EDDY CURRENT TESTING

Qualification training according to the ISO 9712

ET

PROCESS	SYSTEM	METHOD	LEVEL / TECHNIQUE	SECTOR	CODE	VALID FROM	PREPARED BY
NDT	**ISO 9712**	ET	1, 2, 3	MS, t	-	**1 / 2023**	**TICHÝ**

INTRODUCTION

Purpose of Eddy-current Testing method (ET, sometimes also referenced as ECT or ECI) is detection of surface and subsurface defects in conductive materials.

ET qualified personnel has to have knowledge of its **physics principles**, be familiar with overall **requirements of most widely codes and standards**, be able to expand them to new applications and be **able to perform and document testing**.

Training focuses on **gaining knowledge and essential skills** to be further strengthened when collecting experience. Duration and content of the training **depends on the qualification level pursued** as well as the **product or industrial sector selected** (e.g. welding, casting, multisector applications etc.).

Training are designed to prepare participants for all examination parts – **general** (physics principles), **specific** (use of standards and codes), and **practical** (performance of the method) acc. to EN ISO 9712 in the ATG CERT Examination Center.

RECOMMENDED PUBLICATIONS

ATG publications

- ET – Eddy Current Testing, Level 1, 2 (ATG handbook)
- ET – Collections of formulas (published by ATG)

Other publications

- Personnel Training Publications: Electromagnetic Testing Classroom Training Book (ASNT handbook)
- Level II Study Guide: Eddy Current Testing Method (ET) (ASNT handbook)
- Nondestructive Testing Handbook, Third Edition: Volume 5, Electromagnetic testing (ASNT handbook)

SYLLABUS COVERAGE

Training provides theoretical and practical training to understand Eddy-current Testing (ET) principles, be familiar with various types of equipment, accessories, and other aids, and handling of tested parts and components to perform safely Eddy-current Testing, report (and evaluate for Level 2 and Level 3) results of the testing.

TRAINING DURATION

SECTOR		LEVEL I	LEVEL II	LEVEL III
MS	Multisector	5 d (40 h)	8 d (64 h)	6 d (48 h)
t	Tubes	5 d (40 h)	6 d (48 h)	6 d (48 h)

BODY OF KNOWLEDGE – DISCONTINUITIES OF MATERIALS

Content of this body of knowledge does not have dedicated part of examination, however it can be indirectly included in other examination parts.

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
1	**Types of discontinuities**			
1.1	Differentiation of discontinuities based on their initiation	☐	☑	☑
1.2	Discontinuities of castings	☑	☑	☑
1.3	Discontinuities of forgings	☑	☑	☑
1.4	Discontinuities of welds	☑	☑	☑
1.5	Heat treatment	☑	☑	☑
1.6	Discontinuities initiated during processing and service	☑	☑	☑
1.6.1	Abrasion cracks	☐	☑	☑
1.6.2	Material fatigue	☐	☑	☑
1.6.3	Stress corrosion	☐	☑	☑
1.6.4	Creep	☐	☑	☑
1.7	Figures	☑	☑	☑

BODY OF KNOWLEDGE – GENERAL PART

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
1	**Introduction**			
1.1	Introduction, terminology, purpose and history	☑	☑	☑
1.2	Basic Principles of Eddy Current Inspection	☑	☑	☑
2	**Physical principles and associated knowledge**			
2.1	Generation of eddy currents	☑	☑	☑
2.2	Effect of fields created by eddy currents (impedance changes)	☑	☑	☑
2.3	Properties of eddy currents	☑	☑	☑
2.3.1	Travel mode	☑	☑	☑
2.3.2	Depth of penetration	☑	☑	☑
2.3.2	Effects of test part characteristics - conductivity & permeability	☑	☑	☑
2.3.3	Current flow	☑	☑	☑
2.3.4	Frequency and phase	☑	☑	☑
2.3.5	Effects of permeability variations - noise	☐	☑	☑
2.3.6	Effects of discontinuity orientation	☐	☑	☑
3	**Equipment**			
3.1	Test part	☑	☑	☑
3.1.1	Conductivity	☑	☑	☑
3.1.2	Permeability	☑	☑	☑
3.1.3	Mass	☑	☑	☑

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
3.1.4	Homogeneity	☑	☑	☑
3.2	Test system	☑	☑	☑
3.2.1	Frequency	☑	☑	☑
3.2.2	Coupling	☑	☑	☑
3.2.3	Field strength	☑	☑	☑
3.2.4	Test coil and shape	☑	☑	☑
4	**Signal-to-Noise Ratio**			
4.1	Definition	☑	☑	☑
4.2	Relationship to eddy cui-rent testing	☐	☑	☑
4.3	Methods of improving signal-to-noise ratio	☐	☑	☑
5	**Equipment / Materials**			
5.1	Probes -general	☑	☑	☑
5.1.1	Advantages / limitations	☑	☑	☑
5.2	Through, encircling or annular coils and hall elements	☑	☑	☑
5.2.1	Advantages/limitations/differences	☑	☑	☑
5.3	Factors affecting choice of sensing elements	☑	☑	☑
5.3.1	Type of part to be inspected	☑	☑	☑
5.3.2	Type of discontinuity to be detected	☑	☑	☑
5.3.3	Speed of testing required	☑	☑	☑
5.3.4	Amount of testing required	☑	☑	☑
5.3.5	Probable location of discontinuity	☐	☑	☑
5.3.6	Applications other than discontinuity detection	☑	☑	☑
5.4	Read out selection	☑	☑	☑
5.4.1	Meter	☑	☑	☑
5.4.2	Oscilloscope, X-Y and other displays	☑	☑	☑
5.4.3	Alarm, lights, etc.	☑	☑	☑
5.4.4	Strip chart recorder	☑	☑	☑
5.5	Instrument design considerations	☑	☑	☑
5.5.1	Amplification	☑	☑	☑
5.5.2	Phase detection	☑	☑	☑
5.5.3	Differentiation or filtering	☑	☑	☑
2.5.4	Thresholds, box gates, etc.	☑	☑	☑
6	**Selection Of Test Frequency**			
6.1	Relationship of frequency to type of test	☑	☑	☑
6.2	Considerations affecting selection of test frequency	☑	☑	☑
6.2.1	Signal-to-noise ratio	☑	☑	☑
6.2.2	Causes of noise	☐	☑	☑
6.2.3	Methods to reduce noise	☐	☑	☑
6.2.3.1	DC saturation	☐	☑	☑

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
6.2.3.2	Shielding	☐	☑	☑
6.2.3.3	Grounding	☐	☑	☑
6.2.4	Phase discrimination	☐	☑	☑
6.2.5	Response speed	☐	☑	☑
6.2.6	Skin effect	☑	☑	☑
7	**Coupling**			
7.1	Fill factor	☑	☑	☑
7.2	Lift-off	☑	☑	☑
8	**Field Strength and its Selection**			
8.1	Permeability changes	☑	☑	☑
8.2	Saturation	☐	☑	☑
8.3	Effect of AC field strength on eddy current testing	☐	☑	☑
9	**User Standards and Operating Procedures**			
9.1	Explanation of standards and specifications used in eddy current testing	☑	☑	☑
10	**Inspection System Output**			
10.1	Accept / reject criteria	☑	☑	☑
10.1.1	Sorting, go / no-go	☑	☑	☑
10.2	Signal classification processes	☑	☑	☑
10.2.1	Discontinuity	☐	☑	☑
10.2.2	Flaw	☐	☑	☑
10.3	Detection of signals of interest	☑	☑	☑
10.3.1	Near surface	☑	☑	☑
10.3.2	Far surface	☑	☑	☑
10.4	Flaw sizing techniques	☐	☑	☑
10.4.1	Phase to depth	☐	☑	☑
10.4.2	Volts to depth	☐	☐	☑
10.5	Calculation of Flaw Frequency	☑	☑	☑
10.6	Sorting for properties related to conductivity	☑	☑	☑
10.7	Thickness evaluation	☑	☑	☑
10.8	Measurement of ferromagnetic properties	☐	☑	☑
10.8.1	Comparative circuits	☐	☑	☑

BODY OF KNOWLEDGE – SPECIFIC PART

The content of specific part is modified according to product sector which is covered by training. Multisector includes standards from all sectors. Level of detail paid to particular documents depends on the level of the training (Level I, Level II or III).

STANDARD		LEVEL I	LEVEL II	LEVEL III
1	**General methodology**			
EN ISO 15549	Nondestructive testing – Eddy Current testing – General principles	☑	☑	☑
EN ISO 2360	Non-conductive coatings on non-magnetic electrically conductive basis materials – Measurement of coating thickness – Amplitude sensitive eddy current method	☐	☑	☑
EN ISO 15548-1	Non-destructive testing - Equipment for eddy current examination - Part 1: Instrument	☐	☐	☑
EN ISO 15548-2	Non-destructive testing - Equipment for eddy current examination - Part 2: Probes	☐	☐	☑
EN ISO 15548-3	Non-destructive testing - Equipment for eddy current examination - Part 3: Test systems	☐	☐	☑
2	**Welds**			
EN 1711	Non - destructive examination of welds - Eddy current examination of welds by complex plane analysis	☑	☑	☑
3	**Tubes**			
EN ISO 10893-1	Non-destructive testing of steel tubes – Part 1: Automated electromagnetic testing of seamless and welded (except SAW) steel tubes for verification of hydraulic leak tightness	☐	☑	☑
EN ISO 10893-2	Non-destructive testing of steel tubes – Part 2: Automated eddy current testing of seamless and welded (except SAW) steel tubes for the detection of imperfections	☑	☑	☑
EN 1971	Copper and copper alloys. Eddy current test for measuring defects on seamless round copper and copper alloy tubes. Test with an encircling test coil on the outer surface	☐	☑	☑

BODY OF KNOWLEDGE – PRACTICAL PART

In the practical part of the training the trainees practice working with instructions and procedures as well as knowledge gained from the standards discussed in the specific part. Training and examination specimens are representative for given product sectors.

SUBEJCT		LEVEL I	LEVEL II	LEVEL III
1	**Pick-up Probe**			
1.1	Basic parameters of testing – pick-up probe	☑	☑	☐
1.2	Changing of basic parameters	☑	☑	☐
1.3	Surface eddy current testing	☑	☑	☑
1.3.1	Forgings	☑	☑	☑
1.3.2	Plates	☑	☑	☑
1.3.3	Welds (in accordance with EN 1711)	☑	☑	☑
1.4	Bolt hole eddy current testing	☑	☑	☑
1.5	Eddy current testing in aviation services	☑	☑	☑
1.6	Eddy current testing in automotive	☑	☑	☑

	SUBEJCT	LEVEL I	LEVEL II	LEVEL III
1.7	Thickness measurement	☑	☑	☑
1.8	Recording, reporting	☑	☑	☑
2	**Material Sorting**			
2.1	Sorting of ferromagnetic parts	☑	☑	☑
2.2	Sorting of non-ferromagnetic parts - Conductivity measurement	☑	☑	☑
3	**Automated Tube Testing**			
3.1	Tube testing by encircling coils	☑	☑	☑
3.2	Steel tubes testing in accordance EN ISO 10893-1,2 simulation	☑	☑	☑
3.3	Cuprum tubes testing in accordance EN 1971	☐	☑	☑
4	**Heat Exchangers Testing**			
4.1	Heat exchangers tube testing by boobin probe	☑	☑	☑
4.2	Multi-frequency testing – Mix technique	☐	☑	☑
4.3	Evaluation	☐	☑	☑
4.4	Heat exchangers tube in accordance ASME V,8	☐	☑	☑
4.5	Recording, reporting	☑	☑	☑
5	**Test System Characterization And Confirmation**			
5.1	Equipment, probes and system confirmation in accordance with ISO 15548-1,2,3	☐	☐	☑

BODY OF KNOWLEDGE – DOCUMENTATION

In the practical part of the training the trainees practice dealing with process documentation from reporting results to reports, drafting instructions and procedures.

	SUBEJCT	LEVEL I	LEVEL II	LEVEL III
1	**Test Report**			
1.1	Purpose	☑	☑	☑
1.2	Tested part	☑	☑	☑
1.3	Testing conditions	☑	☑	☑
1.4	Reporting findings	☑	☑	☑
1.5	Evaluation	☐	☑	☑
2	**Written Instruction**			
2.1	Validity range	☐	☑	☑
2.2	Personnel requirements	☐	☑	☑
2.3	Inspection range and area of interest	☐	☑	☑
2.4	Equipment and accessories	☐	☑	☑
2.5	Testing parameters and their verification	☐	☑	☑
2.6	Evaluation, acceptance criteria	☐	☑	☑
2.7	Reporting	☐	☑	☑
2.8	Post-testing activity	☐	☑	☑

	SUBEJCT	LEVEL I	LEVEL II	LEVEL III
3	**Written Procedure**			
3.1	Validity range	☐	☐	☑
3.2	Personnel requirements	☐	☐	☑
3.3	Inspection range and scheduled plan	☐	☐	☑
3.4	Equipment, accessories and control activities	☐	☐	☑
3.5	Setting of parameters	☐	☐	☑
3.6	Testing parameters	☐	☐	☑
3.7	Evaluation, acceptance criteria	☐	☐	☑
3.8	Documentation	☐	☐	☑
3.9	Post-testing activity	☐	☐	☑