



Natural Resources  
Canada

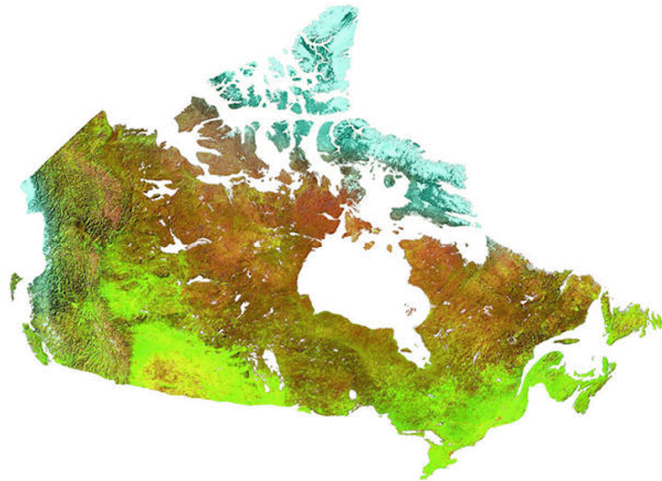
Ressources naturelles  
Canada

Minerals and  
Metals Sector

Secteur des minéraux  
et des métaux

# Examination Guide for Initial Certification

## Magnetic Particle



**Engineering, Materials and  
Components Sector**

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Canada 

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Ce guide est aussi disponible en français à l'adresse suivante :

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## A INTRODUCTION

Natural Resources Canada (NRCan), through the Materials Technology Laboratory (MTL) of Minerals and Metals Sector (MMS), is the NDT Certifying Agency for the Canadian Nondestructive Testing Personnel Certification Program. NRCan certifies individuals according to CAN/CGSB 48.9712 standard.

In performing this function, NRCan carries out the following tasks:

- a) examines information provided by the applicant to ensure that the applicant has the basic education, NDT training and experience required by the standard;
- b) prepares, supervises and evaluates both written and practical examinations;
- c) maintains a network of test centres across Canada for both written and practical examinations;
- d) renews certificates of candidates as specified by the standard; and,
- e) recertifies candidates as specified by the standard.

In certifying the candidate, NRCan is only attesting that the candidate has demonstrated sufficient knowledge, skill, training and experience to meet the requirements of the CAN/CGSB 48.9712 standard. NRCan cannot attest to the operator's competence in any specific situation at the time of original certification or at any time thereafter.

In undertaking the administration of the program, NRCan attempts to provide the unbiased Canada-wide services required to implement a national program. An Advisory Committee composed of individuals knowledgeable about NDT in Canada advises NRCan on the operation of this program.

**B SUGGESTIONS FOR THE SUCCESSFUL COMPLETION OF WRITTEN EXAMINATIONS FOR CERTIFICATION IN NDT**

1. Do some personal studying prior to attempting the written examinations. In general, training courses are meant to complement your personal efforts, not to substitute them. Furthermore, training courses tend to cover a lot of material over a short period of time. To assimilate the subject material covered, a great deal of personal studying is usually necessary.

**Note:** The marks obtained on a training course test should not be used to gauge your eventual performance on NRCAn examinations. Usually, applicants find NRCAn examinations more difficult.

2. Before starting a test, read all the instructions.

3. Before answering a multiple choice question read the stem and all of the options. Remember, only the best answer is correct.

4. If a question is difficult to answer, proceed by elimination. This will often result in having to choose between two possible options.

5. If you cannot answer a question, do not waste time, proceed to the next question. If you complete the test before the time limit, return to the unanswered questions.

6. To test your skills, we recommend the following sample questions that are available on the market:

- a) Ginzel Bros. NDT Testmaker Questions Data Base
- b) Supplements to Recommended Practice SNT-TC-1A (Question and Answer Books)

**Reference Material**

The textbooks identified in this guide as reference study material may be purchased from the following sources:

**Canadian Institute for NDE**  
135 Fennell Avenue W., Port. #7  
Hamilton, Ontario  
L8N 3T2

Telephone: (905) 387-1640  
Facsimile: (905) 574-6080

**ASNT**  
1711 Arlingate Lane, Box 28518  
Columbus, Ohio  
43228 - 0518, U.S.A.

Telephone: (614) 274-6003 or 1-800-222-2768  
Facsimile: (614) 274-6899

**C.1 LEVEL 2 EXAMINATION SCHEME TO MEET THE CAN/CGSB - 48.9712 STANDARD**

***LEVEL 2 MAGNETIC PARTICLE (MT) WRITTEN AND PRACTICAL EXAMINATIONS IN THE ENGINEERING MATERIALS & COMPONENTS (EMC) SECTOR***

<i>EXAMINATION</i>	<i>PASS</i>	<i>CONTENT</i>	<i>DURATION</i>	<i>COMMENTS</i>
General Paper	≥70%	40 m.c.q. on theoretical principles of MT test method	1 hour	Need not be repeated for other sectors.
EMC Paper (Multi-Sector)	≥70%	50 m.c.q. total: -20 m.c.q. on M&P and flaws -10 m.c.q. on one code -20 m.c.q. on MT applications and techniques	2 hours	
<b>General Practical</b>	≥70%	Performance/Calibration checks.	1 hour	
EMC Practical (Multi-Sector)	≥70%	Inspect 6 specimens - A combination of welds, castings and forgings tested with a yoke using black magnetic particle fluid, and by wet fluo particles on bench unit. Prepare technique records and write one detailed instruction.	6 hours	

m.c.q. => multiple choice questions  
 M&P => Materials and Processes

**C.2 REFERENCES TO PREPARE FOR THE LEVEL 2 WRITTEN EXAMINATIONS**

**General and EMC Papers:**

- A. NDT Handbook – Latest Edition
- B. Principals of Magnetic Particle, C.E. Betz
- C. ASM Metals Handbook - Latest Edition
- D. ASM Metals Handbook - Latest Edition

**EMC Paper:**

Publication	Pages	Subject
A. Materials and Processes for NDT Technology By ASNT  - Latest Edition	31 to 44	Nature of Materials & Solid State Changes in Metals
	50 to 54	Ferrous Metals
	57 to 65	Nonferrous Metals
	79 to 93	Casting Processes
	95 to 117	Welding Processes
	121 to 135	Metal Forming Processes
	171 to 173	Surface Finishing
	183 to 186	Inspection
C. Basic Metallurgy for Nondestructive Testing  - Latest Edition	1 to 5	Solidification and Crystallinity
	20	Hardenability of Steel
	22 to 28	Fusion Welding of Steel
	29 to 35	Defects in Fusion Welds
	36 to 43	Flaws in Steel Castings
	50 to 56	Defects in Steel Forgings
	58 to 60	Mechanical Testing
	69 to 74	Corrosion of Metals
B. Nondestructive Testing Handbook - Latest Edition		
D. General Dynamics Classroom Training Handbook CT-6-2 - Latest Edition		
E. General Dynamics Classroom Training Handbook CT-6-4 - Latest Edition		
F. ASM Metals Handbook - Latest Edition		

At the present, four (4) codes/specifications are used for Level 2 EMC paper. These are as follows:

1. Sample Magnetic Particle Specification  
NDT Handbook, Volume 6, Magnetic Particle Testing (pages 427-438)
2. Standard Recommended Practice for Magnetic Particle Examination E709-80
3. Magnetic Particle Examination of Steel Forgings A-275-83
4. Magnetic Particle Inspection of Large Crankshaft Forgings A456-83

**Note:**

New codes and questions are added periodically.

It is recommended that candidates **do not** purchase these publications, but rather that they familiarize themselves with the general layout of codes and standards.

**Note: Most of the subjects of the General and EMC written examinations are found in the above publications. It should be noted that additional studying from other books might be useful.**

*References are based on the Recommended Training Course Guidelines of Standard CAN/CGSB 48.9712 for Both General and EMC Papers*

### C.3 SAMPLE QUESTIONS FOR THE LEVEL 2 WRITTEN EXAMINATIONS

#### Level 2 General Examination:

1. Magnetic lines of force are:
  - a) isolated mono-poles
  - b) elongated bi-poles
  - c) manifestations of the "string-theory"
  - d) imaginary concepts for mapping magnetic fields
  
2. In a ferromagnetic material, a region where all the "atomic moments" are aligned parallel to each other is called a:
  - a) magnetic zone
  - b) confederation
  - c) domain
  - d) magnetic junta
  
3. In order to be detectable by magnetic particle testing, a flaw must:
  - a) be surface breaking
  - b) be no deeper than 1mm below the surface
  - c) produce a leakage field at the test surface
  - d) all of the above
  
4. A void in an otherwise homogenous magnetized material presents itself as a point magnetic dipole. This is the basis for:
  - a) magnetic particle flaw detection
  - b) multi frequency eddy current
  - c) para-magnetism
  - d) de-magnetization
  
5. 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.
  
6. The opposition to the formation of a magnetic flux in a magnetic circuit is referred to as:
  - a) reactance.
  - b) reluctance.
  - c) resistance.
  - d) antimagnetics.
  
7. Hysteresis loops and the magnetic properties of materials may be affected by:
  - a) grain size
  - b) micro structure
  - c) chemical composition
  - d) all of the above



8. The value of H applied to bring the residual value of B to zero is called:
  - a) saturation field
  - b) demagnetization value
  - c) coercive force
  - d) phase reversal factor
  
9. 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
  
10. The flux density of the magnetism induced by a coil can be controlled by varying:
  - a) the coil size.
  - b) the current in the coil.
  - c) the number of turns in the coil.
  - d) all of the above.
  
11. An electric current which flows steadily in one direction is:
  - a) direct current.
  - b) full wave current.
  - c) half wave current.
  - d) alternating current.
  
12. A magnetic particle build-up from a discontinuity is strongest when the discontinuity is oriented:
  - a)  $180^\circ$  to the magnetic field.
  - b)  $45^\circ$  to the magnetic field.
  - c)  $90^\circ$  to the magnetic field.
  - d)  $90^\circ$  to the current flow.
  
13. The most important characteristic(s) that a dry powder should have is/are:
  - a) low coercive force.
  - b) low magnetic retentivity.
  - c) high magnetic permeability.
  - d) all of the above.
  
14. The negative magnetizing force required to reduce the residual flux density in a part to zero after saturation is called:
  - a) residual force
  - b) coercive force
  - c) demagnetizing field strength
  - d) null force

15. In the inspection of a part, the following may justify rejection of some parts:
- inherent defects.
  - service defects.
  - processing defects.
  - all of the above.

**Answers**

1. D      2. C      3. C      4. A      5. B      6. B      7. D  
8. C      9. C      10. D      11. A      12. C      13. D      14. B      15. D

**Level 2 E.M.C. Examination:**

- Grain boundaries are areas of a metal micro structure:
  - where high melting point constituents are concentrated.
  - made up of rows of atoms arrayed in straight lines.
  - that are not attacked by etchants and generally stand in relief during metallographic examination.
  - where low melting impurities tend to concentrate.
- Steels that contain more than 0.30 percent carbon, if welded, are prone to which type of discontinuity?
  - Heat-affected zone cracking
  - Porosity
  - Incomplete fusion
  - Slag formation
- Most manufacturing defects in a tube are:
  - axial in direction.
  - circumferential in direction.
  - on the outside of the tube.
  - subsurface.
- What are the three main types of corrosion?
  - General corrosion, pitting and intergranular corrosion
  - General corrosion, pitting and transgranular corrosion
  - General corrosion, intergranular corrosion and transgranular corrosion
  - Transgranular corrosion, intergranular corrosion and pitting
- Where is the most logical place, on a casting, to look for discontinuities?
  - on the top surface
  - on the bottom surface
  - at internal surfaces
  - at junctions between light and heavy sections
- What is the cause of cracks in the heat-affected zone?
  - a thermal cycle that increases hardness and reduces brittleness
  - a thermal cycle that reduces hardness and increases brittleness
  - a thermal cycle that reduces hardness and brittleness
  - a thermal cycle that increases hardness and brittleness

7. Elongated configurations of foreign substances aligned in the direction of working wrought metals are called:
  - a) slag
  - b) inclusions
  - c) stringers
  - d) worms
  
8. A defect which bears no relation to the direction of metal grains is:
  - a) intergranular corrosion
  - b) grinding crack
  - c) quenching crack
  - d) lamellar tearing
  
9. The strength of a circular magnetic field is not diminished by \_\_\_\_\_ of a part:
  - a) permeability
  - b) diameter
  - c) length
  - d) any of the above
  
10. Which of the following provides the NDT inspector with a brief outline of the steps to perform a test on a specific item?
  - a) code
  - b) standard
  - c) procedure (instruction)
  - d) specification
  
11. The width of a magnetic particle indication:
  - a) indicates flaw depth
  - b) is always wider than the actual flaw opening
  - c) is equal to the height of particle indication
  - d) is determined by the angle of repose
  
12. When the central conductor MPI method is used to inspect a ring shaped object, or short cylinder:
  - a) only inside diameter surface flaws can be found
  - b) only outside diameter surface flaws can be found
  - c) both inside and outside surface and subsurface flaws can be found if the wall thickness is not too great
  - d) none of the above, central conductors cannot be used for ring shaped objects
  
13. Given a steel bar 1 foot long and 3 inches diameter, what current should you use for the coil shot with a 3 turn coil (part placed at bottom of coil)?
  - a) 100 amps
  - b) 2000 amps
  - c) 4000 amps
  - d) 6000 amps

14. When welds are required to have only partial penetration use of HWDC yokes often give rise to nonrelevant indications. This problem can be eliminated by:
- using an A.C. yoke
  - increasing leg spacing
  - reducing magnetizing current
  - using a pie gage
15. The best way to demagnetize a long tube would be:
- reversing D.C. with a central conductor
  - pulsating A.C. with a central conductor
  - a portable yoke
  - passing the tube through an A.C. coil
16. To reduce the discomfort of eye fatigue when performing fluorescent MPI you can:
- take breaks at regular intervals
  - wear yellow-green tinted glasses (of the appropriate filtering ability)
  - both a and b
  - increase dark adaption time
17. Nonrelevant indications due to residual local poles interfere with magnetic particle testing. For a successful examination one should?
- Magnetize in another direction
  - Demagnetize then remagnetize in the desired direction
  - Use lower amperage
  - Use more amperage
18. If a discontinuity is shallow and broad like a scratch, the flux lines may stream-line below the discontinuity. This will result in:
- a false indication
  - a non-relevant indication
  - a sub surface indication
  - a lack of indication

**Answers**

1. D    2. A    3. A    4. A    5. D    6. D    7. C    8. B    9. C  
10. C    11. B    12. C    13. B    14. A    15. A    16. C    17. B    18. D

#### **C.4 GENERAL INFORMATION FOR THE LEVEL 2 PRACTICAL EXAMINATIONS**

1. The level 2 magnetic particle practical examination is a closed book examination. No books or notes other than those provided will be permitted during the test. A scientific calculator may be used provided it does not contain information or established programs which provide solutions to examination problems.

The duration of the practical test is seven (7) hours.

2. The candidate shall be shown the operation and placement of equipment and accessories required to complete the test.
3. The candidate will be given a lightmeter, ammeter, field indicator and a graduated cylinder.
4. The candidate is required to demagnetize the test specimens at the completion of the test.
5. The candidate is requested not to mark the test specimens.
6. The candidate is not allowed to take the paperwork nor the test specimens out of the laboratory. All reporting must be completed within the testing room or facility.
7. The candidate may, at any particular time, ask any questions concerning the test. A supervisor may refuse to answer any questions he/she considers to be part of the test.
8. Candidates will be given the opportunity to give feedback concerning the practical test. After completing the test, simply fill in and return the comment sheet provided. Hand in the comment sheet to the test supervisor or complete it at home and send directly to:

NDT Certifying Agency  
Natural Resources Canada  
183 Longwood Road South  
Hamilton, Ontario  
L8P 0A5

Telephone: (866) 858-0473  
Fax: (905) 645-0836

**Note:** There is concern about candidates who appear confused and unsure of themselves while attempting their practical test. It is the prerogative of the supervisor to discuss this situation with the candidate and, in the extreme, terminate the practical test.

## C.5 TEST PROGRAM FOR THE LEVEL 2 PRACTICAL EXAMINATIONS

The candidate is required to do the following:

### General Practical Test

- A. Perform three (3) calibration/performance tests.
  - Plot on graph paper, the amperage output vs equipment setting.
  - Determine particle concentration of wet bath.
  - Measure highest black light intensity.

### EMC Practical Test

- B. Inspect six (6) specimens:
  - Two specimens are to be tested with a yoke using black magnetic particle fluid,
  - Four specimens are to be tested with the wet fluorescent method.

#### Note:

As accurately as possible, draw on the illustrations provided, the appearance of the indications and make a preliminary interpretation of your findings. Show their relative size, shape, length and location. Whenever necessary draw a sketch of a missing view.

### C. NDT Written Instruction

Write a detailed instruction for one of the tested specimens. The written instruction must be completed in a manner that will permit a Magnetic Particle inspector to follow your steps and duplicate your results. It should include:

- a. A description of the test specimen.
- b. A list of equipment, reference standards and accessories used.
- c. A description of the calibration procedures specific for the test specimen.
- d. A description of the inspection procedures specific for the test specimen.
- e. The instrument settings at the time of inspection.
- f. A report of the results.

Note: Although to write instructions a candidate may obtain inspiration from the general information accompanying the test specimen, he or she should remember that the NDT Certifying Agency requires a specific instruction to inspect a specific specimen.

## C.6 HINTS FOR SUCCESSFUL LEVEL 2 PRACTICAL EXAMINATIONS

1. Budget your time. Don't spend too much time on one part of the test at the expense of the other parts. We suggest you devote:
  - 1 hour to conduct the General practical test,
  - 3 hours to inspect four specimens with the fluorescent particles,
  - 2 hours to inspect two specimens with a yoke using black magnetic particle fluid.
  - 1 hour to write an NDT instruction for one of the above specimens.
2. Fill in the report sheets completely, clearly and neatly.
3. Do not hesitate to ask questions to the supervisor. If the supervisor cannot answer your question because it is part of the test, he or she will tell you so.

**D.1 LEVEL 3 EXAMINATION SCHEME TO MEET THE CAN/CGSB - 48.9712 STANDARD**

**LEVEL 3 MAGNETIC PARTICLE (MT) WRITTEN AND PRACTICAL EXAMINATIONS IN THE ENGINEERING MATERIALS & COMPONENTS (EMC) SECTOR**

EXAMINATION	PASS	CONTENT	TIME	COMMENTS
Basic Paper	Part A ≥70%  Part B ≥70%  Part C ≥70%	140 m.c.q. <sup>1</sup> total: - 10 m.c.q. on CAN/CGSB 48.9712 standard - 30 m.c.q. on M&P <sup>2</sup> (General) - 40 m.c.q. on M&P and flaws specific to welds, castings, wrought products, etc. - 60 m.c.q. (4 x 15) on NDT methods	3½ hours	Need not be repeated for other sectors and methods.
General Paper	≥70%	30 m.c.q. on theoretical principles of MT method	¾ hour	Need not be repeated for other sectors in MT.
Written Procedure <sup>3</sup> <b>OR</b> Written Procedure Review <sup>4</sup>	≥70%	<b>Writing</b> 1 NDT procedure for certification in the <i>first</i> method and the option of <b>Reviewing</b> an NDT procedure for certification in each <i>additional</i> method	4 hours  <b>OR</b> 1 ½ hours	Need not be repeated for other sectors in MT.
EMC Sector -Codes and Applications Paper	≥70%	40 m.c.q. total: -10 m.c.q. on one code -30 m.c.q. on MT applications	1 ¾ hours	
<b>Practical Test</b>	≥70%	Same as Level 2	2 ½ days	This exam need not be done again if successfully completed at Level 2.

<sup>1</sup> m.c.q. => multiple choice questions

<sup>2</sup> M&P => Materials and Processes

<sup>3</sup> Written Procedure Examination

This four hour examination **must** be completed by those seeking Level 3 certification in a **first method**.

Because writing a comprehensive NDT procedure, which meets industrial standards, would normally take many days to complete, the NDT Certifying Agency will provide the applicant, at the time of application, with a pre-test package having all the information and details needed to prepare for this examination.

<sup>4</sup> Written Procedure Review Examination

Candidates seeking Level 3 certification in a **second and subsequent method** have the option of completing a one and one-half hour procedure review examination.

To complete this examination, the candidate will be handed a Procedure which he/she is to assume comes from their staff for review and approval. The candidate, as the responsible Level 3 individual for the company in question, must review the Procedure and identify all that is unsatisfactory or incorrect with the document. The candidate is required to write what is unsatisfactory or incorrect directly in the Procedure, adjacent to the problem area. An example of this will be shown in the Procedure to be reviewed.

The candidate must report *at least* 10 problem areas or deficiencies with the Procedure document. Deficiencies may include any of the following: no cover sheets, no provision for approval signatures, approval signatures by unauthorized personnel, missing or incorrect information in headers, missing attachments/references, missing sections, incorrect paragraph numbering, contradicting technical data, technical data contrary to good practice, unclear statements, inconsistent formatting of the document, information placed in wrong sequence, typographical errors, etc.

## D.2 REFERENCES TO PREPARE FOR THE LEVEL 3 WRITTEN EXAMS

### General and EMC-Codes and Applications Papers:

- A. NDT Handbook - Latest Edition
- B. Principals of Magnetic Particle, C.E. Betz
- C. ASM Metals Handbook - Latest Edition
- D. ASM Metals Handbook - Latest Edition

### Materials and Processes:

- A. Materials and Processes for NDT Technology - Latest Edition
- B. Nondestructive Testing Handbook - Latest Edition
- C. Basic Metallurgy for Nondestructive Testing - Latest Edition
- D. General Dynamics Classroom Training Handbook CT-6-2 - Latest Edition
- E. General Dynamics Classroom Training Handbook CT-6-4 - Latest Edition
- F. ASM Metals Handbook - Latest Edition

### EMC-Codes and Applications Paper:

At the present, three (3) codes/specifications are used for Level 3 EMC codes and applications paper:

1. Inspection Process, Magnetic Particle MIL-16868E
2. Magnetic Particle Examination of Steel Forgings A-275
3. Inspection Process, Magnetic Rubber MIL-183387 (USAF)

#### Note:

New codes and questions are added periodically.

It is recommended that candidates **do not** purchase these publications, but rather that they familiarize themselves with the general layout of codes and standards.

### Basic:

1. Materials and Processes for NDT Technology, By ASNT
2. Basic Metallurgy for Nondestructive Testing, By British Institute of NDT
3. Why Metals Fail, chapter 2, By R.D. Barer and B.F. Peters
4. Qualification and Certification of Nondestructive Testing Personnel CAN/CGSB - 48.9712

#### Note:

A general familiarity with capabilities and limitations of other NDT methods is required for the Basic paper.

### Written Procedure Examination

As indicated in D.1, notes 4 and 5, the NDT candidate will be provided with, at the time of application, a pre-test package having all the information and details needed.

*References are based on the Recommended Training Course Guidelines of Standard CAN/CGSB 48.9712 for the General and EMC Papers*



### D.3 SAMPLE QUESTIONS FOR THE LEVEL 3 WRITTEN EXAMINATIONS

#### Level 3 General Examination:

1. In a magnetic circuit, a small air gap will provide a point of:
  - a) high reluctance
  - b) low reluctance
  - c) phase reversal
  - d) Barkhausen delay
  
2. The equations which when combined with the appropriate boundary condition can be solved to describe all electro-magnetic phenomena are \_\_\_\_\_ equations.:
  - a) Maxwell's
  - b) Einstein's
  - c) Poisson's
  - d) Gauss'
  
3. The inverse quantity of electrical resistivity is:
  - a) resistance
  - b) conductivity
  - c) reluctance
  - d) reactance
  
4. An electromagnetic yoke has a very high flux output for the low input power. Which one of the following is not a reason why this probe is efficient?
  - a) The coil has many turns and low amperage.
  - b) The iron core provides magnetic circuit of low permeability.
  - c) The coil has few wraps of high amperes.
  - d) The tight close wraps of the coil on the iron core of the probe provides a minimum of fill factor in the coil.
  
5. The lines of flux or force in a circularly magnetized ferromagnetic bar:
  - a) are aligned through the piece from the south to the north pole.
  - b) are aligned through the piece from the north to the south pole.
  - c) leave the south pole and enter the north pole.
  - d) are contained within and around the part.
  
6. Four bars of the same alloy steel are cut and to be circularly magnetized using a 1000 amp head shot. Which bar will have the greatest surface field strength?
  - a) 10mm diameter 1000mm long
  - b) 15mm diameter 1000mm long
  - c) 20mm diameter 500mm long
  - d) 25mm diameter 100mm long
  
7. In reversing D.C. demagnetization of a part using a coil, the test piece is:
  - a) held stationary in the coil
  - b) rotated during the step down process
  - c) drawn through the coil during stepdown of current
  - d) sprayed with magnetic particles to verify demagnetization

8. The difference between red iron oxide (alpha) and brown iron oxide (gamma) apart from colour is:
  - a) magnetic properties
  - b) crystalline structure
  - c) one is used for MPI and the other is not
  - d) all of the above
  
9. The super magnets, such as samarium-cobalt and neodymium-iron are virtually impossible to de-magnetize by any means other than raising their temperature over the curie point because of:
  - a) low retentivity
  - b) low coercivity
  - c) high coercivity
  - d) high retentivity
  
10. Ultimately the function of any NDT inspection is to:
  - a) find all defects in the part tested
  - b) locate only those discontinuities deemed harmful in the object tested
  - c) ensure all parts tested will be safe to use
  - d) find all discontinuities that the proper use of the test method is capable of indicating

**Answers**

- |      |      |      |      |       |
|------|------|------|------|-------|
| 1. A | 2. A | 3. B | 4. C | 5. D  |
| 6. A | 7. A | 8. D | 9. C | 10. D |

**Level 3 EMC-Codes & Applications Examination:**

1. A permanent magnet yoke used to magnetize a plate will produce magnetic lines of force:
  - a) perpendicular to the principal surfaces of the plate.
  - b) only at the north pole.
  - c) of greatest density midway between the poles.
  - d) generally straight between the poles, and radially elsewhere.
  
2. If the same amperage is passed through a 25 mm and a 50 mm diameter bar of the same length, which of the following statements is most applicable relevant to the magnetic field at the surface of the bars?
  - a) The strength of the magnetic field at the surfaces will be the same for both bars.
  - b) The strength of the magnetic field at the surface of the 25 mm bar will be approximately twice that of the 50 mm bar.
  - c) The strength of the magnetic field at the surface of the 50 mm bar will be approximately four times that of the 25 mm bar.
  - d) The strength of the magnetic field at the surface of the 25 mm bar will be one-half that of the 50 mm bar.
  
3. Given a solid steel shaft 1.5m long and 50cm diameter, what current setting should you use if you had a 5 turn coil and the part is not centred in the coil?
  - a) 1000 amperes
  - b) 2000 amperes
  - c) 3000 amperes
  - d) 4000 amperes

4. Due to load demands on power supplies \_\_\_\_\_ is the preferred current for MPI on larger parts:
  - a) three phase full wave rectified
  - b) single phase full wave rectified
  - c) single phase half wave rectified
  - d) all of the above place equal demands on supply
  
5. In the residual test method, which of the following material characteristics would give the best results?
  - a) High permeability - low retentivity
  - b) High permeability - low coercive force
  - c) High retentivity - low permeability
  - d) High retentivity - high coercive force
  
6. Although it has been proven that some defects can be located through some types and thicknesses of paint, a reason to remove paint for MPI testing is:
  - a) paint type and thickness is not known
  - b) HWDC yokes cannot couple through paint
  - c) both a and b
  - d) none of the above, defects are hidden by paint removal techniques
  
7. A heat treated bolt was tested for quench cracks and must be demagnetized. Using the bolt as a conductor, the demagnetizing current:
  - a) should be sufficiently high to magnetically saturate the part.
  - b) need not exceed the magnetizing current.
  - c) should somewhat exceed the original magnetizing current.
  - d) is irrelevant since demagnetization is not necessary on heat treated parts.
  
8. Most specifications for establishing properties of oil base carriers for wet MPI will state:
  - a) minimum viscosity
  - b) maximum viscosity
  - c) maximum viscosity at a specified temperature
  - d) minimum fluorescence permitted
  
9. If the results of an MPI test make you suspect the indication seen is nonrelevant, originating from hardness or alloy differences, you would:
  - a) double check results by magnetizing a different direction
  - b) verify using penetrant or ultrasonic methods
  - c) reject the part ("when in doubt throw it out")
  - d) accept it if it shows up on a similar piece in the batch
  
10. 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.

**Answers**

- |      |      |      |      |       |
|------|------|------|------|-------|
| 1. D | 2. B | 3. C | 4. A | 5. C  |
| 6. A | 7. C | 8. C | 9. B | 10. B |

**Level 3 Basic Examination:**

1. The Canadian standard for the certification of nondestructive testing personnel is developed and maintained by:
  - a) the Canadian General Standards Board (CGSB).
  - b) standard committee composed of representatives from industry working under the auspice of CGSB.
  - c) Natural Resources Canada under the auspice of the Canadian General Standards Board.
  - d) a cooperative effort between various Canadian regulatory bodies and Natural Resources Canada.
  
2. The levels of certification covered by the CGSB standard on NDT personnel certification are:
  - a) trainee, Level 1, Level 2, Level 3.
  - b) apprentice, trainee, Level 1, Level 2, Level 3.
  - c) Level 1, Level 2, Level 3.
  - d) none of the above.
  
3. The pickling time will be least for:
  - a) low carbon steel.
  - b) high carbon steel.
  - c) alloy steels.
  - d) pickling time is the same for all three materials.
  
4. Which of the following may be considered an advantage of powder metallurgy as a manufacturing method?
  - a) Production of parts of closer tolerances
  - b) Mass production of hard-to-shape parts
  - c) Produce parts with a high strength to weight ratio
  - d) All of the above
  
5. Which of the following heat treatments usually follows a hardening treatment in order to make the steel more ductile?
  - a) Annealing
  - b) Tempering
  - c) Spheroidizing
  - d) Normalizing
  
6. Which of the following statements is correct?
  - a) Alkaline solutions are never used to clean aluminum alloys.
  - b) Acid solutions are never used to clean aluminum alloys.
  - c) Acid solutions are usually used to clean aluminum alloys.
  - d) Alkaline solutions are usually used to clean aluminum alloys.
  
7. Suitable combinations of two different materials each with specific properties may result in a composite that:
  - a) is better in terms of resistance to heat than either of the two components alone.
  - b) is stronger in tension per unit weight than either of the two components alone.
  - c) is stiffer per unit weight than either of the two components alone.
  - d) any of the above.

8. The practical length standards used by industry for gauging are:
  - a) angle slip gauges.
  - b) sine bars.
  - c) wavelengths of light emitted by different elements.
  - d) gauge blocks.
  
9. Thermal conductivity of a metal is an important factor to consider in making quality weldments because:
  - a) some metals, such as aluminum, have a low conductivity which results in weld defects due to localized heat build up.
  - b) some metals, such as stainless steel, have a high conductivity which results in lack of fusion defects as the heat is quickly removed from the weld zone.
  - c) in some metals, such as aluminum, very high temperature gradients are produced, causing stresses during cooling.
  - d) none of the above.
  
10. Fracture is a type of material failure. Of the following, which is another type of material failure?
  - a) Fracture mechanics
  - b) Low frequency dynamic loading
  - c) Permanent deformation
  - d) Elongation within the elastic range
  
11. To remove iron from the ore in a blast furnace, the following materials are added to the furnace to generate the desired chemical reactions:
  - a) coke, ore and oxygen.
  - b) bauxite, ore and air.
  - c) coke, ore, limestone and air.
  - d) coke, ore, limestone and bauxite.
  
12. The reason for putting ingots in a soaking pit is:
  - a) to control the direction of crystallization.
  - b) to homogenize the structure and composition of the ingots.
  - c) to permit slow cooling of the ingots.
  - d) to bring them to the temperature required for rolling.
  
13. An advantage of using green sand molds over dry sand molds is:
  - a) green sand molds are stronger than dry sand molds and thus are less susceptible to damage in handling.
  - b) surface finish of large castings are better when using green sand molds.
  - c) over-all dimensional accuracy of the mold is better with green sand.
  - d) there is less danger of hot tearing of castings when using green sand molds.
  
14. Shielded metal-arc welding is a process of joining metals which is:
  - a) fully automated.
  - b) semi-automated.
  - c) carried out manually.
  - d) all of the above.
  
15. In the resistance spot welding of low-carbon steel the heat generated is:
  - a) concentrated between the positive electrode and the work.
  - b) concentrated at the interface of the two plates to be welded.
  - c) concentrated between the negative electrode and the work.
  - d) evenly distributed in the work between the electrodes.

16. Which of the following is not a brazing process?
  - a) Furnace brazing
  - b) Induction brazing
  - c) Infrared brazing
  - d) Electron beam brazing
  
17. Completely recrystallized hot rolled steel products have:
  - a) exactly the same mechanical properties in the longitudinal and transverse directions.
  - b) superior mechanical properties in the direction of rolling.
  - c) superior mechanical properties in the transverse direction.
  - d) inferior mechanical properties than the original cast structure.
  
18. Care must be taken not to splash steel on the walls of the mold when pouring to prevent formation of surface defects like:
  - a) inclusions.
  - b) seams.
  - c) cold shots.
  - d) bursts.
  
19. Bursts are caused by:
  - a) casting at too low a temperature.
  - b) forging metal which is either too hot or too cold.
  - c) insufficient reduction in size is attempted in one forging operation.
  - d) none of the above.
  
20. Slag inclusions in welds are caused by:
  - a) wide weaving.
  - b) incomplete deslagging of a previous pass.
  - c) moisture entrapped in the joint.
  - d) both a) and b).
  
21. Cobalt-60 is reported to have a half life of 5.3 years. By how much should exposure time be increased (over that used initially to produce excellent radiographs when the cobalt-60 source was new) when the source is two years old?
  - a) no change in exposure time is needed.
  - b) exposure time should be about 11% longer.
  - c) exposure time should be about 37% longer.
  - d) exposure time should be from 62 to 100% longer.
  
22. In ultrasonics, increasing the length of the pulse to activate the search unit will:
  - a) decrease the resolving power of the instrument.
  - b) increase the resolving power of the instrument.
  - c) have no effect on the test.
  - d) will decrease the penetration of the sound wave.
  
23. Optimum magnetic particle inspection of a 50 mm inside diameter gear containing a keyway would require:
  - a) circular method with magnetic field parallel to keyway.
  - b) circular method with magnetic field perpendicular to keyway.
  - c) using central conductor.
  - d) all of the above.

24. Which of the following physical properties, more than any other, determines what makes a material a good penetrant?
- a) viscosity.
  - b) surface tension.
  - c) wetting ability.
  - d) no one single property determines if a material will or will not be a good penetrant.
25. Direct current saturation coils would most likely be used when testing \_\_\_\_\_ by the eddy current method.
- a) steel
  - b) aluminum
  - c) copper
  - d) brass

**Answers**

- |       |       |       |       |       |       |       |
|-------|-------|-------|-------|-------|-------|-------|
| 1. B  | 2. C  | 3. C  | 4. D  | 5. B  | 6. D  |       |
| 7. D  | 8. D  | 9. D  | 10. C | 11. C | 12. D |       |
| 13. D | 14. C | 15. B | 16. C | 17. B | 18. C |       |
| 19. B | 20. D | 21. C | 22. A | 23. D | 24. D | 25. A |

#### **D.4 GENERAL INFORMATION FOR THE LEVEL 2 PRACTICAL EXAMINATIONS**

1. The level 2 magnetic particle practical examination is a closed book examination. No books or notes other than those provided will be permitted during the test. A scientific calculator may be used provided it does not contain information or established programs which provide solutions to examination problems.

The duration of the practical test is seven (7) hours.

2. The candidate shall be shown the operation and placement of equipment and accessories required to complete the test.
3. The candidate will be given a lightmeter, ammeter, field indicator and a graduated cylinder.
4. The candidate is required to demagnetize the test specimens at the completion of the test.
5. The candidate is requested not to mark the test specimens.
6. The candidate is not allowed to take the paperwork nor the test specimens out of the laboratory. All reporting must be completed within the testing room or facility.
7. The candidate may, at any particular time, ask any questions concerning the test. A supervisor may refuse to answer any questions he/she considers to be part of the test.
8. Candidates will be given the opportunity to give feedback concerning the practical test. After completing the test, simply fill in and return the comment sheet provided. Hand in the comment sheet to the test supervisor or complete it at home and send directly to:

NDT Certifying Agency  
Natural Resources Canada  
183 Longwood Road South  
Hamilton, Ontario  
L8P 0A5

Telephone: (866) 858-0473  
Fax: (905) 645-0836

**Note:** There is concern about candidates who appear confused and unsure of themselves while attempting their practical test. It is the prerogative of the supervisor to discuss this situation with the candidate and, in the extreme, terminate the practical test.



## **D.5 TEST PROGRAM FOR THE LEVEL 2 PRACTICAL EXAMINATIONS**

The candidate is required to do the following:

### **General Practical Test**

- A. Perform three (3) calibration/performance tests.
- Plot on graph paper, the amperage output versus equipment setting.
  - Determine particle concentration of wet bath.
  - Measure highest black light intensity.

### **EMC Practical Test**

- B. Inspect six (6) specimens:
- Two specimens are to be tested with a yoke using black magnetic particle suspension,
  - Four specimens are to be tested with the wet fluorescent method.

**Note:**

As accurately as possible, draw on the illustrations provided, the appearance of the indications and make a preliminary interpretation of your findings. Show their relative size, shape, length and location. Whenever necessary draw a sketch of a missing view.

C. NDT Written Instruction

Write a detailed instruction for one of the tested specimens. The written instruction must be completed in a manner that will permit another inspector to follow your steps and duplicate your results. It should include:

- a. A description of the test specimen.
- b. A list of equipment, reference standards and accessories used.
- c. A description of the calibration procedures specific for the test specimen.
- d. A description of the inspection procedures specific for the test specimen.
- e. The instrument settings at the time of inspection.
- f. A report of the results.

Note: Although to write instructions a candidate may obtain inspiration from the general information accompanying the test specimen, he or she should remember that the NDT Certifying Agency requires a specific instruction to inspect a specific specimen.

## **D.6 HINTS FOR SUCCESSFUL LEVEL 2 PRACTICAL EXAMINATIONS**

1. Budget your time. Don't spend too much time on one part of the test at the expense of the other parts. We suggest you devote:
  - 1 hour to conduct the General practical test,
  - 3 hours to inspect four specimens with the fluorescent particles,
  - 2 hours to inspect two specimens with a yoke using black magnetic particle suspension,
  - 1 hour to write an NDT instruction for one of the above specimens.
2. Fill in the report sheets completely, clearly and neatly.
3. Do not hesitate to ask questions to the supervisor. If the supervisor cannot answer your question because it is part of the test, he or she will tell you so.