

Course Name: CGSB Magnetic Particle Testing (MT) Level 2

Course Description

The CGSB Magnetic Particle Testing (MT) Level 2 course teaches the principles of magnetism and how they are applied in non-destructive testing (NDT). The goal of the course is to help students understand not only the testing methods but also the underlying principles and reasoning. Students learn Magnetic Particle Testing techniques for detecting defects in various ferromagnetic materials, including castings, forgings, and weldments, as well as the related equipment, accessories, inspection procedures, and standards. The course covers test principles, applications and limitations, test variables, calibration and performance checks, sensitivity evaluation, and result interpretation, including both theoretical and practical components designed to meet NRCan and CAN/CGSB-48.9712 requirements. The skills gained in this course help prepare students to meet the training requirements for MT Level 2 according to the CGSB 48.9712-2022 standards. ***Before enrollment, students must complete the Math requirement and pass the Materials and Processes examination.***

Course Duration

Total 40 hours (60% Theory + 40% Practical)

Delivery Method

Training takes place at A. I NDT Labs Training Facility, located at #3120-580 Nicola Avenue, Port Coquitlam.

Course Curriculum

Section	Subject
1.Introduction	1.1 History and Discovery of Non-destructive Testing and Magnetic Particle Testing 1.2 Purpose of magnetic particle testing ● At what stage of the life of a “product” is NDT performed? ● How does it add value? ● Responsibilities of each level of certification. ● NRCan NDTCB Code of Conduct 1.3 Basic principles 1.4 Capabilities and limitations of MT 1.5 Types of magnetic media commercially available 1.6 Terminology associated with Magnetic Particle Testing
2.Principles of Magnets and Magnetic Fields	2.1 Theory of magnetic fields ● Earth’s magnetic field ● Magnetic fields around magnetized materials ● Flux patterns ● Frequency and voltage factors ● Current calculations ● Surface flux strength ● Subsurface effects 2.2 Theory of magnetism ● Magnetic poles ● Law of magnetism ● Materials influenced by magnetic fields ○ Ferromagnetic ○ Paramagnetic ○ Diamagnetic ● Distance factors vs. strength of flux ● Internal and external flux patterns ● Phenomenon action at the discontinuity ● Heat effects on magnetism ● Material hardness vs. magnetic retention ● Magnetic characteristics of nonferrous materials 2.3 Terminology associated with magnetic particle testing
3.Characteristics of Magnetic Fields	3.1 Bar magnet 3.2 Ring magnet 3.3 Direct current ● Depth of penetration factors ● Source of current

	3.4 Direct pulsating current ● Similarity to direct current ● Advantages ● Typical fields 3.5 Alternating current ● Cyclic effects ● Surface strength characteristics ● Safety precautions ● Voltage and current factors ● Source of current
4.Effects of Discontinuities on Materials	4.1 Scratches 4.2 Surface defects 4.3 Subsurface defects 4.4 Design factors ● Mechanical properties ● Part use 4.5 Relationship to load-carrying ability
5.Magnetization by Means of Electric Current	5.1 Circular field ● Field around a straight conductor ● Right-hand rule ○ Current Flow ○ Electron flow ● Field in parts through which current flows ○ Long, solid, cylindrical, regular parts ○ Irregularly shaped parts ○ Tubular parts ○ Parts containing machined holes, slots, etc. ● Methods of including current flow in parts ○ Contact plates ○ Prods ○ Central conductors ○ Through cables ○ Contact leeches ● Discontinuities commonly discovered by circular fields 5.1.1 Circular techniques

- Current calculations
- Depth-factor considerations
- Precautions - safety and overheating
- Contact plates and prods
 - Requirements
 - Current-carrying capabilities

5.2 Longitudinal field

- Field produced by current flow in a coil
- Field direction in a current-carrying coil
- Field strength in a current-carrying coil
- Discontinuities commonly discovered by longitudinal fields
- Advantages of longitudinal magnetization
- Disadvantages of longitudinal magnetization

5.2.1 Longitudinal technique

- Principles of induced flux fields
- Geometry of part to be inspected
- Shapes and sizes of coils
- Use of coils, cables, and yokes
 - Strength of the field
 - Current directional flow vs. flux
 - Field
 - Shapes, sizes, and current
 - Capacities

5.3 Current calculations

- Formulas
- Types of current required
- Current demand

5.4 Multidirectional magnetization

6. Selecting the Proper Method of Magnetization

6.1 Alloy, shape and condition of part

6.2 Type of magnetizing current

6.3 Direction of magnetic field

6.4 Sequence of operations

6.5 Value of flux density

7.Inspection Materials	7.1 Inspection particles ● Wet particles ● Dry particles 7.2 Liquids and powders ● Safety precautions ● Liquid requirements as a particle vehicle ● Temperature needs ● Powder and paste contents ● Mixing procedures ● Need for accurate proportions
8.Principles of Demagnetization	8.1 Residual magnetism 8.2 Reasons for requiring demagnetization 8.3 Longitudinal and circular residual fields 8.4 Basic principles of demagnetization 8.5 Retentivity and coercive force 8.6 Methods of demagnetization 8.7 Current, frequency and field orientation 8.8 Heat factors and precautions 8.9 Need for collapsing flux fields
9.Magnetic Particle Testing Equipment	9.1 Equipment-selection considerations ● Type of magnetizing current ● Location and nature of the test ● Test Materials used ● Purpose of the test ● Area inspected 9.2 Manual inspection equipment 9.3 Medium and heavy-duty equipment 9.4 Portable type ● Reason for portable equipment ● Capabilities of portable equipment

- Similarity to stationary equipment

9.5 Stationary equipment

- The capability of handling large and heavy parts
- Flexibility in use
- Need for stationary equipment
- Use of accessories and attachments

9.6 Mechanized inspection equipment

- Semi-automatic inspection equipment
- Single-purpose semi-automatic equipment
- Multi-purpose semi-automatic equipment

9.7 Automatic type

- Requirements for automation
- Sequential operations
- Control and operation factors
- Alarm and rejection mechanisms

9.8 Black light type

- Black light and fluorescence
- Visible and black light comparisons
- Requirements in the testing cycle
- Techniques in use

9.9 Light-sensitive instruments

- Need for instruments
- Light characteristics

10.Types of Discontinuities Detected by Magnetic Particle Testing

10.1 Recognizing the appearance of cracks, seams, stringers, flakes, forging bursts, laminations, laps, cold shuts, porosity, blowholes, inclusions, pipes, and shrinkage tears.

10.2 General types of discontinuities and flaws, defects most commonly found in wrought, cast and welded products and their general appearance.

11.Interpretation and Evaluation of Indications

11.1 Vision

- Anatomy of the eye

- Understanding the mechanics of vision: rods and cones
- Colour perception
- Vision limitations, scotopic and Photopic vision
- Personnel dark adaptation, visual acuity, and viewing time

11.2 Non-relevant and false indications

11.3 Evaluation Techniques

- Use of standards
 - Need for standards and references
 - Comparison of known with unknown
 - Specifications and certifications
 - Comparison techniques
- Defect appraisal
 - History of part
 - Manufacturing process
 - Possible causes of the defect
 - Use of part
 - Acceptance and rejection criteria

12. Standards, Codes, Specifications and Reports

12.1 Standards CAN/CGSB-48.9712, Certification Scheme

12.2 Specifications and Codes

- Interpretation of specifications and codes
- Definition of the scope of the examination
- Definition of acceptance criteria
- Establishing specifications
- Technical evaluation of the given specification

12.3 Reports

- Establishing reports
- Technical estimation of reports
- Technical evaluation of reports
- Implementation of corrective action

13. Quality Control of Equipment and Processes

13.1 Malfunctioning of equipment

13.2 Proper magnetic particles and bath liquid

13.3 Process control

- Technique sheets
- Control of wet method particle concentration
- Brilliance and contamination

- Verifying illumination
 - White light
 - Ultraviolet light
- Calibration of current output using shunts
- Verifying the magnetic field
- Quick break test

14.Human Factors Affecting Quality of Testing

Factors that may influence work related behaviour.

14.1 The inspector's health

14.2 The inspector's mental attitude and any fatigue

14.3 Understanding the role of inspection

(e.g. thoroughness, carefulness, and vigilance).

14.4 What influences the inspector's probability of detection.

14.5 Understanding the NRCan NDTCB Code of Conduct.

15.Other NDT Methods

15.1 Certification and accreditation of NDT facilities

16.Creating a Written Instruction

16.1 Ability to prepare a detailed NDT instruction providing written step-by-step information on the testing of a sample and to prove the instruction by application

Overview:

- requirements of test personnel
- safety precautions

Identification or description of test specimen:

- surface condition
- object to be tested
- kind of manufacture
- extent of test coverage

Test conditions and application:

- accessibility
- equipment, calibration standards, and accessories
- particular inspection stage

Technique and sequence performing test:

	● surface preparation ● order of inspection ● report of finding size, location ● post-test operations
17. Creating a Written Procedure	17.1 Ability to prepare a detailed NDT procedure whose content would include the following: ● Scope ● Reference documents ● Definitions ● Safety precautions ● Personnel qualification and certification ● Part/Product identification and datum ● Surface preparation ● Extent of Inspection ● Equipment details, calibrations, and checks ● Inspection technique ● Results assessment, flaw characterization, interpretation, and evaluation against acceptance criteria ● Noncompliance and disposition ● Reporting ● Tables/figures/appendices

What to bring

Students are required to bring a scientific calculator, pens, pencils, and a ruler to class. For lab sessions, safety shoes (steel-toed) and long pants are mandatory for safety.

Instructor

Our company has five certified instructors, each holding CGSB/CWB Level 2 and Level 3 certifications and P.Eng. designation in their respective NDT methods. They bring extensive industry experience and practical knowledge to ensure high-quality, professional training.

Entrance requirement

1) Majority

The age of majority requirement comes into effect for the date of certification issuance, not the application submission date.

*All participants must submit a copy of their ID to verify their legal age.

2) English Proficiency

Participants from abroad must demonstrate English proficiency to ensure successful participation in the course. Acceptable proof includes:

- CLB minimum 6, or
- Completion of a high school or post-secondary program in a country where English is the primary language (transcripts may be accepted).

3) Pre-requisites

In order to take the CGSB PT course, all participants must provide evidence of completion for the following subjects;

(1) Math for NDT

Participants shall demonstrate that they have completed Math. This can be achieved by submitting proof of completion using one of the following methods:

- Transcript of Math for NDT exam at AEC or
- Transcript of Math for NDT exam at RTO

(2) Materials & Processes

- Transcript of a minimum of 32 hours of the Materials & Processes course at RTO or
- The transcript shall indicate that they have scored 70% or higher

Student Evaluation

1) Attendance

If a participant does not attend the course at least once, they cannot pass the course even if they receive a passing grade.

2) Quiz

The instructor may administer two quizzes throughout the course.

3) End-of-Course Exam

The end-of-course exam is administered after the completion of the entire course.

4) The Final Grade

The participants must achieve a passing grade ($\geq 70\%$) on the final examination for certification.

Remediation policy

- If the students fail the final course exam, he/she may re-take the one-time repeat exam in 2 weeks.
- The students who achieve a failing grade of 60% or above may apply to attempt a repeat exam immediately.