



Ressources naturelles  
Canada

Natural Resources  
Canada

Secteur des minéraux  
et des métaux

Minerals and  
Metals Sector

# Examination Guide for Initial Certification

## Liquid Penetrant

**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 operators 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) Ginzler 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 LIQUID PENETRANT (PT) 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 the PT 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 PT applications and techniques	2 hours	
<b>General Practical</b>	≥70%	Performance/Calibration checks.	1 hour	
EMC Practical (Multi-Sector)		Inspect 6 specimens - A combination of welds, castings and forgings tested by colour-contrast solvent removable, fluo WW & fluo P.E. penetrants. Prepare technique records and write one detailed instruction.	3 hours	

m.c.q. → multiple choice questions

M&P → Materials and Processes

**Note: For Level 2 certification, a final weighted average grade (written and practical) must ≥80%.**

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

**General and EMC Papers:**

- A. Nondestructive Testing Handbook, Volume 2, Liquid Penetrant Testing; By ASNT
- B. Penetrant Testing, A Practical Guide, By David Lovejoy
- C. ASM Metals Handbook, Eighth Edition, Volume 11

**EMC Paper:**

Publication	Pages	Subject
A. Materials and Processes for NDT Technology 1981 edition By ASNT	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
C. Basic Metallurgy for Nondestructive Testing 1988 edition	183 to 186	Inspection
	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, Volume 2, 2<sup>nd</sup> edition
- D. General Dynamics Classroom Training Handbook CT-6-2, 1967
- E. General Dynamics Classroom Training Handbook CT-6-4, 1981
- F. ASM Metals Handbook Volume 17, 9<sup>th</sup> edition
- G. General Dynamics Classroom Training Handbook PT 4-1, 1967

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

1. Article 6 Liquid Penetrant Examination, ASME
2. Standard Practice for Liquid Penetrant Method, SE-165
3. MIL-STD-6866
4. Standard Test Method for Fluorescent Penetrant Examination Using the Water Washable Process

**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. Aside from increasing the integrity and safety of manufactured pieces, nondestructive testing cuts costs by:
  - a) increasing production rates
  - b) reducing personnel
  - c) eliminating poor stock prior to processing
  - d) all of the above
  
2. The tendency of a liquid penetrant to enter a discontinuity is primarily related to:
  - a) the viscosity of the penetrant.
  - b) the capillary forces.
  - c) the chemical inertness of the penetrant.
  - d) the specific gravity of the penetrant.
  
3. The ability of a liquid to wet a surface is measured by the contact angle, i.e. the angle between the liquid and the surface at the point of contact as the liquid advances. Good penetrants should have:
  - a) a very small contact angle.
  - b) a very large contact angle.
  - c) a contact angle of approximately 45°.
  - d) a contact angle greater than 90°.
  
4. Acids and chromates should not be left on the surface of parts that will be inspected with a water-washable fluorescent penetrant because:
  - a) they may prevent the penetrant from entering any discontinuities.
  - b) they may reduce the bleed-out.
  - c) they may kill the fluorescence of the penetrant.
  - d) they may produce non-relevant indications.
  
5. Which of the following is the best reason why excessive drying of a part is not desired?
  - a) The extra time required is wasted.
  - b) The developer may lose its blotting ability.
  - c) A reduction in resolution may result.
  - d) The excess developer may be difficult to remove.
  
6. Both fluorescent and visible dye penetrants are identified by:
  - a) dwell times
  - b) viscosity
  - c) method of application
  - d) method of removal
  
7. Black light used in penetrant testing has its peak at:
  - a) 5550 angstroms (555 nm)
  - b) 4850 angstroms (485 nm)
  - c) 4250 angstroms (425 nm)
  - d) 3650 angstroms (365 nm)



8. Blacklight is considered to be in the range of:
  - a) long wavelength ultraviolet
  - b) short wavelength ultraviolet
  - c) short wavelength infrared
  - d) 500 to 800 nm
  
9. The single most important factor determining the speed penetrant enters a flaw is:
  - a) surface finish
  - b) viscosity
  - c) method of application
  - d) depth of defect
  
10. A good penetrant must be:
  - a) inert with respect to the materials being tested.
  - b) highly viscous.
  - c) highly volatile.
  - d) an inorganic base liquid.
  
11. Nonaqueous suspensible developers are used primarily with:
  - a) fluorescent penetrants
  - b) oil and whiting
  - c) colour contrast penetrants
  - d) post emulsified penetrants
  
12. Which factor does not determine the liquid penetrant technique to be used?
  - a) Expected service of part
  - b) form and stage of manufacture of the part
  - c) expected defect orientation
  - d) cost of inspection
  
13. In order to evaluate a defect an inspector must have:
  - a) a knowledge of the test
  - b) a knowledge of the material tested
  - c) a knowledge of the applicable codes
  - d) all of the above
  
14. Viscosity is used to determine drag out. Units used to measure viscosity are:
  - a) poundals
  - b) m/sec
  - c) centistokes
  - d) milligravs per cc
  
15. The preferred colour for liquid penetrants used in leak detection is:
  - a) yellow-green
  - b) green-blue
  - c) orange
  - d) red

**Answers**

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

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

1. It may be said that specialists in non-destructive testing must:
  - a) be aware of the capabilities of materials to sustain deformation without forming defects.
  - b) be knowledgeable about the materials they inspect and the defects which can form in them.
  - c) have an exhaustive knowledge of metallurgy.
  - d) all the above answers are correct.
  
2. Which of the following statements is correct?
  - a) The heat-affected zone of a weld is basically a homogeneous structure.
  - b) In some areas of the weld heat-affected zone, grain size can be smaller than in the unaffected base metal.
  - c) The temperature in the heat-affected zone can sometimes exceed the temperature in the fusion zone.
  - d) Transverse cracks do not occur in the heat-affected zone.
  
3. Metal forming such as rolling results in:
  - a) plastic flow of the metal.
  - b) elongation of existing defects perpendicular to the rolling direction.
  - c) directional properties which are always beneficial for secondary forming operations.
  - d) the flattening out of defects which makes them more easily detectable by most NDT methods.
  
4. What can cause stress raisers?
  - a) Punch marks
  - b) Corrosion grooves
  - c) Corrosion pits
  - d) All the above answers
  
5. When a metal (or alloy) cools from a liquid to a solid state, the lack of molten metal to feed the shrinkage will lead to:
  - a) pipes, voids and cavities.
  - b) sponge like appearance and hot tears.
  - c) none of the above.
  - d) both a) and b).
  
6. Which of the following is not a cause of undercutting.
  - a) excessive amperage
  - b) excessive travel speed
  - c) excessive electrode diameter
  - d) excessive restraint during welding

7. An extremely thin discontinuity that is the result of pipes, or inclusions flattened and made directional by working is called:
  - a) a stringer.
  - b) a lamination.
  - c) a seam.
  - d) a cold shut.
  
8. In general, where can you find heat treatment cracks?
  - a) at the centre of a weld
  - b) in areas of sudden change in thickness
  - c) on a cast plate
  - d) all the above answers
  
9. Which of the following statements concerning contaminating materials on the surface of a part to be penetrant tested is not true?
  - a) The contaminant may be of a composition that attacks the penetrant and reduces the fluorescence or color of the penetrant.
  - b) The contaminants may be of such a nature that they reduce or even prevent capillary action by the penetrant.
  - c) The contaminant may retain the penetrant and thus increase the sensitivity of the inspection.
  - d) The contaminant may completely fill the crack and thus prevent the entry of penetrant.
  
10. If inspection of parts is delayed:
  - a) indication from larger defects loose sharpness
  - b) small indications become prevalent
  - c) retesting is needed
  - d) wet developer can only be removed with vapour degreasing
  
11. Choosing the correct method of liquid penetrant inspection requires:
  - a) knowing the capabilities of the Liquid Penetrant Inspection methods available
  - b) history of the part
  - c) intended use of the part
  - d) all of the above
  
12. Black light intensity from a standard mercury vapour lamp may vary due to:
  - a) the isotope of mercury used
  - b) line voltage supplied by utilities
  - c) both a and b
  - d) none of the above
  
13. Improper post cleaning of an Aluminum or Magnesium part tested with a penetrant containing an emulsifier may result in:
  - a) pitting
  - b) cavitation
  - c) excessive bleed out
  - d) blotching

14. A somewhat linear intermittent penetrant indication would be formed by a:
- a) crater crack
  - b) hot tear
  - c) forging lap
  - d) cold shut
15. Which one of the following statements is true?
- a) If the dryer temperature is too high, the heat may degrade the effectiveness of the penetrant.
  - b) It is not necessary to remove a film of oil from a part prior to penetrant testing because the penetrant is basically an oil.
  - c) Parts should be heated prior to the application of a penetrant.
  - d) Development time should be at least twice the penetration time.
16. All indications found by NDT methods are:
- a) rejectable
  - b) direct
  - c) indirect
  - d) dimensionally correct
17. The term defect or flaw indicates:
- a) a minimum or maximum size
  - b) suitability of the part for a given purpose
  - c) nature of the fault
  - d) none of the above
18. Plastic film developers are used:
- a) on plastics only
  - b) for maximum sensitivity
  - c) if permanent records are wanted
  - d) all of the above

**Answers**

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

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

1. The level 2 liquid penetrant 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 four (4) 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 and a thermometer.
4. The candidate must not clean the specimen after testing since the supervisor must also inspect each specimen.
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:

Doug Lusk  
NDT Certifying Agency  
Natural Resources Canada  
568 Booth Street  
Ottawa, Ontario  
K1A 0G1

Phone: (613) 992-0108  
Fax: (613) 943-8297

**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 four (4) calibration/performance tests.
- Set the wash station's water temperature and pressure.
  - Compare the relative sensitivity of two samples of water-washable fluorescent penetrants.
  - Measure drier's maximum temperature.
  - Measure highest intensity of black light.

### **EMC Practical Test**

- B. Inspect six (6) specimens.
- One specimen is to be tested with a colour contrast, solvent removable penetrant.
  - Five specimens are to be tested with a fluorescent, water-washable and post emulsifiable penetrants.
- 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 Liquid Penetrant 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:
  - 30 minutes to conduct the General practical test,
  - 3 hours to conduct the EMC practical test, to test and inspect 6 specimens,
  - 30 minutes to write an NDT instruction for one of the above specimens,
  - it is recommended that the specimens be tested simultaneously (ie. penetrant dwell time) in order to make efficient use of time.
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 LIQUID PENETRANT (PT) WRITTEN AND PRACTICAL EXAMINATIONS IN THE ENGINEERING MATERIALS & COMPONENTS (EMC) SECTOR**

EXAMINATION	PASS	CONTENT	TIME	COMMENTS
Basic Paper	≥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 PT method	¾ hour	Need not be repeated for other sectors in PT.
<sup>4</sup> Written Procedure  <b>OR</b> Written Procedure Review <sup>5</sup>	≥70% ≥80% <sup>3</sup>	<b>Writing</b> 1 NDT procedure for certification in the <i>first</i> method and the <i>option</i> 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 PT.
EMC Sector –Codes and Applications Paper	≥70%	40 m.c.q. total: -10 m.c.q. on one code -30 m.c.q. on PT 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> The General paper; EMC Sector Codes & Applications paper; and the Procedure Writing marks are weighted. A composite grade ≥80% is required.

<sup>4</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 pretest package having all the information and details needed to prepare for this examination.

<sup>5</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. Nondestructive Testing Handbook, Volume 2, Liquid Penetrant Testing, By ASNT
- B. Penetrant Testing, A Practical Guide, By David Lovejoy
- C. ASM Metals Handbook, Eighth Edition, Volume 11

### Materials and Processes:

- A. Materials and Processes for NDT Technology, 1981
- B. Nondestructive Testing Handbook, Volume 2, 2<sup>nd</sup> edition
- C. Basic Metallurgy for Nondestructive Testing 1989
- D. General Dynamics Classroom Training Handbook CT-6-2, 1967
- E. General Dynamics Classroom Training Handbook CT-6-4, 1981
- F. ASM Metals Handbook Volume 17, 9<sup>th</sup> edition
- G. General Dynamics Classroom Training Handbook PT 4-1, 1967

### EMC-Codes and Applications Paper:

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

1. Standard E-165, ASTM
2. Military Specification, MIL-1-6866B (ASG)
3. McDonnell Douglas Standard, DPS 4.7c7 Revision "AA"

#### Note:

New codes and questions are added periodically.

It is recommended that candidates **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 pretest 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. Capillary force is inversely proportional to:
  - a) size of surface openings
  - b) surface tension
  - c) contact angle
  - d) all of the above
  
2. One of the two most important properties of a good penetrant is wetting ability. Wetting ability is:
  - a) measured by contact angle and is not related to surface tension.
  - b) a function of viscosity and increases as surface tension decreases.
  - c) measured by contact angle and decreases as surface tension increases.
  - d) measured by surface tension and increases as contact angle decreases.
  
3. Methylene chloride and dimethyl formamide are used:
  - a) in the distillation of penetrants
  - b) as traces dyes
  - c) to clean crack test samples
  - d) for medical LPI
  
4. Test experience comparing drain dwell and immersion dwell procedures has found drain dwell to be:
  - a) inferior
  - b) superior
  - c) about the same
  - d) obsolete
  
5. The actual cost of colour contrast penetrants may be more than fluorescent penetrants because:
  - a) the market is larger and manufacturers can make higher profits
  - b) less demand merits higher pricing
  - c) more dye must be added to the penetrant
  - d) sufficient profit is made on black lights
  
6. In darkened surroundings, the eye dark adapts. This is called:
  - a) myopia
  - b) scopic vision
  - c) hypermyopia
  - d) photopic vision
  
7. The flash point is an important characteristic of a penetrant. Choose in the following, the statement that is not correct.
  - a) Flash points of volatile liquids are usually measured in an apparatus called "Tag closed cup" or in a similar one called the "Pensky-Martens closed cup".
  - b) Closed cup flash points are always lower than open cup flash points.
  - c) Liquids with flash points higher than 35°C are classified as "flammable" and must be shipped in small quantities.
  - d) The fire point of a penetrant is always higher than its flash point.

8. The width of cracks formed in the chromium plated penetrant test panels is primarily a function of:
- chrome alloy
  - rate of bending to produce fracture
  - degree of polishing on the brass sub panel
  - thickness of chromium plate
9. Persistence of penetrant indications implies:
- microshrinkage
  - incomplete cleaning
  - large volume discontinuities
  - all of the above
10. Locating leaks by pressurized fluids can be accomplished by:
- natural fluorescence in the hydraulic fluid
  - adding fluorescent dye to the hydraulic fluid
  - simple visual inspection
  - any of the above may locate leaks

**Answers**

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

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

1. The main risk of testing cold parts is:
- chilling the penetrant bath
  - condensed moisture forming on the part blocking penetration
  - increased drain time
  - none of the above
2. The most desirable objectives governing the cleaning operations when removing surface penetrant are to:
- remove little penetrant from defects and a minimum of residual penetrant remaining on the surface.
  - remove little penetrant from a defect and no residual penetrant remaining on the surface.
  - remove no penetrant from defects and leave a minimum of residual on the part surface.
  - remove no penetrant from defects and leave no penetrant on the part surface.
3. The type of penetrant to be used on an investment casting should be:
- water-washable fluorescent for adequate sensitivity and water washability.
  - solvent removable because of size and shape.
  - post-emulsifiable fluorescent for maximum sensitivity and water washability.
  - solvent removable for greater visibility.
4. Even absolute values of fluorescence measured by photometers are not reliable without a reference standard because of:
- variations in metals
  - variation in black light source intensity
  - non-linear response of photosensors
  - meter saturation

5. When dipping parts in water suspendible developer, when the parts are slightly warmer than room temperature:
  - a) extra safety precautions are needed
  - b) shock cooling is a risk
  - c) bath concentrations may increase
  - d) excessive bleed out is expected
  
6. Evaluation of liquid penetrant tests for different depth cracks can be determined by:
  - a) increasing pre quench temperature on the aluminum block
  - b) capillary activity in the glass wedge
  - c) varying coating thickness on chrome plated brass panels
  - d) none of the above
  
7. In a situation where several methods of testing are necessary for complete inspection of a part, the preferred sequence would be:
  - a) to use penetrant inspection before ultrasonic inspection.
  - b) to use magnetic particle inspection before penetrant inspection.
  - c) to use ultrasonic inspection before penetrant inspection.
  - d) any of the above depending on the existing situation.
  
8. The inspection of a number of parts from a lot to determine the quality of the lot is called:
  - a) lot testing
  - b) periodic checks
  - c) spot examination
  - d) statistical inspection
  
9. For locating cracks in glass or glazed ceramics the preferred method is:
  - a) water washable penetrant
  - b) post emulsifiable penetrant
  - c) electrified particle
  - d) solvent removable
  
10. What is the method which uses a color contrast penetrant in conjunction with a developer containing a low intensity fluoragent called?
  - a) Fluorescent developer method
  - b) Reversed fluorescent method
  - c) Contrast fluorescent method
  - d) Reversed contrast method

**Answers**

- |      |      |      |      |       |
|------|------|------|------|-------|
| 1. B | 2. D | 3. C | 4. B | 5. C  |
| 6. C | 7. A | 8. C | 9. C | 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 liquid penetrant 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 four (4) 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 and a thermometer.
4. The candidate must not clean the specimen after testing since the supervisor must also inspect each specimen.
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:

Doug Lusk  
NDT Certifying Agency  
Natural Resources Canada  
568 Booth Street  
Ottawa, Ontario  
K1A 0G1

Phone: (613) 992-0108  
Fax: (613) 943-8297

**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 four (4) calibration/performance tests.
- Set the wash station's water temperature and pressure.
  - Compare the relative sensitivity of two samples of water-washable fluorescent penetrants.
  - Measure drier's maximum temperature.
  - Measure highest intensity of black light.

### **EMC Practical Test**

- B. Inspect six (6) specimens.
- One specimen is to be tested with a colour contrast, solvent removable penetrant.
  - Five specimens are to be tested with a fluorescent, water-washable and post emulsifiable penetrants.

**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 Liquid Penetrant 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:
  - 30 minutes to conduct the General practical test,
  - 3 hours to conduct the EMC practical test, to test and inspect 6 specimens,
  - 30 minutes to write an NDT instruction for one of the above specimens,
  - it is recommended that the specimens be tested simultaneously (ie. penetrant dwell time) in order to make efficient use of time.
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.