

## MAGNETIC ROPE TESTING (MRT)

This document provides specific information relating to the magnetic rope testing method (MRT) with special reference to:

- 1) the training program depending on the level
  - 2) the requirements to be admitted to the examination
- in accordance with the UNI EN ISO 9712 and UNI EN 12927 standards (parts 1 to 8)

### 1.1) TRAINING PROGRAM - LEVEL 1

Contents	Level 1
<b>G.1 Introduction to NDT terms and history</b>	Tasks of NDT personnel NDT history History of the MRT method Relevant terms
<b>G.2 Characteristics of wire ropes: physical and mechanical properties, types, defects, use and maintenance (UNI EN 12927 parts 1 to 8 for cableways)</b>	Physical and chemical properties Mechanical properties Magnetic properties Description of the main applications of wire ropes (cable ways, lifting equipment, lifts) Types of ropes depending on their use Production technologies Lubrication methods Rope fixing methods (hot melt heads, fixing cylinders) Maintenance of ropes during operation
<b>G.3 Physical principles of the method and associated knowledge</b>	<b>Electromagnetism concepts</b> The magnetic field and its related quantities Magnetic fields generated by currents Magnetic fields generated by permanent magnets Ferromagnetism, paramagnetism and diamagnetism <b>Brief overview of flux leakage detection methods</b> Detection principle through coils Detection principle through Hall-effect sensors <b>Brief overview of global flux detection methods</b> Detection principle through coils Detection principle through Hall-effect sensors <b>Signal Acquisition/Recording/Printing/Storing systems</b> Analog recorder Digital acquisition device Data Logger
<b>G.4 Knowledge of product and method capability</b>	<b>Applications in the various sectors</b> Applications of the instruments for cableways, in accordance with the requirements of the UNI EN 12927 standard, parts 1 to 8 Applications of the instruments for lifting of goods Application of the instruments for lifting of people
<b>G.5 Instrumentation</b>	<b>Probe heads and collectors.</b> Probe heads Collectors DataLogger Data processing SW Reporting Fixed installation of systems
<b>G.6 Information before the test</b>	<b>Overview of written instructions (prepared by a level 2 or 3 technician):</b> Objectives Requirements
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<b>Total duration</b>	

## 1.2) TRAINING PROGRAM – LEVEL 2

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<b>G.1</b> <b>Introduction to NDT terms and history</b>	Tasks of NDT personnel NDT history History of the MRT method Relevant terms
<b>G.2</b> <b>Characteristics of wire ropes: physical and mechanical properties, types, defects, use and maintenance (UNI EN 12927 parts 1 to 8 for cableways)</b>	Physical and chemical properties Mechanical properties Magnetic properties Description of the main applications of wire ropes (cable ways, lifting equipment, lifts) Types of ropes depending on their use Production technologies Lubrication methods Rope fixing methods (hot melt heads, fixing cylinders) Description of the main defects and their correlation with the rope stress Correlation of defects with application sectors Maintenance of ropes during operation
<b>G.3</b> <b>Physical principles of the method and associated knowledge</b>	<b>Electromagnetism concepts</b> The magnetic field and its related quantities Magnetic fields generated by currents Magnetic fields generated by permanent magnets Magnetic permeability Ferromagnetism, paramagnetism and diamagnetism Elementary magnetic circuits Magnetic field behaviour near discontinuities: flux leakage Characterization of the method applied to ropes <b>The magnetizing circuit</b> Analysis of simple magnetizing structures Magnetization through field coils Magnetization through permanent magnets <b>Magnetic flux leakage detection methods</b> Detection principle through coils Detection principle through Hall effect sensors <b>Global flux detection methods</b> Detection principle through coils Detection principle through Hall effect sensors <b>Detected signal analysis</b> Influence of defect position Influence of defect extension Influence of defect type (corrosion, broken wires) <b>Signal Acquisition/Recording/Printing/Storing systems</b> Analog recorder Digital acquisition device Data Logger
<b>G.4</b> <b>Knowledge of product and method capability</b>	<b>Applications in the various sectors</b> Applications of the instruments for cableways in accordance with the requirements of the UNI EN 12927 standard, parts 1 to 8 Applications of the instruments for lifting of goods Application of the instruments for lifting of people
<b>G.5</b> <b>Instrumentation</b>	<b>Probe heads and collectors</b> Probe heads Collectors DataLogger Data processing SW Reporting Fixed installation of systems

Contents	Level 2
<b>G.6</b> Information before the test	<b>Written instruction (prepared by a level 2 or 3 technician):</b> Objectives Requirements
<b>G.7</b> Inspection	<b>Preparation for the test</b> Functionality check <b>Use of detectors in the various sectors</b> <b>Safety</b> <b>Operating phases of the inspection</b>
<b>G.8</b> Interpretation and relation	<b>Track analysis</b> Defect analysis Background noise analysis <b>Visual inspection following interpretation</b> <b>Drafting of a report</b>
<b>G.9</b> Quality	<b>Personnel qualification (in accordance with UNI EN ISO 9712)</b> Tasks and duties of qualified personnel The qualification and certification system defined by UNI-EN ISO 9712
<b>Total duration</b>	

## 1.3) TRAINING PROGRAM – LEVEL 3

Contents	Level 3
<b>G.1</b> Introduction to NDT terms and history	Tasks of NDT personnel NDT history History of the MRT method Relevant terms
<b>G.2</b> <b>Characteristics of wire ropes: physical and mechanical properties, types, defects, use and maintenance (UNI EN 12927 parts 1 to 8 for cableways)</b>	Physical and chemical properties Mechanical properties Magnetic properties Description of the main applications of wire ropes (cable ways, lifting equipment, lifts) Types of ropes depending on their use Production technologies Lubrication methods Rope fixing methods (hot melt heads, fixing cylinders) Description of the main defects and their correlation with the rope stress Correlation of defects with application sectors Maintenance of ropes during operation
<b>G.3</b> <b>Physical principles of the method and associated knowledge</b>	<b>Elettromagnetism concepts</b> The magnetic field and its related quantities Magnetic fields generated by currents Magnetic fields generated by permanent magnets Magnetic permeability Ferromagnetism, paramagnetism and diamagnetism Elementary magnetic circuits Magnetic field behaviour near discontinuities: flux leakage Characterization of the method applied to ropes <b>The magnetizing circuit</b> Analysis of simple magnetizing structures Magnetization through field coils Magnetization through permanent magnets <b>Magnetic flux leakage detection methods</b> Detection principle through coils Detection principle through Hall effect sensors <b>Global flux detection methods</b> Detection principle through coils Detection principle through Hall effect sensors <b>Correlation between LF signal and LMA signal</b> Problems associated with the LF signal Problems associated with the LMA signal <b>Overview of FEM design</b> Finite element approach design applied to the MRT method Problems related to the use of FE software Importance of the experimental design method <b>Detected signal analysis</b> Influence of defect position Influence of defect extension

	<p>Influence of defect type (corrosion, broken wires)</p> <p><b>Signal Acquisition/Recording/Printing/Storing systems</b></p> <p>Analog recorder Digital acquisition device Data Loggers</p>
<p><b>G.4</b> <b>Knowledge of product and method capability</b></p>	<p><b>Applications in the various sectors</b></p> <p>Applications of the instruments for cableways, in accordance with the requirements of the UNI EN 12927-8 standard Applications of the instruments for lifting of goods Application of the instruments for lifting of people Typical defects of cableway applications, in accordance with the requirements of the UNI EN 12927-6 standard Typical defects of port and goods lifting applications Typical defects of applications in the lift sector, with special reference to electric and hydraulic lifts</p>
<p><b>G.5</b> <b>Instrumentation</b></p>	<p><b>Probe heads and collectors</b></p> <p>Probe heads Collectors DataLoggers Data processing SW Reporting Fixed installation of systems Fixed point detection experimental systems LF, LMA and mixed systems. Instrument type selection</p>
<p><b>G.6</b> <b>Information before the test</b></p>	<p><b>Written instruction (prepared by a level 2 or 3 technician):</b></p> <p>Objectives Requirements</p>
<p><b>G.7</b> <b>Inspection</b></p>	<p><b>Preparation for the test</b></p> <p>Functionality check</p> <p><b>Use of detectors in the various sectors</b></p> <p><b>Safety</b></p> <p><b>Operating phases of the inspection</b></p>
<p><b>G.8</b> <b>Interpretation and relation</b></p>	<p><b>Track analysis</b></p> <p>Defect analysis Background noise analysis Identification of possible correlations between LF signal and LMA signal Operational recognition of LMA instrumentation limits</p> <p><b>Visual inspection following interpretation</b></p> <p><b>Drafting of a report</b></p>
<p><b>G.9</b> <b>Quality</b></p>	<p><b>Personnel qualification (in accordance with UNI EN ISO 9712)</b></p> <p>Tasks and duties of qualified personnel The qualification and certification system defined by UNI-EN ISO 9712</p>
<p><b>Total duration</b></p>	

## 2) EXAMINATION ADMITTANCE REQUIREMENTS

To be admitted to the examinations, a candidate must have the minimum training, experience and physical fitness requirements set out in the UNI EN ISO 9712 and UNI EN 12927-8 standards and summarized here below:

### 1. Physical fitness

The candidate shall provide evidence of good vision, being able to read the Jaeger 1 2 eye chart or equivalent at a distance of 0.5 m (with the aid of spectacles, if necessary), assessed and attested by an ophthalmologist, an optometrist or another person entitled to practice medicine. The certificate may not date from more than three months after the examination request date.

### 2. Training

- I. The candidate must provide evidence of having the required knowledge for performing the expected tasks to the extent related to the level for which certification is sought.

This knowledge must be:

- general basic knowledge of mathematics and physics, behaviour of materials, production technologies and types of defects
- general and specific knowledge of test methods and applicable codes and standards

An individual classified to level 1 shall be able to:

- a) set up the equipment;
- b) perform the tests;
- c) record and classify the results in terms of written criteria;
- d) report on the results;
- e) perform immediately a visual inspection of the dubious zones and make measurements such as rope diameter, lay length, and so on;
- f) recognize the type and function of ropes and to understand their mode of deterioration;
- g) understand the method of splicing, the shortening and the method of repair.

The operator shall not be responsible for the choice of test method or technique to be used nor for the assessment or characterisation of test results.

An individual classified to level 2 shall be able to:

- a) carry out and supervise all level 1 duties;
- b) know wire rope types and their modes of deterioration;
- c) choose the technique for the test method to be used;
- d) define the limitations of application of the testing method for which the level 1 individual is qualified;
- e) understand MRT standards and specifications and translate them into practical testing instructions adapted to actual working conditions;
- f) set up and calibrate equipment;
- g) perform and supervise the tests;
- h) interpret and evaluate results;
- i) prepare written test instructions;
- j) train or to guide personnel below level 2;
- k) organise and report the results of non destructive tests;

- l) recommend the use of additional non destructive tests.

	Level 1	Level 2
Hours	20	24

Table I – Duration of the expected training for the MRT method

- II. Taking into account the scientific and technical potential of candidates for Level 3 certification, no specific training is foreseen. Preparation for qualification may be done by attending training courses, conferences or seminars, studying books, periodicals and other specialized printed material. The candidate must provide RINA with documentary evidences of his/her preparation.

3. Experience

The candidate shall have the experience specified in the table below, except for any reductions set out in the Rules:

	Level 1	Level 2	Level 3
Months	3	9	18

Table II – Minimum required times for the MRT method