

Recommended Practice No.

SNT-TC-1A

1996

Second Edition



**The American Society for
Nondestructive Testing, Inc.**

Magnetic Particle Testing Method

(MT – Training Course Outline – TC-2)

Recommended Hours of Instruction

	A*	B*
Level I	12	8
Level II	8	4

***A** High school graduate or equivalent

***B** Completion with passing grades of at least two years of engineering or science study at a university, college, or technical school.

This is a progressive training course; i.e., consideration as Level I is based on satisfactory completion of the Level I training course; consideration as Level II is based on satisfactory completion of both Level I and Level II training courses.

Topics in the training outline may be deleted or expanded to meet the employer's specific applications or for limited certification and may be accompanied by a corresponding change in training hours.

Recommended Training for Level I Magnetic Particle Testing

1. Principles of Magnets and Magnetic Fields

- a. Theory of magnetic fields
 - (1) Earth's magnetic field
 - (2) Magnetic fields around magnetized materials
- b. Theory of magnetism
 - (1) Magnetic poles
 - (2) Law of magnetism
 - (3) Materials influenced by magnetic fields
 - (a) Ferromagnetic
 - (b) Paramagnetic
 - (4) Magnetic characteristics of nonferrous materials
- c. Terminology associated with magnetic particle testing

2. Characteristics of Magnetic Fields

- a. Bar magnet
- b. Ring magnet

3. Effect of Discontinuities of Materials

- a. Surface cracks
- b. Scratches
- c. Subsurface defects

4. Magnetization by Means of Electric Current

- a. Circular field
 - (1) Field around a straight conductor
 - (2) Right-hand rule
 - (3) Field in parts through which current flows
 - (a) Long, solid, cylindrical, regular parts
 - (b) Irregularly-shaped parts
 - (c) Tubular parts
 - (d) Parts containing machined holes, slots, etc.
 - (4) Methods of inducing current flow in parts
 - (a) Contact plates
 - (b) Prods
 - (5) Discontinuities commonly discovered by circular fields
- b. Longitudinal field
 - (1) Field produced by current flow in a coil
 - (2) Field direction in a current-carrying coil
 - (3) Field strength in a current-carrying coil
 - (4) Discontinuities commonly discovered by longitudinal fields
 - (5) Advantages of longitudinal magnetization
 - (6) Disadvantages of longitudinal magnetization

5. Selecting the Proper Method of Magnetization

- a. Alloy, shape, and condition of part
- b. Type of magnetizing current
- c. Direction of magnetic field
- d. Sequence of operations
- e. Value of flux density

6. Inspection Materials

- a. Wet particles
- b. Dry particles

7. Principles of Demagnetization

- a. Residual magnetism
- b. Reasons for requiring demagnetization
- c. Longitudinal and circular residual fields
- d. Basic principles of demagnetization
- e. Retentivity and coercive force
- f. Methods of demagnetization

8. Magnetic Particle Testing Equipment

- a. Equipment-selection considerations
 - (1) Type of magnetizing current
 - (2) Location and nature of test
 - (3) Test materials used
 - (4) Purpose of test
 - (5) Area inspected
- b. Manual inspection equipment
- c. Medium- and heavy-duty equipment
- d. Stationary equipment
- e. Mechanized inspection equipment
 - (1) Semiautomatic inspection equipment
 - (2) Single-purpose semiautomatic equipment
 - (3) Multipurpose semiautomatic equipment
 - (4) Fully automatic equipment

9. Types of Discontinuities Detected by Magnetic Particle Testing

- a. Inclusions
- b. Blowholes
- c. Porosity
- d. Flakes
- e. Cracks
- f. Pipes
- g. Laminations
- h. Laps
- i. Forging bursts
- j. Voids

10. Magnetic Particle Test Indications and Interpretations

- a. Indications of nonmetallic inclusions
- b. Indications of surface seams
- c. Indications of cracks
- d. Indications of laminations
- e. Indications of laps
- f. Indications of bursts and flakes

- g. Indications of porosity
- h. Nonrelevant indications

Total recommended hours of instruction for this course:

Classification A - 12 hours

Classification B - 8 hours

Recommended Training for Level II Magnetic Particle Testing

1. Principles

- a. Theory
 - (1) Flux patterns
 - (2) Frequency and voltage factors
 - (3) Current calculations
 - (4) Surface flux strength
 - (5) Subsurface effects
- b. Magnets and magnetism
 - (1) Distance factors vs. strength of flux
 - (2) Internal and external flux patterns
 - (3) Phenomenon action at the discontinuity
 - (4) Heat effects on magnetism
 - (5) Material hardness vs. magnetic retention

- (4) Contact prods and yokes
 - (a) Requirements for prods and yokes
 - (b) Current-carrying capabilities
- (5) Discontinuities commonly detected
- b. Longitudinal technique
 - (1) Principles of induced flux fields
 - (2) Geometry of part to be inspected
 - (3) Shapes and sizes of coils
 - (4) Use of coils and cables
 - (a) Strength of field
 - (b) Current directional flow vs. flux field
 - (c) Shapes, sizes, and current capacities
 - (5) Current calculations
 - (a) Formulas
 - (b) Types of current required
 - (c) Current demand
 - (6) Discontinuities commonly detected

2. Flux Fields

- a. Direct current
 - (1) Depth of penetration factors
 - (2) Source of current
- b. Direct pulsating current
 - (1) Similarity to direct current
 - (2) Advantages
 - (3) Typical fields
- c. Alternating current
 - (1) Cyclic effects
 - (2) Surface strength characteristics
 - (3) Safety precautions
 - (4) Voltage and current factors
 - (5) Source of current

5. Selecting the Proper Method of Magnetization

- a. Alloy, shape, and condition of part
- b. Type of magnetizing current
- c. Direction of magnetic field
- d. Sequence of operations
- e. Value of flux density

6. Demagnetization Procedures

- a. Need for demagnetization of parts
- b. Current, frequency, and field orientation
- c. Heat factors and precautions
- d. Need for collapsing flux fields

3. Effects of Discontinuities on Materials

- a. Design factors
 - (1) Mechanical properties
 - (2) Part use
- b. Relationship to load-carrying ability

7. Equipment

4. Magnetization by Means of Electric Current

- a. Circular techniques
 - (1) Current calculations
 - (2) Depth-factor considerations
 - (3) Precautions - safety and overheating

- a. Portable type
 - (1) Reason for portable equipment
 - (2) Capabilities of portable equipment
 - (3) Similarity to stationary equipment
- b. Stationary type
 - (1) Capability of handling large and heavy parts
 - (2) Flexibility in use

- (3) Need for stationary equipment
- (4) Use of accessories and attachments

c. Automatic type

- (1) Requirements for automation
- (2) Sequential operations
- (3) Control and operation factors
- (4) Alarm and rejection mechanisms

d. Liquids and powders

- (1) Liquid requirements as a particle vehicle
- (2) Safety precautions
- (3) Temperature needs
- (4) Powder and paste contents
- (5) Mixing procedures
- (6) Need for accurate proportions

e. Black-light type

- (1) Black light and fluorescence
- (2) Visible- and black-light comparisons
- (3) Requirements in the testing cycle
- (4) Techniques in use

f. Light-sensitive instruments

- (1) Need for instrumentation
- (2) Light characteristics

8. Types of Discontinuities

- a. In castings
- b. In ingots
- c. In wrought sections and parts
- d. In welds

9. Evaluation Techniques

a. Use of standards

- (1) Need for standards and references
- (2) Comparison of known with unknown
- (3) Specifications and certifications
- (4) Comparison techniques

b. Defect appraisal

- (1) History of part
- (2) Manufacturing process
- (3) Possible causes of defect
- (4) Use of part
- (5) Acceptance and rejection criteria
- (6) Use of tolerances

10. Quality Control of Equipment and Processes

a. Malfunctioning of equipment

b. Proper magnetic particles and bath liquid

c. Bath concentration

- (1) Settling test
- (2) Other bath-strength tests

d. Tests for black-light intensity

Total recommended hours of instruction for this course:

Classification A - 8 hours

Classification B - 4 hours

Recommended Training References

Magnetic Particle Testing Method, Level I, II, and III

Annual Book of ASTM Standards, Volume 03.03, *Nondestructive Testing*. Philadelphia, PA: American Society for Testing and Materials. Latest edition.*

ASNT Level III Study Guide – Magnetic Particle Testing Method. Columbus, OH: The American Society for Nondestructive Testing, Inc. 1980.*

Betz, Carl E. *Principles of Magnetic Particle Testing*. Chicago: Magnaflux Corp. 1985.

Magnetic Particle Testing, Classroom Training Handbook (CT-6-3). San Diego, CA: General Dynamics/Convair Division. 1977.†

Magnetic Particle Testing, Programmed Instruction Handbook (PI-4-3). San Diego, CA: General Dynamics/Convair Division. 1977.†

McGonnagle, Warren J. *Nondestructive Testing*, second edition. New York: Gordon & Breach. 1975.*

McMaster, Robert C., ed. *Nondestructive Testing Handbook*, first edition. Columbus, OH: The American Society for Nondestructive Testing, Inc. 1959.*

Mix, Paul E. *Introduction to Nondestructive Testing: A Training Guide*. New York: John Wiley & Sons. 1987.*

Nondestructive Inspection and Quality Control: Metals Handbook, Volume 11, eighth edition. Metals Park, OH: American Society for Metals. 1976.*

Schmidt, J. Thomas and Kermit Skeie, technical eds, and Paul McIntire, ed. *Nondestructive Testing Handbook*, Volume 6: second edition, *Magnetic Particle Testing*. Columbus, OH: The American Society for Nondestructive Testing, Inc. 1989.*

Supplement to Recommended Practice No. SNT-TC-1A (Q&A Book): Magnetic Particle Testing Method. Columbus, OH: The American Society for Nondestructive Testing, Inc. 1994.*

Welding Handbook. Volume 1. Miami, FL: American Welding Society. Latest edition.*

* Available from The American Society for Nondestructive Testing, Inc., Columbus, OH.

† Currently published by The American Society for Nondestructive Testing, Inc., Columbus, OH.