# NZ Non Destructive Testing Association Inc.

**C/- HERA, PO Box 76-134 Manukau City, Auckland 2241**


**COURSE TITLE** **MAGNETIC PARTICLE INSPECTION Level 2**

**COURSE CODE** **MT20A**

**Revision** **Initial Issue Dated 01 June 2021**

## Purpose:

The body of technical knowledge required of non-destructive testing (NDT) personnel is essential for maintaining the quality level of all NDT inspections regardless of method or technique. The content and expected outcomes of this course are designed to cover the Magnetic Particle (MT) inspection of all product forms for evaluation of surface and near surface discontinuities ((Manufacturing and In-service) at qualification Level 2 (ISO 9712).

This course is also designed to prepare the trainee for the **Theory** (Formal Training) part of the CBIP Magnetic Particle certification **MT2**

Practical training and assessments have been included in this course for demonstration purposes and to confirm the adequacy of the training.

Introduction to specialized inspection techniques such as Multidirectional Inspection and Magnetic Flux Leakage Testing are included in the training, however additional formal training in these categories will be required before applying for certification in these techniques

## Competency Standards:

This course and associated training materials have been designed to comply with the following documents

ISO 9712-2012 -Non-Destructive Testing - Qualification and Certification of NDT Personnel

ISO/TS 25107:2019 - Non-destructive testing — NDT training syllabuses

CBIP PRO-CER-18 - Guidelines for certification General

CBIP PRO-CER-14 - Guidelines for certification Magnetic testing

**Learning Outcome:**

Trainees will be able to demonstrate knowledge of the Magnetic Particle inspection process including practical applications and Interpretation and evaluation at Level 2

They should be able to perform the following;

- Select the MT technique to be used based on general specifications (AS 1171)
- Define the limitations of MT (Magnetic Particle) method.
- Translate MT standards, specifications and procedures into written instructions.
- Set up and verify equipment settings and perform MT inspections including interpretation and evaluation of results according to applicable standards
- Provide supervision and guidance for personnel at or below Level 2,
- Report the results of Magnetic Particle Inspections.

**For Whom**

Personnel involved in the MT inspection of all product forms for surface and near surface discontinuities and personnel seeking MT certification to Level 2 iaw CBIP PRO-CER-14 and ISO 9712.

**Prerequisite**

This course is designed for personnel seeking qualification directly to **MT Level 2**. Level 1 certification (or equivalent) is not a prerequisite for this course, ***however it is strongly advised that trainees have a basic understanding of the method along with some practical experience with both portable and bench equipment.***

Theory and Practical training hours are based upon the candidate possessing both prior knowledge of materials and processes and exposure to the basic magnetic particle processing steps (including inspection).

If the CBIP certification exams are to be attempted at the completion of this course, it is recommended that the candidate have at least 2 months practical experience in the MT method in addition to this course.

Trainees shall also have an understanding of English (written and spoken) to a level of TOEFL 500

**Course Duration**

The course will be delivered over a period of 40 hours covering (5 days).
A course plan detailing the expected timetable will be issued to the trainee at the start of the course. The course will consist of theory lecturers, practical exercises and assessments as detailed in the course programme and attached syllabi.

The practical content of this course can be delivered at a remote training facility or at the trainee's workplace.

## Instructor

Course instructors shall be accepted by NZNDTA and their adequacy documented.
Instructors should be qualified to L3 (or equivalent as determined by NZNDTA) in the Magnetic Particle method.

## Assessments:

Informal assessments will be allocated to trainees at the end of each day. These will be used for determining training effectiveness. The end of course assessment shall consist of a minimum of 40 questions adapted from the ASNT Recommended Practice SNT-TC-1A question and answer book. To successfully complete this course a minimum pass mark of 70% is required
***CBIP certification exams need to be applied for separately – Additional charges apply***

## Resources:

Trainees will be issued with training notes and handouts reflecting the training presentation as identified in the course program.
Course evaluation/feedback forms will also be supplied and, upon successful completion of all modules, an NZNDTA endorsed completion certificate will be issued.

Trainees will also be provided with a list of training material required along with any Health and Safety requirements prior to commencement.

## Course Delivery

The course may be delivered by one (or a combination) of the following

A. ***Computer based interactive webinar***.- This will be confined to specific theory modules that do not include any practical content or where trainees are required to have only minimal participation. Trainees will have the ability to communicate with the instructor and other participants. Learning outcomes and training effectiveness will be evaluated by written assessments delivered at the end of each module

C ***Classroom***.- Interactive classroom training where the trainee has access training material, equipment and test pieces.

B ***Home study***. - Trainees will be given written assessments that require them to review and interpret the training material at the end of each day/module

D ***Workplace Practical Exercises*** – Trainees will be given written practical exercises that can be completed at their normal place of work. This will enable trainees to access additional equipment and resources to complement their training. These will be supervised by the instructor or delegated representative to confirm and supervise the effectiveness of the training. The delegated representative will be approved by the instructor and NZNDTA and will be at least MT Level 2 and IANZ signatory. This may be the trainees employer/supervisor. Training effectiveness will be evaluated by specific checks documented at each stage of the exercise.

## Course Program and Syllabi

The Course syllabus is designed to comply with CBIP PRO-CER-14 and ISO 25107

## Appendix A

The course syllabi and instructor guide (appendix A) will detail the acceptable delivery system(s) and timing for each module.

Practical exercises are documented at the end of appendix A along with itemised practical training samples required for each exercise.

Minimum requirements for the MT equipment used for the practical exercises are also included.

## Documentation Control

Course documentation will be approved, controlled and owned by NZNDTA.

## Course APPROVAL:

NZNDTA Rep _____

MT Level 3 _____

# Appendix A

# Course MT20A
# Magnetic Particle Inspection Level 2

### Course Syllabi and Instructor Time Table

**The following referenced material has been used to develop the structure and content of this MT course MT20A**

- CBIP PRO-CER-18 and 14 Training Guidelines
- ISO/TS 25107 Non-destructive testing — NDT training syllabus
- ANSI/ASNT CP-105 Qualification outlines
- ASNT Training handbook – Magnetic Particle Testing
- NDE/NDT Resource Centre
- OEM supplied equipment training material

| **Module 1**<br>**Introduction to terminology and history of Magnetic Particle testing (MT)** | |
|---|---|
| **Content** | **Timeframe and notes** |
| Introduction to NDT and Certification (ISO9712) | **Notes**<br>**3 hours** |
| Certification Examination overview | |
| Definitions | |
| Introduction to NDT | |
| Magnetic Particle Limitations and capabilities | |
| MT overview - Why How and Why | |
| History of Magnetic Particle Inspection | |
| Developments – Actinic lighting and Robotics | |
| Confirmation of training effectiveness - Module 1 | • Review questions |

| Module 2<br>Magnetism | | |
|---|---|---|
| **Section** | **Content** | **Timeframe and notes** |
| Magnetism | Magnetic Theory | **Notes**<br><br>**2.5 hours** |
| | Magnetic Domains | |
| | Dia, Para, and Ferromagnetic Materials | |
| | Bar Magnet | |
| | Magnetic Poles | |
| | Horseshoe and Ring Magnets | |
| | Magnetic Lines of Force | |
| | Electromagnetic Fields | |
| | Magnetic fields in a Coil | |
| Magnetic properties | Field Strength | **Notes**<br><br>**2.5 hours**<br><br>**(End of Day 1)** |
| | A/m, Oersted, Gauss, Tesla | |
| | Magnetic Flux and Flux Density | |
| | Magnetising Force | |
| | Hysteresis Loop and B/H Curve | |
| | Permeability | |
| | Permeability values of various materials | |
| | Relative permeability | |
| | Permeability vs Temperature | |
| Confirmation of training effectiveness - Module 2 | | • Review questions |

| Module 3<br>Magnetisation of Ferromagnetic Materials | | |
|---|---|---|
| **Section** | **Content** | **Timeframe and notes** |
| Magnetising Methods | Magnetic field orientation | **Notes**<br><br>**2 hours** |
| | Flaw dectability | |
| | Sub Surface Inspection | |
| | Direct vs Indirect | |
| | Circular Magnetisation | |
| | Longitudinal Magnetisation | |
| Magnetising Currents | AC | |
| | HWDC | |
| | FWDC | |
| | Three phase full wave DC | |
| | Skin effect | |
| | Peak vs RMS | |
| Magnetic Field distribution | Magnetic vs Non Magnetic | |
| | Longitudinal | |
| | Circular | |
| | AC vs DC | |
| Demagnetisation | Curie point | **Notes**<br>**Practical exercise**<br>**1.5 hours** |
| | AC Demagnetisation | |
| | DC Demagnetisation | |
| | Demagnetisation check | |
| Confirmation of training effectiveness - Module 3 | | • Review questions |

| Module 4<br>Magnetic Field Strength | | |
|---|---|---|
| **Section** | **Content** | **Timeframe and notes** |
| Magnetic Field measurement | Min Flux density for MPI | • **Notes**<br>• **Practical exercises**<br>**2 hours** |
| | Gauss, Tesla, Weber | |
| | Oersted, kA/M | |
| | Hall-Effect meter | |
| | Pie Gages | |
| | Castro Strips | |
| | Current Formula | |
| | Prods | |
| | Circular Direct Current | |
| | Central conductor | |
| | Off set central conductor | |
| | Longitudinal current values using coil | |
| | Fill factor | |
| | Field direction and Intensity | |
| Confirmation of training effectiveness - Module 4 | | • Review questions<br>• Formula exercises |

| Module 5<br>Equipment and Materials | | |
|---|---|---|
| **Section** | **Content** | **Timeframe and notes** |
| Equipment | Permanent Magnets | **Notes**<br>**2.5 hours**<br>**(End of Day 2)** |
| | Yokes | |
| | Portable coils and cables | |
| | Wet Bench units | |
| | Central conductors and Threader Bars | |
| | Extenders | |
| | Multi Directional equipment | |
| | Inspection Lights | |
| | UV | |
| | LED lights | |
| | Dark adaption | |
| Magnetic Particles | Geometric properties | |
| | Mobility | |
| | Visibility | |
| | Dry and Wet | |
| | Suspension Liquid &concentration | |
| | Viscosity | |
| | Fluorescence | |
| Confirmation of training effectiveness - Module 5 | | • Review questions |

| Module 6<br>MT Techniques | | |
|---|---|---|
| **Section** | **Content** | **Timeframe and notes** |
| Information prior to testing | Specification, product form, acceptance standards, surface condition accept criteria & coverage | **Notes**<br>**1 hour** |
| Human Factors | | |
| MT Techniques | Dry Particle Inspection | • **Notes**<br>• **Practical exercises**<br><br>**4 hours** |
| | Wet – Fluorescent and Visible | |
| | Magnetising sequence | |
| | Magnetic Rubber | |
| | Continuous and Residual | |
| | Paint and Coatings | |
| Technique variations | Magnetic Flow | |
| | Current Flow | |
| | Threader Bar – Central Conductor | |
| | Coils | |
| | Split Coil | |
| | Spiral Coil | |
| | Induced Current | |
| Test Record and Report | | |
| Confirmation of training effectiveness - Module 6 | | • Review questions<br>• Practical exercises |

| Module 7<br>Equipment Checks | | |
|---|---|---|
| **Section** | **Content** | **Timeframe and notes** |
| Equipment checks | System performance | • **Notes**<br>• **Practical exercises**<br><br>**2 hours** |
| | Ketos ring | |
| | Particle concentration | |
| | Particle condition | |
| | Suspension contamination | |
| | Water break test | |
| | Electrical system checks | |
| | Maximum output | |
| | Ammeter check | |
| | Quick break | |
| | Shot timer | |
| | Yoke test | |
| | White light and ambient checks | |
| | UV light checks | |
| | Environmental and safety conditions | |
| Confirmation of training effectiveness - Module 7 | | • Review questions<br>• Practical exercises |

| Module 8<br>Indications | | |
|---|---|---|
| **Section** | **Content** | **Timeframe and notes** |
| Indications | Non Relevant indications | **Notes<br>1 hour<br>(End of Day 3)** |
| | Relevant Indications | |
| | Interpretation | |
| | Evaluation | |
| | Recording Indications | |
| Confirmation of training effectiveness - Module 8 | | • Review questions<br>• Practical exercises |

| Module 9<br>Product Knowledge and Manufacturing | | |
|---|---|---|
| **Section** | **Content** | **Timeframe and notes** |
| Basic manufacturing and associated discontinuities | Production of steel and fabrication processes. | **Notes<br>4 hours** |
| | Casting, Rolling, Forging and Wrought | |
| | Heat treatment | |
| | Welding | |
| | Extrusion, Tubing and Pipe | |
| | Common defects associated with the processing and finishing | |
| In-service inspection | Corrosion and cracking | |
| | Fatigue | |

| Module 10<br>Examination Preparation | |
|---|---|
| **Content** | **Timeframe and notes** |
| Production of written Instruction (Level 2) | **BINDT CP 25<br>4 hours<br><br>(End of Day 4)** |
| Theory, Specific and Practical exam review | |
| Formula | |
| AS 1171 – ISO9934-1-2-3 | |
| ASTM E 1444 | |
| Review and CBIP examinations | **8 hours - Day 5** |

| MT20A Practical Exercises | | |
|---|---|---|
| **Test Piece Description** | **Identification** | **Practical Demonstration** |
| KETOS steel ring ASTME1444 | Magnaflux S/n 98168 | • **DC bench calibration**<br>• **Subsurface defects**<br>• **Circular formula** |
| Welded bracket | MT02 | • **Portable yoke**<br>• **Weld defects**<br>• **Reporting** |
| Steering arm - Forged | S/n 513338 | • **Circular and Longitudinal formula**<br>• **Crack detection**<br>• **Written Instruction** |
| Gear | MP201 | • **Off-set threader bar**<br>• **Crack detection** |
| Bolts - Steel | MPB6, MPB8 and MPB10 | • **Longitudinal formula**<br>• **Crack detection**<br>• **Interpretation**<br>• **Reporting** |
| Lever – Cast Iron | MP26 | • **Crack detection**<br>• **Reporting** |
| IQI shims and field indicator | Magnaflux Type A RB Annis model 25 | • **Field direction and measurement**<br>• **Demagnetisation** |
| Centrifuge tube | ASTM E 1444 | • **Wet Particle concentration** |
| 10 Lb (4.5Kg) weight | Local manufacturer | • **Yoke calibration** |
| UV Light meter | Hagar - UVA | • **UV light intensity checks** |

| MT20A Practical Exercises - Equipment |
|---|
| All MT equipment used for the practical exercises shall comply with AS 1171 Section 2 with the following as a minimum<br>• AC/DC Wet horizontal bench (Threader bars, Head stocks and coil)<br>• Portable AC yoke<br>• Colour contrast (wet and dry) and fluorescent wet particles.<br>• UV inspection light<br>• Ketos ring, IQI shims, Field indicator and Centrifuge |