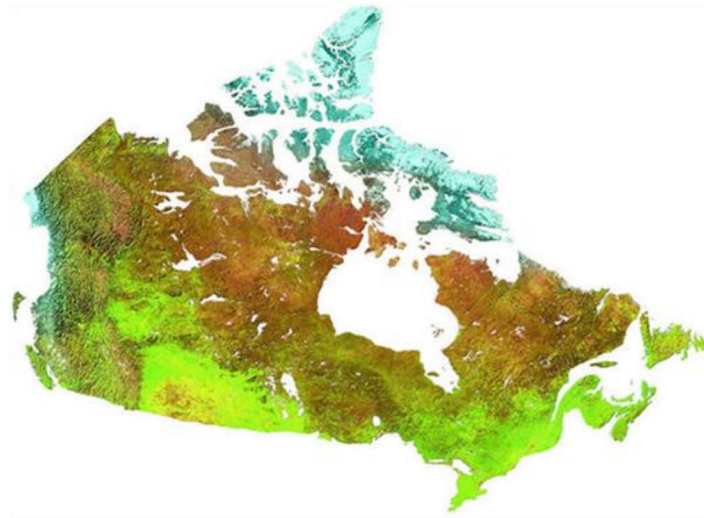




Magnetic Testing

Examination Guide for Initial Certification



Engineering, Materials and Components Sector

Canada



Contact Information

National Non-Destructive Testing Certification Body
CanmetMATERIALS
Natural Resources Canada
183 Longwood Road South
Hamilton, Ontario
L8P 0A5

Email: ndt-end@nrca-nrcan.gc.ca
Telephone: 1-866-858-0473
Web Site: <http://ndt.nrcan.gc.ca>

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

Organisme de certification national en essais non destructifs
CanmetMATÉRIAUX
Ressources naturelles Canada
183 chemin Longwood Sud
Hamilton, Ontario
L8P 0A5

Courriel : ndt-end@nrca-nrcan.gc.ca
Téléphone : 1-866-858-0473
Site Web : <http://end.nrcan.gc.ca>

Version 2 Description of Changes:

Revised online exam times, Written Instruction Criteria and Important Notice;
Added sample reporting sheets



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Overview of NRCan National Non-destructive Testing Certification Body Services

The Natural Resources Canada (NRCan) National Non-Destructive Testing Certification Body (NDTCB) manages Canada's nation-wide program for the certification of individuals performing non-destructive testing (NDT). The NRCan NDTCB certifies individuals according to CAN/CGSB-48.9712 / (ISO 9712, IDT) standard.

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

- a) Examines the information provided by the applicant to ensure that the applicant has the basic education, recommended NDT training and experience required by the standard
- b) Prepares, administers and evaluates both written and practical examinations
- c) Maintains a network of examination centres across Canada for both written and practical examinations
- d) Renews and recertifies certificates as specified by the standard.

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

In undertaking the administration of the program, the NRCan NDTCB attempts to provide the unbiased Canada-wide services required to implement a national program. A group of Scheme, Technical and Advisory Committees composed of stakeholders and individuals knowledgeable about NDT in Canada advises the NRCan NDTCB on the operation of this program.

IMPORTANT NOTICE

The candidate is responsible to ensure that the examination centre has proof of their Examination Admittance and Registration form issued by the NRCan NDTCB prior to the scheduled practical examination/re-examination. For written examination, an Electronic Written Authorization form issued by NRCan NDTCB is required prior to purchasing an electronic written examination/re-examination. Failure to do this may delay the start time of the certification examination and may increase cost to the candidate.

In accordance with CAN/CGSB-48.9712-2022 / (ISO 9712:2021, IDT) section 8.5.2 a candidate who fails to achieve a grade of at least 70% on each individual written examination element (i.e. general, specific), written instruction or each practical examination specimen/subpart may retake the examination according to the following criteria and schedule:

A candidate who fails to obtain the pass grade for any examination element or practical examination specimen/subpart may be re-examined twice in the failed examination, provided that the re-examination takes place not sooner than 1 month and shall not exceed 2 years after the original examination.

The NDT Certification Body reserves the right of choice for written or practical examination components.

All practical examination times are shown in increments of ½ day or 1 day; ½ day shall be considered a maximum of 4 hours and 1 day shall be considered a maximum of 8 hours. Requests for accommodation (such as additional examination time) can only be granted with authorization from the NRCan NDTCB, following its "8.5-009 - NRCan NDTCB Procedure for Consideration of Candidate Requests for Accommodation". The authorized accommodations shall be noted in the candidate's examination registration approval and/or examination admittance and registration form. It is the candidate's responsibility to notify the examination centre of these accommodations at least 10 working days in advance of the examination.

NOTE: Additional information/instruction may be provided to the candidate at the start of the examination. The NRCan NDTCB may have implementation rules and policies that supersede the information provided within this guide.



Suggestions for Success: Written Examinations

- 1 The NRCAN NDTCB recommends that all candidates for NDT written qualification examinations study extensively on their own time using the suggested reference material, in addition to the material learned during the method/level-specific training course, prior to attempting a written examination. Simply using your knowledge obtained by completing the theoretical portion of the training course will not adequately prepare you to succeed in your written examinations.

Note: You should not use the results of your end-of-course examination from your method/level-specific training course to estimate your level of success on the NRCAN NDTCB written qualification examinations.

- 2 To assess your knowledge/abilities in preparation for a written examination, the NRCAN NDTCB recommends completing/reviewing the following sample question resources available for personal purchase:
 - a) Ginzel Bros. NDT Testmaker Questions Data Base
 - b) Supplements to Recommended Practice SNT-TC-1A (Question and Answer Books)
- 3 When you begin your written examination, ensure that you carefully read the examination instructions prior to reading and answering the questions.
- 4 Before you answer a multiple-choice question, ensure that you carefully read the stem (beginning portion) of the question and each alternative answer in order to accurately understand the question.
- 5 Remember, that although more than one multiple-choice alternative answer may appear to be correct or partially correct, only the **best** answer is correct.
- 6 If you have difficulty with choosing an answer to a multiple-choice question, proceed by first eliminating the alternative answers that you believe are incorrect, and then choose between the remaining alternative answers.
- 7 If you find that you cannot answer a question, proceed to the next question(s), and return to any unanswered questions prior to the end of the examination. Do not spend too much time on difficult questions at the expense of completing the remaining questions.

Reference Material

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

Canadian Institute for NDE (CINDE) 135 Fennell Avenue W. Hamilton, Ontario L8N 3T2 Canada Telephone: (905) 387-1655 or 1 800-964-9488 Facsimile: (905) 574-6080	ASNT 1711 Arlingate Lane P.O. Box 28518 Columbus, Ohio 43228 - 0518 U.S.A. Telephone: (614) 274-6003 or 1-800-222-2768 Facsimile: (614) 274-6899
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Magnetic Testing Level 2

Magnetic Testing Level 2 (MT2) - Engineering, Materials and Components (EMC) Sector Examination Scheme in Accordance with CAN/CGSB-48.9712-2022

Examination Part	Pass Grade	Examination Content	Duration
General Written Examination	≥70%	<ul style="list-style-type: none"> 40 multiple choice questions on the theoretical principles of MT. 	1 hour & 20 minutes
EMC (Specific) Written Examination	≥70%	<ul style="list-style-type: none"> 50 multiple choice questions (total) <ul style="list-style-type: none"> ➤ 20 questions on materials & processes and discontinuities. ➤ 10 questions on a code (worth 4 pts each) ➤ 20 questions on MT applications and techniques. 	2 ½ hours
Practical Examination	≥70% (on each specimen/subpart)	<ul style="list-style-type: none"> Performance/Calibration checks Four (4) specimen inspections, including inspection reports for each. <ul style="list-style-type: none"> ➤ Two specimens inspected with a yoke using black magnetic particle fluid. ➤ Two specimens inspected using the wet fluorescent method. Detailed written instruction for one (1) of the inspected specimens. 	8 hours



Reference Material for MT2 EMC Written Examination Preparation

General and EMC Examinations

1. Principals of Magnetic Particle, C.E. Betz
2. ASM Metals Handbook – Volume 17; by ASM International
3. Magnetic Particle Inspection a Practical Guide; by M. J. Lovejoy 1993 edition
4. Handbook of Non-destructive Evaluation, 2nd edition; by Chuck Hellier
5. Non-destructive Testing Handbook – Electromagnetic Testing; by ASNT
6. Non-destructive Testing Handbook – Magnetic Testing; by ASNT
7. Non-destructive Testing Handbook – Volume 6 2nd edition; by ASNT
8. General Dynamics Classroom Training Handbook CT-3; by PH Diversified
9. General Dynamics Classroom Training Handbook CT-6-2 - Latest Edition
10. Personnel Training Publications, Magnetic Particle Testing; by ASNT

Materials and processes

Although Materials & Processes (M&P) training is a prerequisite to all NDT training, method-specific M&P content is still a component of the NDT certification examinations. The following reference material may have been used to prepare examination questions:

1. Basic Metallurgy for Non-destructive Testing by BINDT
2. Materials and Processes for NDT Technology by ASNT
3. Non-destructive Testing Handbook, Introduction (PI-4-1) by General Dynamics
4. Metallurgy for the Non-Metallurgist. Second Edition by ASM International

Codes and Standards

The following four (4) codes/specifications/techniques were utilized to draft the MT2 EMC examination questions on codes (new codes/questions may be added periodically):

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

Note: Most of the subjects covered by the General and EMC written examinations are found in the above publications; however, additional studying from other reference material may be useful.

**Sample Questions: MT2 General Written 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) magnetic zone
 - b) confederation
 - c) domain
 - d) magnetic regime

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) antimagnetic.

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° to the magnetic field.
b) 45° to the magnetic field.
c) 90° to the magnetic field.
d) 90° 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:
a) inherent defects.
b) service defects.
c) processing defects.
d) all of the above.

Answer Key:

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)	

**Sample Questions: MT2 EMC Written Examination**

1. Grain boundaries are areas of a metal microstructure:
 - a) where high melting point constituents are concentrated.
 - b) made up of rows of atoms arrayed in straight lines.
 - c) that are not attacked by etchants and generally stand in relief during metallographic examination.
 - d) where low melting impurities tend to concentrate.
2. Steels that contain more than 0.30 percent carbon, if welded, are prone to which type of discontinuity?
 - a) Heat affected zone cracking
 - b) Porosity
 - c) Incomplete fusion
 - d) Slag formation
3. Most manufacturing defects in a tube are:
 - a) axial in direction.
 - b) circumferential in direction.
 - c) on the outside of the tube.
 - d) subsurface.
4. What are the three main types of corrosion?
 - a) General corrosion, pitting and intergranular corrosion
 - b) General corrosion, pitting and transgranular corrosion
 - c) General corrosion, intergranular corrosion and transgranular corrosion
 - d) Transgranular corrosion, intergranular corrosion and pitting
5. Where is the most logical place, on a casting, to look for discontinuities?
 - a) on the top surface
 - b) on the bottom surface
 - c) at internal surfaces
 - d) at junctions between light and heavy sections
6. What is the cause of cracks in the heat-affected zone?
 - a) a thermal cycle that increases hardness and reduces brittleness
 - b) a thermal cycle that reduces hardness and increases brittleness
 - c) a thermal cycle that reduces hardness and brittleness
 - d) 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:
- permeability
 - diameter
 - length
 - 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?
- code
 - standard
 - procedure (instruction)
 - specification
11. The width of a magnetic particle indication:
- indicates flaw depth
 - is always wider than the actual flaw opening
 - is equal to the height of particle indication
 - 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:
- only inside diameter surface flaws can be found
 - only outside diameter surface flaws can be found
 - both inside and outside surface and subsurface flaws can be found if the wall thickness is not too great
 - 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)?
- 100 amps
 - 2000 amps
 - 4000 amps
 - 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?
- a) Magnetize in another direction
 - b) Demagnetize then remagnetize in the desired direction
 - c) Use lower amperage
 - d) Use more amperage
18. If a discontinuity is shallow and broad like a scratch, the flux lines may streamline below the discontinuity. This will result in:
- a) a false indication
 - b) a non-relevant indication
 - c) a sub-surface indication
 - d) a lack of indication

Answer Key:

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)						



General Information for the MT2 EMC Practical Examination

Prior to the attempting the practical examination, the candidate should be aware of the following:

1. The duration of the MT2 practical examination is a maximum of 8 hours (1 day).
2. The MT2 practical examination is a closed book examination. The following items are strictly **forbidden** and must be left outside the laboratory/examination room.
 - Books, notes and papers belonging to the candidate.
 - Electronic devices (cell phones, tablets, cameras, etc.).
 - Other items which could provide answers/information for examination questions/content or are capable of recording examination material.
3. The candidate is **not** allowed to bring their own equipment and is **not** allowed to take the examination documents, equipment or specimens out of the laboratory/examination room. All reporting must be completed within the laboratory/examination room:
4. The candidate will be supplied with the necessary examination equipment and accessories as per NRCan NDTCB examination centre requirements, as well as all reporting sheets, any additional examination documents, and additional paper supplies (provided by the examination centre) as needed to complete the examination.
5. The candidate will be shown the operation and placement of equipment and accessories required to complete the examination. Candidates are advised to review the candidate instructions included with the examination documents.
6. Surface preparations are **not** permitted on the examination specimens. The candidate is requested to **not** mark the specimens, equipment and reference samples.
7. The candidate is required to demagnetize the specimens at the completion of the examination.
8. The candidate may ask questions concerning the examination. The invigilator may refuse to answer any questions that may be considered part of the examination requirements.
9. The candidate has the opportunity to provide feedback concerning the practical examination. After completing the examination, the candidate will complete the comment sheet and place it into the return envelope with the examination paper(s) prior to sealing the envelope. The comment sheet will then be sent to the NRCan NDTCB along with the examination in the sealed return envelope.

Note: If the candidate is operating unsafely or improperly while attempting their practical examination, it is the prerogative of the invigilator to discuss this situation with the candidate and, if necessary, terminate the practical examination. All such actions, as well as any special assistance given to the candidate, will be reported to the NDTCB examiner on the invigilator's assessment sheet.



MT2 EMC Practical Examination Program

MT2 EMC Practical Examination candidates shall complete the following:

1. Performance/Calibration Check

Perform three (3) performance/calibration tests:

- Plot the amperage output versus equipment setting on graph paper.
- Determine and record (including the units of measurement) the particle concentration of the wet bath. Ensure that it meets the minimum required before proceeding with the examination.
- Measure and record (including the units of measurement) the highest black light intensity. Ensure that it meets the minimum required before proceeding with the examination.

2. Specimen Inspection

Inspect four (4) specimens:

- Inspect two specimens using the wet fluorescent method.
- Inspect two specimens with a yoke using magnetic particle fluid.
 - The yoke can only be used to inspect the 2 specimens intended; invigilators are instructed to terminate the examination if the yoke is used on any other specimen.
- Complete the reporting sheets/illustrations provided with the specimen.

Note: Draw the appearance of the indications on the illustrations provided as accurately as possible and make a preliminary interpretation of your findings. Show the relative size, shape, length and location of the indications and ensure the inspection techniques are clearly shown. When necessary, draw a sketch of a missing view.

3. Written Instruction

Complete a written instruction for one of the specimens. The instruction must be written in a way that will enable another MT inspector to easily follow the steps and duplicate the results. It should include:

- a) Foreword – Scope of the inspection and reference documents.
- b) Personnel qualification requirements.
- c) List of equipment and accessories used.
- d) Description of the examination specimen, area of interest and purpose of the test.
- e) Description of test conditions and calibration procedures specific for the examination specimen.
- f) Detailed inspection procedures and settings specific for the examination specimen.
- g) Recording and classifying of test results.
- h) Reporting the results.

Note: A candidate may use the general information accompanying the exam specimen for writing the instruction; however, the candidate must ensure to write a specific instruction to inspect the specific specimen.



Suggestions for Success: MT2 EMC Practical Examination

1. Ensure that you have sufficient experience and knowledge in MT inspection prior to booking your practical examination.
2. When you begin your practical examination, ensure that you carefully read the examination instructions prior to proceeding with the examination requirements.
3. Do not spend too much time on one section of the examination at the expense of the other sections. We suggest that you devote:
 - 30 minutes to read instructions and familiarize yourself with the requirements.
 - 1 hour to conduct the performance/calibration test.
 - 5½ hours to inspect the four (4) examination specimens.
 - 1 hour to write an NDT instruction for one of the examination specimens.
4. Sequence of shots: The coil shots should always be last, after head shots and central conductor shots.
5. Correct amperages: A general criterion of 800 - 1200 amps per inch of solid diameter for head shots.
6. Ensure that you know and utilize the ASME Sec. V Coil Formulae.
7. Look under pads and inside examination specimens to avoid missing indications.
8. Fill in the reporting sheets clearly, completely and concisely, ensuring that you show the correct length and location of indications.
9. Ensure that you write a complete written instruction as indicated in the candidate instruction document.
10. The candidate may ask questions concerning the examination. However, the invigilator may refuse to answer any question if it is considered part of the examination requirements.



Sample MT 2 Initial Practical Examination Reporting Sheet

Wet Bench

Candidate Name: _____ NRCan NDTCB Registration #: _____

DATE: _____

Conduct the MT Specimen Inspection and record the results as indicated in the table below.
NOTE: Ensure that you follow the instructions in the “Magnetic Testing Level 2 Initial Practical Examination Candidate Instructions” exam document, including the “**Evaluation Criteria Procedure**”.
 Ensure that you mark **ALL** indications in **RED** on the illustration provided with the Specimen.

Specimen #: Sample 1 Wet Bench Residual
 Yoke Continuous

Pre Inspection: I made sure that the specimen is cleaned and I carried out a visual inspection noting and surface irregularities. I consulted the Evaluation Criteria for rejectable indications.

Shot #	Type of Shot	Amperage	Remarks
1	Central conductor	600	13 mm (1/2”) diameter rod
2	Head	800	
3	Coil	1200	6000 Amp. turns
	Demagnetize specimen		

Inspection Findings		
1. Fatigue crack	2. Fatigue crack	3.
4.	5.	6.

Post Inspection: Demagnetized and post cleaned specimen

Defect Interpretation/Evaluation
(Mark in RED on the Accompanying Sketch)

Accept Specimen Reject Specimen

**Sample MT 2 Initial Practical Examination Reporting Sheet****Yoke**

Candidate Name: _____ NRCan NDTCB Registration #: _____

DATE: _____

Conduct the MT Specimen Inspection and record the results as indicated in the table below.**NOTE:** Ensure that you follow the instructions in the “Magnetic Testing Level 2 Initial Practical Examination Candidate Instructions” exam document, including the “**Evaluation Criteria Procedure**”. Ensure that you mark **ALL** indications in **RED** on the illustration provided with the Specimen.Specimen #: Sample 2Wet Bench Residual Yoke Continuous

Pre Inspection: I made sure that the specimen is cleaned and I carried out a visual inspection noting and surface irregularities. I consulted the Evaluation Criteria for rejectable indications.				
Indication #	Indication Type	Indication Length	Distance from 0	Remarks
1	Transverse crack	5 cm	125 cm	
2	Longitudinal crack	50 cm	200 cm	
3	Porosity	30 cm	180 cm	
	Demagnetize specimen			
Post Inspection: Demagnetized and post cleaned specimen				
Defect Interpretation/Evaluation (Mark in RED on the Accompanying Sketch)				
Accept Specimen <input type="checkbox"/>		Reject Specimen <input checked="" type="checkbox"/>		

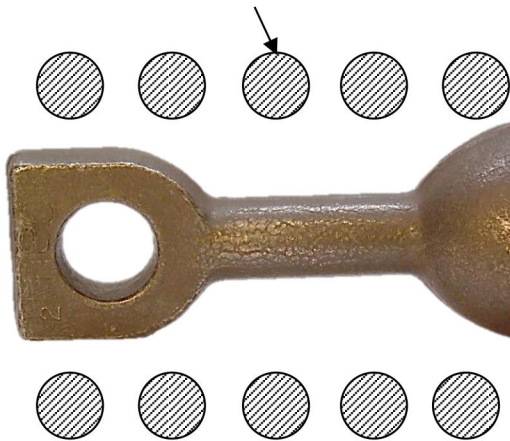


MAGNETIC PARTICLE TEST

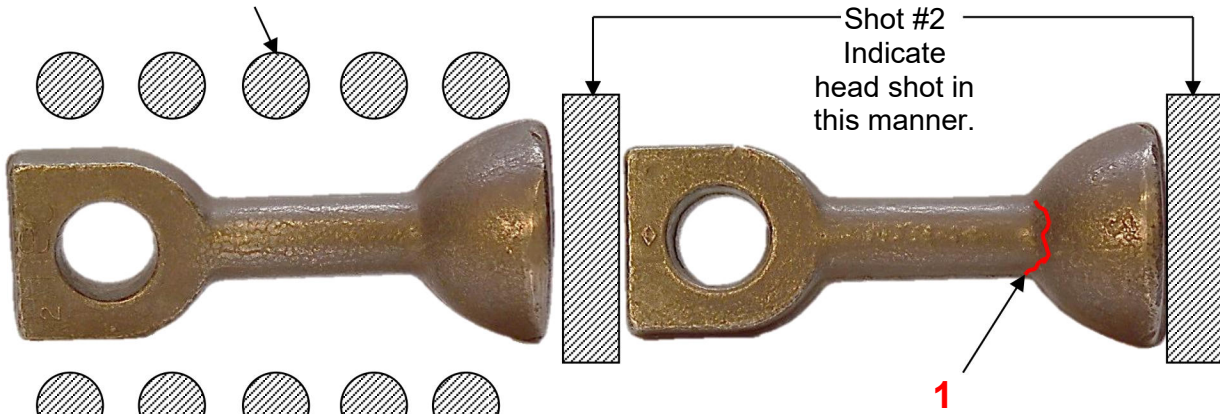
Sample 1

CONTRÔLE MAGNÉTIQUES

Shot #3 Indicate coil shot in this manner.



Shot #2 Indicate head shot in this manner.

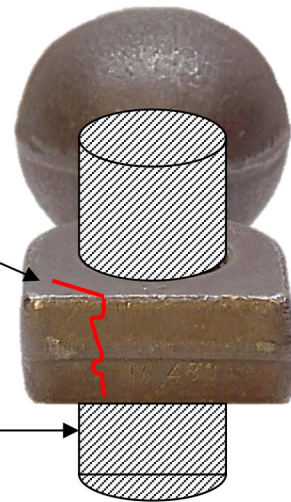


Relevant indications to be identified on the sketches by indication number and marked in RED.



2

Shot #1 Indicate central conductor in this manner.



MATERIAL DATA

- Forging
- has not been in service

INFORMATION

- pièce forgée
- n'a pas été en service

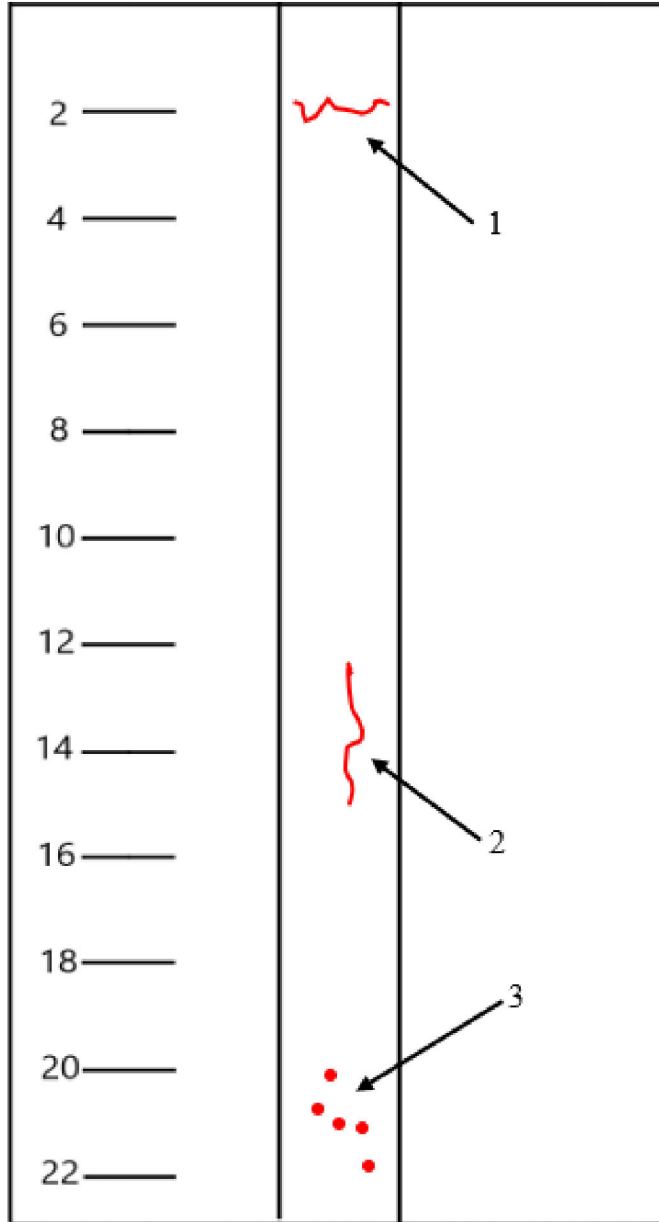
SUR LA PIÈCE



MAGNETIC PARTICLE TEST

Sample 2

CONTRÔLE MAGNÉTIQUES



MATERIAL DATA

SAW
Carbon Steel
Has not been in service.
Inspect only with yoke.

INFORMATION SUR LA PIECE

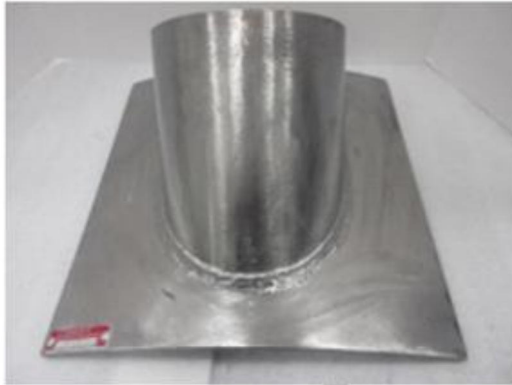
SAW
Steel de la carbon
Controle apres service
Controle avec electroaiment seulement



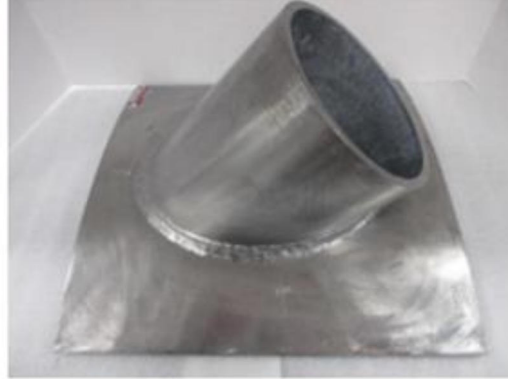
MAGNETIC PARTICLE TEST

Sample 3

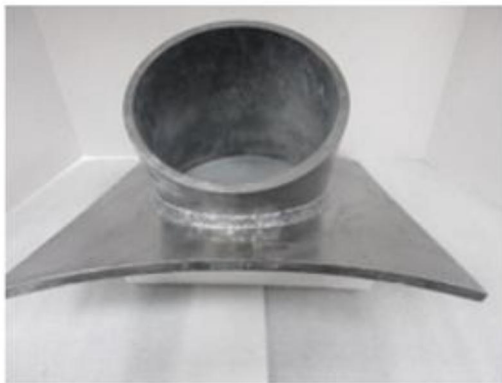
CONTRÔLE MAGNÉTIQUES



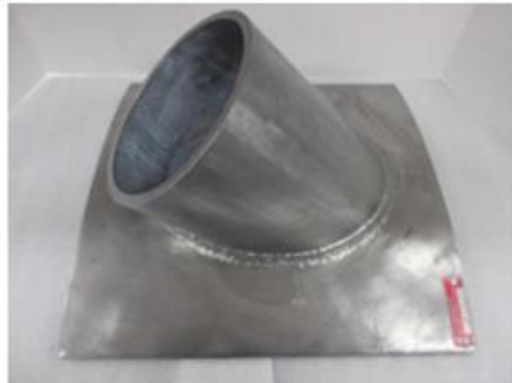
Front View (600→200)



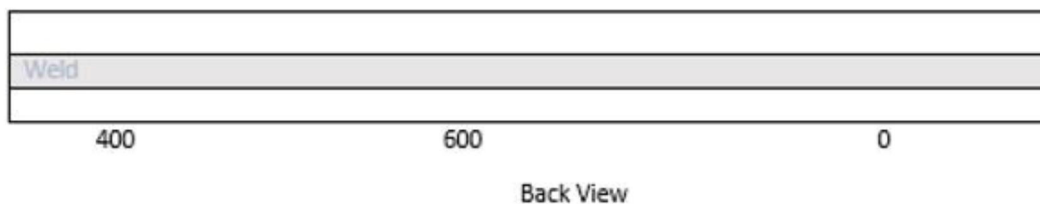
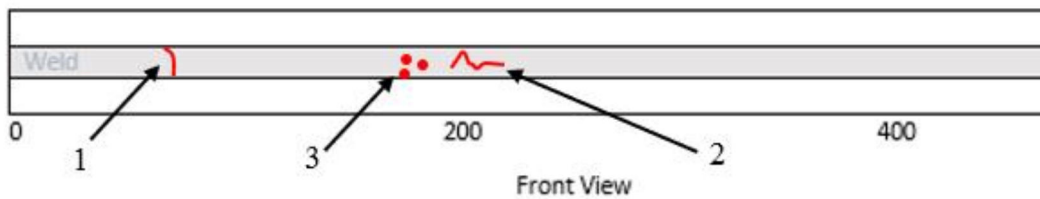
Side View (0-400→)



Back View (200→600) (Drawings not to scale)



Side View (400→0)



MATERIAL DATA

SMAW
Has not been in service.
Inspect only with yoke.

INFORMATION SUR LA PIÈCE

SMAW
N'a pas été en service
Contrôle avec électroaimant seulement



Magnetic Testing Level 3

Magnetic Testing Level 3 (MT3) - Engineering, Materials and Components (EMC) Sector Examination Scheme in Accordance with CAN/CGSB-48.9712-2022

Examination Part	Pass Grade	Content	Duration
Basic Written Examination: Parts A, B and C (Unless successfully completed during other Level 3 method certification)	≥70% (on each part)	140 multiple choice questions (total) <ul style="list-style-type: none"> • Part A: <ul style="list-style-type: none"> ➤ 70 questions on general Materials & Processes (M&P) and discontinuities specific to welds, castings, wrought products, etc. • Part B: <ul style="list-style-type: none"> ➤ 10 questions on CAN/CGSB48.9712 standard • Part C: <ul style="list-style-type: none"> ➤ 60 questions (15 questions per method) on 4 NDT methods selected by candidate. 	4 hours
General Written Examination	≥70%	<ul style="list-style-type: none"> • 30 multiple choice questions on the theoretical principles of MT. 	1 hour
EMC – Codes and Applications Written Examination	≥70%	<ul style="list-style-type: none"> • 40 multiple choice questions (total) <ul style="list-style-type: none"> ➤ 10 questions on a code (worth 5 pts each) ➤ 30 questions on MT applications and techniques 	2 hours
Written Procedure ¹ or Written Procedure Review ²	≥70%	<ul style="list-style-type: none"> • Write one NDT procedure (required for first Level 3 certification). • Option to instead review an NDT procedure (for each additional Level 3 method certification) 	4 hours or 1½ hours
EMC Practical Examination (If not successfully completed at Level 2) ³	≥70% (on each specimen/subpart)	<ul style="list-style-type: none"> • Same as level 2 examination 	8 hours



¹ Written Procedure:

This four-hour (4) examination must be completed by candidates seeking their first Level 3 method certification.

- To complete this examination, the candidate will write a method-specific NDT procedure.
- Writing a comprehensive NDT procedure that meets industrial standards may typically take several days to complete; the NDT Certification Body therefore provides Level 3 candidates (upon application approval) with a pre-examination package that includes all the information and details necessary to prepare for this examination.

² Written Procedure Review:

Candidates seeking a subsequent Level 3 method certification have the option of completing a 1½ hour procedure review examination, instead of writing another procedure examination.

- To complete this examination, the candidate will review a sample procedure that is assumed to come from their staff for review and approval.
- The candidate (as the responsible Level 3 individual/supervisor) must review the procedure and identify the mistakes and deficiencies; the candidate will record the mistakes and deficiencies directly in the procedure, adjacent to the problem area. (An example of this will be shown in the procedure review examination document.)
- The candidate must identify and report as many problem areas or deficiencies as they can find within the procedure document. Deficiencies may include, but are not limited to 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.

³ Practical Examination:

Candidates seeking direct access to Level 3 certification must successfully complete the Level 2 method-specific practical examination with a grade of ≥ 70 %.

- A candidate who is Level 2 in the same NDT method and product sector or who has successfully passed a Level 2 practical examination for the same NDT method and product sector is exempt from the Level 2 practical examination.
- Please refer to the [General Information for the MT2 EMC Practical Examination](#) and the [MT2 EMC Practical Examination Program](#).



Reference Material for MT3 EMC Written Examination Preparation

General and EMC Examinations

1. Principals of Magnetic Particle, C.E. Betz
2. ASM Metals Handbook – Volume 17; by ASM International
3. Magnetic Particle Inspection a Practical Guide; by M. J. Lovejoy 1993 edition
4. Handbook of Non-destructive Evaluation, 2nd edition; by Chuck Hellier
5. Non-destructive Testing Handbook – Electromagnetic Testing; by ASNT
6. Non-destructive Testing Handbook – Magnetic Testing; by ASNT
7. Non-destructive Testing Handbook – Volume 6 2nd edition; by ASNT
8. General Dynamics Classroom Training Handbook CT-3; by PH Diversified
9. General Dynamics Classroom Training Handbook CT-6-2 - Latest Edition
10. Personnel Training Publications, Magnetic Particle Testing; by ASNT

Materials and Processes

Although Materials & Processes (M&P) training is a prerequisite to all NDT training, method-specific M&P content is still a component of the NDT certification examinations. The following reference material may have been used to prepare examination questions:

1. Materials and Processes for NDT Technology - Latest Edition
2. Non-destructive Testing Handbook - Latest Edition
3. Basic Metallurgy for Non-destructive Testing - Latest Edition
4. General Dynamics Classroom Training Handbook CT-6-2 - Latest Edition
5. General Dynamics Classroom Training Handbook CT-6-4 - Latest Edition
6. Metallurgy for the Non-Metallurgist. Second Edition; by ASM International

EMC - Codes and Applications Examination

The following three (3) codes/specifications/techniques were utilized to draft the MT3 EMC - Codes and Applications examination questions (new codes/questions may be added periodically):

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

Basic Examination (Parts A, B & C)

1. Materials and Processes for NDT Technology, By ASNT
2. Basic Metallurgy for Non-destructive 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 Non-destructive Testing Personnel CAN/CGSB - 48.9712

Note: Candidates should familiarize themselves with the capabilities and limitations of other NDT methods when preparing for the Basic Written Examination.

Written Procedure Examination

As indicated in the MT3 EMC examination scheme (above), the candidate will be provided with (at the time of application) a pre-examination package that includes all the information and details necessary to prepare for the examination.

Note: Most of the subjects covered by the Level 3 written examinations are found in the above publications; however, additional studying from other reference material may be useful.

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**Sample Questions: MT3 General Written 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 electromagnetic 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:
- magnetic properties
 - crystalline structure
 - one is used for MPI and the other is not
 - all of the above
9. The super magnets, such as samarium cobalt and neodymium iron, are virtually impossible to demagnetize by any means other than raising their temperature over the curie point because of:
- low retentivity
 - coercivity
 - high coercivity
 - high retentivity
10. Ultimately the function of any NDT inspection is to:
- find all defects in the part tested
 - locate only those discontinuities deemed harmful in the object tested
 - ensure all parts tested will be safe to use
 - find all discontinuities that the proper use of the test method is capable of indicating

Answer Key:

1. a)	2. a)	3. b)	4. c)	5. d)
6. a)	7. a)	8. d)	9. c)	10. d)



Sample Questions: MT3 EMC Codes and Applications Written 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 are 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:
- minimum viscosity
 - maximum viscosity
 - maximum viscosity at a specified temperature
 - 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:
- double check results by magnetizing a different direction
 - verify using penetrant or ultrasonic methods
 - reject the part ("when in doubt throw it out")
 - 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?
- When the parts are large and bulky
 - When increased speed and sensitivity are desired
 - When it is desired to use the fluorescent lighting provided in many plants.
 - When the parts being inspected are to be field welded.

Answers Key:

1. d)	2. b)	3. c)	4. a)	5. c)
6. a)	7. c)	8. c)	9. b)	10. b)



Sample Questions: Level 3 Basic Written Examination

1. The Canadian standard for the certification of non-destructive testing personnel is developed and maintained by:
 - a) the Canadian General Standards Board (CGSB).
 - b) a 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:
- angle slip gauges.
 - sine bars.
 - wavelengths of light emitted by different elements.
 - gauge blocks.
9. Thermal conductivity of a metal is an important factor to consider in making quality weldments because:
- some metals, such as aluminum, have a low conductivity which results in weld defects due to localized heat build-up.
 - 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.
 - in some metals, such as aluminum, very high temperature gradients are produced, causing stresses during cooling.
 - none of the above.
10. Fracture is a type of material failure. Of the following, which is another type of material failure?
- Fracture mechanics
 - Low frequency dynamic loading
 - Permanent deformation
 - 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:
- coke, ore and oxygen.
 - bauxite, ore and air.
 - coke, ore, limestone and air.
 - coke, ore, limestone and bauxite.
12. The reason for putting ingots in a soaking pit is:
- to control the direction of crystallization.
 - to homogenize the structure and composition of the ingots.
 - to permit slow cooling of the ingots.
 - to bring them to the temperature required for rolling.
13. An advantage of using green sand molds over dry sand molds is:
- green sand molds are stronger than dry sand molds and thus are less susceptible to damage in handling.
 - surface finishes of large castings are better when using green sand molds.
 - overall dimensional accuracy of the mold is better with green sand.
 - 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:
- fully automated.
 - semi-automated.
 - carried out manually.
 - all of the above.



15. In the resistance spot welding of low carbon steel, the heat generated is:
- concentrated between the positive electrode and the work.
 - concentrated at the interface of the two plates to be welded.
 - concentrated between the negative electrode and the work.
 - evenly distributed in the work between the electrodes.
16. Which of the following is not a brazing process?
- Furnace brazing
 - Induction brazing
 - Infrared brazing
 - Electron beam brazing
17. Completely recrystallized hot rolled steel products have:
- exactly the same mechanical properties in the longitudinal and transverse directions.
 - superior mechanical properties in the direction of rolling.
 - superior mechanical properties in the transverse direction.
 - 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:
- inclusions.
 - seams.
 - cold shots.
 - bursts.
19. Bursts are caused by:
- casting at too low a temperature.
 - forging metal which is either too hot or too cold.
 - insufficient reduction in size is attempted in one forging operation.
 - none of the above.
20. Slag inclusions in welds are caused by:
- wide weaving.
 - incomplete de-slagging of a previous pass.
 - moisture entrapped in the joint.
 - 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?
- no change in exposure time is needed.
 - exposure time should be about 11% longer.
 - exposure time should be about 37% longer.
 - exposure time should be from 62 to 100% longer.
22. In ultrasonics, increasing the length of the pulse to activate the search unit will:
- decrease the resolving power of the instrument.
 - increase the resolving power of the instrument.
 - have no effect on the test.
 - 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:
- circular method with magnetic field parallel to keyway.
 - circular method with magnetic field perpendicular to keyway.
 - using central conductor.
 - all of the above.
24. Which of the following physical properties, more than any other, determines what makes a material a good penetrant?
- viscosity.
 - surface tension.
 - wetting ability.
 - 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.
- steel
 - aluminum
 - copper
 - brass

Answer Key:

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)							