73. To demag a part, we must not only reduce the magnetic field but must also do what to the magnetic field?

74. Would it be easier to demagnetize a part that has a thin or fat hysteresis curve?

75. Give an example of how demagnetization works

76. Why is AC not the best choice for demagnetization?

77. If we were demagnetizing a mild steel part, what would be the least number of magnetic reversals used and why?

78. Why are some parts placed in an east-west direction, when demagnetizing them?

79. A part may not need to be demagnetized to zero but residual field strength must be less than what value?

80. What is the main function of a field indicator?

81. Which element of the test procedure requires the operator to make mathematical calculations?

82. We are looking for fine surface cracks and the part has been plated with a nonmagnetic metal to a thickness of .010 cm. What action should we take before testing the part?

83. What is one of the fastest and easiest ways to lift an indication, when using dry magnetic particles?

84. Why are the contact pads on the head stock made of copper braid?

85. What is the recommended minimum black light intensity at the surface of a test object?

86. Why would one select magnetic rubber inspection over other magnetic particle methods?

87. What MT test method works on the principle of inducing eddy currents in the part being inspected?

88. Why would one go to the extra trouble to setup or establish a swinging field in a part?

Magnetic Particle Testing
ASME
Examination Procedure
PCC-MT- 1

TABLE OF CONTENTS

1.0 PURPOSE AND SCOPE

1.1. This procedure establishes the process requirements for Magnetic Particle Examination.

1.2. This procedure will be followed by PCC when Magnetic Particle Examination is to be performed on ferromagnetic materials in accordance with ASME Section V Article 7.

1.3. The frequency of examination will be as required by purchase orders, specifications, drawings, codes, or other data as required by the customer.

2.0 REFERENCES

2.1. ASME Boiler and Pressure Vessel Code, Section V, 1989 edition, 1989 addenda.

3.0 QUALIFICATION OF PERSONNEL

3.1. Personnel performing Magnetic Particle Examination will be certified to at least Level I in accordance with the PCC "Qualification and Certification of Nondestructive Examination Personnel".

3.2. MT Level I, II, and III personnel may perform all operations necessary in accordance with this procedure to process the objects being examined.

3.3. Interpretation and evaluation of magnetic particle examination results will be accomplished by personnel certified as MT Level II or III.

4.0 MAGNETIC PARTICLE EQUIPMENT AND MATERIALS

4.1. The MT Level III will document approval of any equipment or material used as an "equivalent" to that specified in this procedure.

4.2. Equipment for Magnetic Particle Examination will be:

4.2.1. Yoke Type - Parker Research Corporation, Model DA-200, A.C./D.C. Contour Probe; Magnaflux Corporation, Models Y-5,Y-6,or Y-7 A.C./D.C. Yokes or equivalent.

4.2.2. Portable Unit - Magnaflux Corporation, Model P910, 1000 Amp. A.C./D.C.; Econospect Corporation, Model M-27D, 1000 Amp. A.C./D.C.; Econospect Corporation, Model M-27, 1000 Amp. D.C., or equivalent.

4.2.3. Black light - Spectronics Corporation, Model BIB-120A; Magnaflux Corporation, Model ZB-26; or equivalent. 4.2.4. Black light meter - Magnaflux Corporation Model DM 365X or equivalent.

4.3. Ferromagnetic particles will be:

4.3.1. Dry visible powder - Magnaflux Corporation, 8A Red, 1 Gray, or equivalent.

4.3.2. Wet fluorescent - Magnaflux Corporation, 14AM premix suspension in a distillate carrier in spray cans or equivalent.

4.4. Calibration of Equipment

4.4.1. Frequency. Each piece of magnetizing equipment with an ammeter will be calibrated at least once a year, or whenever the equipment has been subjected to major electric repair, periodic overhaul, or damage. If equipment has not been in use for a year or more, calibration must be done prior to first use.

4.4.2. Procedure. The accuracy of the unit's meter will be verified by test equipment traceable to the National Bureau of Standards. Comparative readings will be taken for at least three different current output levels encompassing the usable range. (Not required in an educational unit)

4.4.3. Tolerance. The unit's meter reading will not deviate by more than + 10% of full scale, relative to the actual current value as shown by the test meter.

NOTE: When measuring half-wave rectified current with a direct current meter, readings will be multiplied by 2.

4.5. Lifting Power of Yokes

4.5.1. The magnetizing force of yokes will be checked at least once a year, or whenever a yoke has been damaged. If a yoke has not been in use for a year or more, a check must be done prior to first use.

4.5.2. Each alternating current electromagnetic yoke must have a lifting power of at least 10 lb. (4.5kg) at the maximum pole spacing that will be used.

4.5.3. Each direct current or permanent magnetic yoke must have a lifting power of at least 40 lb. (18.1kg) at the maximum pole spacing that will be used.

4.5.4 Each weight will be weighed with a scale from a reputable manufacturer and stenciled with the applicable nominal weight prior to first use. A weight need only be verified again if damaged in a manner that could have caused potential loss of material.

5.0. PREPARATION FOR EXAMINATION

5.1. Satisfactory results are usually obtained when the surfaces are in the as-welded, as-rolled, as- cast, or as-forged conditions.

5.2. Prior to magnetic particle examination, the surface to be examined and all adjacent areas within at least 1 in. will be dry and free of all dirt, grease, lint, scale, welding flux and spatter, oil, or other extraneous matter that could interfere with the examination.

5.3. Cleaning may be accomplished using detergents, organic solvents, descaling solutions, paint remover, vapor degreasing, sand or grit blasting, or ultrasonic cleaning methods.

5.4. Dry powder magnetic particle examination will not be performed if the surface temperature of the part exceeds 600º F.

5.5. Wet particle suspension and the surface of the part will not exceed 135ºF.

6.0 METHOD OF EXAMINATION

6.1. Examination will be done by the continuous method; that is, the magnetizing current remains on while the ferromagnetic particles are being applied and while excess ferromagnetic particles are removed.

6.2. If dry particles are used, the color of the particles (dry visible powder) will be selected to provide adequate contrast with the surface being examined.

6.2.1. White light at the surface of the part being examined will be adequate to distinguish the contrast between the magnetic particles and the part.

6.3. If wet fluorescent particles are used, the examination will be performed using a black light. The examination will be performed as follows:

6.3.1. The NDE examiner will allow a minimum of 5 minutes for black light warm-up (upon initial start-up) before use in examination.

6.3.2. The NDE examiner will maintain a distance between the black light and the part being examined of no greater than 15".

1) The black light will have a minimum intensity of 800 microwatts/cm2 at 15".

2) The black light intensity will be checked:

(a) Every eight hours; or

(b) Whenever the work area is changed.

3) A Black Light Meter, which is calibrated annually, will be used to perform the black light intensity check.

6.3.3. The examination will be performed in a darkened area.

1) Examiners working in darkened areas will allow 5 minutes for dark adaptation each time the darkened area is entered from white light or each time the examiner looks into the direct beam of the black light.

6.3.4. During inspection, personnel will not wear eye glasses which change color in sunlight.

7.0 EXAMINATION COVERAGE

7.1. All examinations will be conducted with sufficient overlap to assure 100% coverage of the part or area of the part requiring examination.

7.2. At least two separate examinations will be performed on each area.

7.2.1. During the second examination, the lines of magnetic flux will be approximately perpendicular to those used during the first examination.

7.2.2. A different technique for magnetization may be used for the second examination.

8.0 MAGNETIZING CURRENT

8.1. When allowed, alternating current may be used when the detection of open to the surface discontinuities is the only concern.

8.2. Direct current will be used for the detection of open to the surface and subsurface discontinuities.

8.2.1. Whenever direct current is required rectified current may be used.

1) The rectified current for magnetization will be single phase (half-wave rectified) current.

9.0 MAGNETIZING FIELD ADEQUACY

9.1. When required by this procedure, the adequacy or direction of the magnetizing field will be verified with the Magnetic Particle Field Indicator described in ASME Section V Article 7.

9.1.1. The indicator will be positioned on the surface to be examined.

1) When using the indicator, a suitable flux or field strength is indicated when a clearly defined line of magnetic particles forms across the copper face of the indicator when the magnetic particles are applied simultaneously with the magnetizing force.

2) When a clearly defined line of particles is not formed, or is not formed in the desired direction, the magnetizing technique will be changed or adjusted.

10.0 MAGNETIZATION TECHNIQUES

10.1. Prod Technique

10.1.1. Magnetization is accomplished by portable prod type electrical contacts pressed against the surface in the area to be examined.

1) To avoid arcing, a remote control switch will be provided to permit the current to be turned on after the prod have been properly position and turned off prior to removing the prods from the part surface.

10.1.2. Direct or rectified magnetizing current will be used.

1) The current will be 100 to 125 amp/in. of prod spacing of sections 3/4 in. thick or greater.

2) For sections less than 3/4 in. thick, the current will be 90 to 110 amp/in. of prod spacing.

10.1.3. Prod spacing will not exceed 8 in. and not be less than 3 in.

10.1.4. The prod tips will be kept clean and dressed.

10.1.5. The open circuit voltage of the magnetizing current source will not be greater than 25 V.

10.2. Yoke Technique

10.2.1. This method will only be applied to detect discontinuities that are open to the surface of the part.

10.2.2. Alternating or direct current electromagnetic yokes will be used.

NOTE: Except for materials 1/4 in. or less in thickness, alternating current yokes are superior to direct current magnet yokes of equal lifting power for the detection of surface discontinuities.

11.0 EVALUATION OF INDICATIONS

11.1. Discontinuities on or near the surface are indicated by retention of the examination medium.

11.2. Localized surface irregularities due to machining marks or other surface conditions may produce nonrelevant indications.

11.2.1. Any indication which is believed to be nonrelevant must be reexamined to verify whether or not actual defects are present.

1) Surface conditioning may precede the reexamination.

11.3. Broad areas of particle accumulation that might mask indications from discontinuities are prohibited, and such areas will be cleaned and reexamined.

11.4. Relevant indications are indications that result from mechanical discontinuities.

11.4.1. Linear indications are indications in which the length is more than three times the width.

11.4.2. Rounded indications are indications which are circular or elliptical with the length less than three times the width.

11.4.3. An indication of a discontinuity may be larger than the discontinuity that causes it; however, the size of the indication and not the size of the discontinuity is the basis of acceptance or rejection.

11.5. All indications will be evaluated in terms of the appropriate acceptance standards (paragraph 14.0).

11.6. A Magnetic particle Examination Report will be used to record examination results.

11.6.1. The customer will be provided with a copy of this report which will include as a minimum:

1) customer name, contract or job number, and report date;

2) signature and certification level of magnetic particle examiner;

3) vessel, tank, part, or weld number;

4) extent of examination;

5) magnetization technique used (i.e., yoke);

6) equipment used;

7) type of ferromagnetic particles used (manufacturer, color, wet or dry, etc.);

8) magnetization current (type and amperage);

9) when required, demagnetization;

10) interpretation of each magnetic particle indication, noting relevant and significant non-relevant indications;

11) evaluation of each relevant magnetic particle indication noting acceptance or rejection;

12) reference to this procedure and the appropriate acceptance standards.

12.0 DEMAGNETIZATION

12.1. The part will be demagnetized after completion of the examination when residual magnetism in the part could interfere with subsequent processing or usage.

12.2. The effectiveness of the demagnetizing operation can be indicated by the use of appropriate magnetic field indicators or field strength meters as required by purchase orders, specifications, drawings, codes, or other data as required by the customer.

13.0 POST INSPECTION CLEANING

13.1. Post-test cleaning is necessary where magnetic particle materials could interfere with subsequent processing or with service requirements. The customer will specify when post-cleaning is needed and the extent required.

13.2. Typical post-cleaning techniques employed are:

13.2.1. the use of compressed air to blow off unwanted dry magnetic particles;

13.2.2. drying of wet particles and subsequent removal by brushing or compressed air;

13.2.3. removal of wet particles by flushing with solvent.

13.2.4. Other suitable post-test cleaning techniques may be used if they will not interfere with subsequent requirements.

14.0 ACCEPTANCE STANDARDS

14.1. The acceptance standards will be as stated in the referencing code.

14.1.1. The edition of the code used for acceptance will be the latest issue in affect at the time of the evaluation of the magnetic particle results or the edition specified by the customer.

14.2. When performing magnetic particle evaluations, the MT Level II or III will have available for reference during evaluation a copy of the acceptance standards from the referencing code.

CERTIFIED
REPORT OF NONDESTRUCTIVE TESTING
Confidence Through Inspection

CUSTOMER			DATE
ADDRESS			REPORT NO.
JOB OR PROJECT	P.O. NO.		PLAN OR DWG. NO.

SURFACE CONDITION	HEAT NO	HEAT TREAT BEFORE ☐ AFTER ☐	TYPE OF MATERIAL	TEMP. OF MAT'L.

TYPE OF EXAMINATION UT☐ MT☐ PT☐ EC☐ VT☐ LT☐ OTHER ______	EXAMINATION STANDARD	ACCEPTANCE STANDARD	N.D.E. PROCEDURE NO.

ULTRASONIC EXAMINATION

EQUIPMENT	TRANSDUCER	TEST BLOCK	METHOD USED	SCANNING METHOD	SENSITIVITY LEVEL

MAGNETIC PARTICLE EXAMINATION

EQUIPMENT	DRY ☐ WET ☐	VISIBLE ☐ FLOURESCENT ☐	AC ☐ DC ☐ RECTIFIED ☐	AMPERAGE	PROD. SPACING ______ IN HEAD ☐ COIL ☐	PARTICLES – COLOR

LIQUID PENETRANT EXAMINATION

VISIBLE ☐ FLUORESCENT ☐	PENETRANT			CLEANER		EMULSIFIER			DEVELOPER			
	BRAND NO.	BATCH NO.	DWELL TIME	BRAND NO.	BATCH NO.	BRAND NO.	BATCH NO.	EMULS. TIME	BRAND NO.	BATCH NO.	DEV. TIME	DRY ☐ WET ☐ AQUEOUS ☐

EDDY CURRENT EXAMINATION

EQUIPMENT	PROBE SURFACE ☐ BOLT HOLE ☐ ENCIRCLE ☐	PHASES AUTO MAN	GATE AUTO MAN	BALANCE AUTO MAN	LIFT OFF AUTO MAN	TEST FREQ.	SCAN METHOD %	SENSITIVITY LEVEL

PART NO.	TOTAL LENGTH EXAMINED FEET	INCHES	TYPE OF WORK NEW ☐ REPAIR ☐	NO. OF ITEMS ACCEPTED	NO. OF ITEMS REJECTED

WELD. PC NO OR SN	ACCEPT	REJECT	DEFECT CODE	REMARKS	WELD PC NO OR SN	ACCEPT	REJECT	DEFECT CODE	REMARKS

DEFECT CODE
C — Crack **P — Porosity** **NF — Non-Fusion** **LI — Linear Indication** **S — Slag** **LA—Lamination** **OTHER—Specif**

______ IN ______ A.M. OUT ______ A.M. Technician ______ SNT-TC-1A Level ______

______ ______ P.M. ______ P.M. Asst. Technician ______ SNT-TC-1A Level ______

______ Total Hours at Jobsite Inspector ______ Cert. # ______

______ Lunch ______ Standby ______ Travel Customer ______

______ Total Hours ______ Total Mileage Witnessed by ______

Signature

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PCC **Name: ____________________**

MAGNETIC PARTICLE TESTING

LAB 1

OBJECT:

To familiarize the student, with the procedures and application of Magnetic Particle inspection using the information and data learned in class. (Visible, Particles) will be used.

PROCDURES:

1. The instructor will provide a number of samples to be inspected. The student must decide the best way to test the part.

2. Students may work in groups of two or as individuals.

3. At least one defect must be located for each lab. May require inspecting more than one sample.

4. Each student must write up a complete report that containing lab 1. Use provided form Student should use one of the discussed methods to preserve indications.

5. Each student should be able to use any and all equipment as discussed or demonstrated in class.

PCC **Name: ________________**
MAGNETIC PARTICLE TESTING
LAB 2

OBJECT:

To familiarize the student, with the procedures and application of Magnetic Particle inspection using the information and data learned in class (Aerosol Suspended Florescent, Particles) will be used.

PROCDURES:

1. The instructor will provide a number of samples to be inspected. The student must decide the best way to test the part.

2. Students may work in groups of two or as individuals.

3. At least one defect must be located for each lab. May require inspecting more than one sample.

4. Each student must write up a complete report that containing lab 2. Use provided form Student should use one of the discussed methods to preserve indications.

5. Each student should be able to use any and all equipment as discussed or demonstrated in class.

PCC **Name: ________________**
MAGNETIC PARTICLE TESTING
LAB 3

OBJECT:

To familiarize the student, with the procedures and application of Magnetic Particle inspection using the information and data learned in Class (Wet Bath Florescent, Particles)will be used.

PROCDURES:

1. The instructor will provide a number of samples to be inspected. The student must decide the best way to test the part.

2. Students may work in groups of two or as individuals.

3. At least one defect must be located for each lab. May require inspecting more than one sample.

4. Each student must write up a complete report that containing lab 3. Use provided form Student should use one of the discussed methods to preserve indications.

5. Each student should be able to use any and all equipment as discussed or demonstrated in class.