

**Magnetic Particle LI/II Testing (24 hours)**

**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

**Characteristics of Magnetic Fields**

- a. Bar magnet
- b. Ring magnet

**Effect of Discontinuities of Materials**

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

**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

**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

**Inspection Materials**

- a. Wet particles
- b. Dry particles

**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

**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

- a. Forging bursts
- b. Voids

**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

**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. Indications of bursts and flakes
- j. Indications of porosity
- k. Nonrelevant indications

**Selecting the Proper Method of Magnetization 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 factor 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

**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

**Magnetization by Means of Electric Current**

- a. Circular techniques
    - (1) Current calculations
    - (2) Depth-factor considerations
    - (3) Precautions – safety and overheating
    - (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
    - (5) Current calculations
      - (a) Formulas
      - (b) Types of current required
      - (c) Current demand
    - (6) Discontinuities commonly detected
- 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

**Demagnetizing Procedures**

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

### **Equipment**

- 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
- 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 florescence
- (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

### **Types of Discontinuities**

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

### **Evaluation Techniques**

- a. Use of standards
  - (1) Need for standards and references
  - (2) Comparisons of known and 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

### **Q Quality Control of Equipment and Process**

- 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

### **Practical demonstrations and structured daily exercises**

### **Summary / Final review**

### **End of Course Test and review**

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