METHODS FOR DETERMINING CORE COMPETENCIES OF NDT PERSONNEL

Prepared By: Robert Potter – ASNT President
Prepared For: 18th World Conference on Nondestructive Testing
April 17, 2012
Durban, SA
“COMPETENCE, LIKE TRUTH, BEAUTY AND CONTACT LENSES, IS IN THE EYE OF THE BEHOLDER”

Dr. Laurence J. Peter
NDT – IN THE BEGINNING...
TRAINING WAS THE KEY...
CERTIFICATION GUIDELINE
SNT-TC-1A

- 1ST ISSUED IN 1966 IN RESPONSE TO INDUSTRY & REGULATORY CONCERNS.
- RECOMMENDATIONS FOR TRAINING, EXPERIENCE AND EXAMINATIONS
WHY DO WE ADMINISTER WRITTEN EXAMINATIONS?

- VERIFY COMPETENCE
- SATISFY CODE, SPECIFICATION OR CONTRACT REQUIREMENTS
# Magnetic Particle Testing Level III Topical Outline

## 1.0 Principles/Theory

1.1 Principles of magnets and magnetic fields
   1.1.1 Theory of magnetic fields
   1.1.2 Theory of magnetism
   1.1.3 Terminology associated with magnetic particle testing

1.2 Characteristics of magnetic fields
   1.2.1 Bar magnet
   1.2.2 Ring magnet

## 2.0 Equipment/Materials

2.1 Magnetic particle test equipment
   2.1.1 Equipment selection considerations
   2.1.2 Manual inspection equipment
   2.1.3 Medium- and heavy-duty equipment
   2.1.4 Stationary equipment
   2.1.5 Mechanized inspection equipment

2.2 Inspection materials
   2.2.1 Wet particle technique
   2.2.2 Dry particle technique

## 3.0 Technique/Calibrations

3.1 Magnetization by means of electric current
   3.1.1 Circular field
      3.1.1.1 Field around a straight conductor
      3.1.1.2 Right-hand rule
      3.1.1.3 Field in parts through which current flows
      3.1.1.4 Methods of inducing current flow in parts
      3.1.1.5 Discontinuities commonly indicated by circular field
      3.1.1.6 Applications of circular magnetization
   3.1.2 Longitudinal field
      3.1.2.1 Field direction
      3.1.2.2 Discontinuities commonly indicated by longitudinal techniques
      3.1.2.3 Applications of longitudinal magnetization

3.2 Selecting the proper method of magnetization
   3.2.1 Alloy, shape and condition of part
   3.2.2 Type of magnetizing field
   3.2.3 Direction of magnetic field
   3.2.4 Sequence of operation
   3.2.5 Value of flux density

---

**Training References**

- *Magnetic Particle Testing, Level I, II and III*

* Available from the American Society for Nondestructive Testing, Inc., Columbus, OH.
Level III Program

- ESTABLISHED TO PROVIDE INDEPENDENT EXAMINATION FOR LEVEL III COMPETENCE.

- 7 METHODS INTRODUCED IN 1977 – 11 METHODS RECOGNIZED IN 2011.

- WORLD RECOGNIZED, ASNT LEVEL III’S IN 50 COUNTRIES.

- ACCREDITED BY ANSI - ISO 17024.

- STANDARDIZED EXAMINATION USING PSYCHOMETRIC PRINCIPLES.
CERTIFICATION EXAMINATION

GOALS

- BASED ON PSYCHOMETRIC PRINCIPLES
  - EXAMINATIONS MUST BE
    - FAIR AND IMPARTIAL
    - VALID
    - RELIABLE

- VALIDATE CORE COMPETENCY
  - ABILITY TO ESTABLISH TECHNIQUES
  - ABILITY TO INTERPRET CODES, STANDARDS & SPECIFICATIONS
  - ABILITY TO PREPARE & APPROVE PROCEDURES

- FOLLOW INDUSTRY PRACTICES & GUIDELINES
  - ISO 17024
ANATOMY OF AN EXAMINATION QUESTION

CP-105
BOK

TRAINING REFERENCE

EXAMINATION QUESTION

ASNT Standard 2011
Topical Outlines for Qualification of Nondestructive Personnel

18th WCNDT
World Conference on Non-destructive Testing
QUESTION (STEM): Using the formula: \( I = \frac{45000}{N(L/D)} \), what is the amperage requirements to produce a longitudinal field using a 5 turn coil if the part to be inspected is a 2” OD solid rod and is 3.25” in length?

DISTRACTER: A. 2,250 amps
DISTRACTOR: B. 2,450 amps
ANSWER: C. 2,770 amps
DISTRACTER: D. 5,500 amps

CP-105 2011: 4.2.5.3 Pg. 64

REFERENCE: ASTM E1444, Page 16, X5.2 and X5.2.1.1
KNOWLEDGE QUESTIONS

- RECALL OF INFORMATION
- KNOWLEDGE OF MAJOR IDEAS
- MASTERY OF SUBJECT MATTER
- CUES: LIST, DEFINE DESCRIBE, IDENTIFY, NAME...

Example:

Identify the formula for determining the fill factor of an AC coil.
COMPREHENSION QUESTIONS

- TRANSLATE KNOWLEDGE INTO NEW CONTEXT
- INTERPRET FACTS, COMPARE
- INFER CAUSES, GROUP, PREDICT CONSEQUENCES
- CUES: INTERPRET, COMPARE, PREDICT DESCRIBE...

Example:

*Describe the effect of lowering the magnetizing amperage on an indication believed to be alloy segregation?*
APPLICATION QUESTIONS

- USE METHODS, CONCEPTS, THEORIES IN NEW SITUATIONS
- SOLVE PROBLEMS USING REQUIRED SKILLS
- CUES: CALCULATE, SOLVE, CLASSIFY, APPLY...

Example:

*If the part cross sectional area is 2.2 in² and the inside coil dimension is 14”, calculate the fill factor.*
ANALYSIS QUESTIONS

- PATTERN RECOGNITION
- RECOGNITION OF HIDDEN MEANINGS
- IDENTIFICATION OF COMPONENTS
- CUES: ANALYZE, SEPARATE, ORDER, EXPLAIN, INFER...

Example:

When creating a technique, what is the next step following the establishment of the head shot (circular magnetism) amperage requirement?
SYNTHESIS QUESTIONS

- USE OLD IDEAS TO CREATE NEW ONES
- GENERALIZE FROM GIVEN FACTS
- DRAW CONCLUSIONS
- CUES: COMBINE, INTEGRATE, MODIFY, REARRANGE....

Example:

*If a part has threads or keyways, what modification should be made to the magnetic inspection technique to further inspect these areas?*
EVALUATION QUESTIONS

- ASSESS VALUES, COMPARE, DESCRTMINATE
- MAKE CHOICES ON PRESENTED VALUES
- VERIFY VALUE OF EVIDENCE
- CUES: ASSESS, MEASURE, JUDGE, CONCLUDE...

Example:

A gauss reading was taken at the center and ends of a part to validate a technique. The values were 15, 22 and 30 gauss. What actions if any, should be taken when establishing the inspection technique?
**QUESTION (STEM):**

Using the formula: \( I = \frac{45000}{N(L \div D)} \), what is the amperage requirements to produce a longitudinal field using a 5 turn coil if the part to be inspected is a 2” OD solid rod and is 3.25” in length?

<table>
<thead>
<tr>
<th>DISTRACTER:</th>
<th>DISTRACTOR:</th>
<th>ANSWER:</th>
<th>DISTRACTER:</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. 2,250 amps</td>
<td>B. 2,450 amps</td>
<td>C. 2,770 amps</td>
<td>D. 5,500 amps</td>
</tr>
</tbody>
</table>

**CP-105  2011:**  4.2.5.3  Pg. 64

**REFERENCE:**  ASTM E1444, Page 16, X5.2 and X5.2.1.1

**CLASSIFICATION:**  Synthesis

**DIFFICULTY RATING:**  0.65

**NOTES:**  Answer based on the fact that L/D is less then 2, so 2 parts would be required to be in contact end to end to produce an L/D greater than 2. L/D used should be 2 x 3.25 or 6.5.
TEST QUESTION VALIDATION BY PEER GROUP

DIFFICULTY RATING

REFINEMENT

FEEDBACK
Using the formula: \( I = \frac{45000}{N(L+D)} \), what is the amperage requirements to produce a longitudinal field using a 5 turn coil if the part to be inspected is a 2” OD solid rod and is 3.25” in length?

| A. 2,250 amps | B. 2,450 amps | C. 2,770 amps | D. 5,500 amps |

*Number of times question used: 75*
*Number of times answered correctly: 61*
*Difficulty Level: 61/75 = 0.81*

**Analysis of the Question:**

*Number of Examinees choosing Answer A: 0*
*Number of Examinees choosing Answer B: 0*
*Number of Examinees choosing Answer C: 61*
*Number of Examinees choosing Answer D: 14*
DIFFICULTY RATING

- BASED ON THE ANGOFF PROCESS – AN INDUSTRY ACCEPTED PSYCHOMETRIC PROCEDURE
- AN INITIAL ESTIMATE BY THE QUESTION ORIGINATOR AND PEER GROUP REVIEWING THE QUESTION OF THE PERCENT OF EXAMINEES THAT WILL ANSWER THE QUESTION CORRECTLY.
- TYPICALLY RANGING FROM 45-90%
- THE RATING IS ADJUSTED AFTER STATISTICAL VALIDATION
ESTABLISHING THE PASSING SCORE

- PSYCHOMETRIC BASED (ANSI 17024 ACCREDITION)
- EXAMPLE
  - 100 TOTAL QUESTIONS
  - 20 PROVISIONAL QUESTIONS
  - 80 SCORABLE QUESTIONS
  - DIFFICULTY LEVEL FOR THE 80 SCORABLE QUESTIONS RANGES FROM .45 - .90.
  - AVERAGE OF THE SUM OF DIFFICULTY LEVEL FOR SCORABLE QUESTIONS = CUT OR PASSING SCORE
  - IF THE DIFFICULTY LEVEL AVERAGE OF THE SCORABLE QUESTIONS IS 0.71 THE PASS OR CUT SCORE WOULD BE 0.71 X 80 = 56.8. 56 QUESTIONS MUST BE ANSWERED CORRECTLY TO PASS THE EXAMINATION.
CONCLUSION

- THE EXAMINATION PROCESS SHOULD FOLLOW INDUSTRY GUIDELINES.
- EXAMINATIONS MAY RANGE IN DIFFICULTY AND DISCRIMINATE BETWEEN THOSE WHO SHOULD PASS THE EXAMINATION AND THOSE WHO SHOULD NOT.
- EXAMINATIONS SHOULD BE UN-BIASED.

THANK YOU!