ULTRASONIC TESTING - TOFD

Qualification training according to the ISO 9712

TOFD

PROCESS	SYSTEM	METHOD	LEVEL / TECHNIQUE	SECTOR	CODE	VALID FROM	PREPARED BY
NDT	**ISO 9712**	UT	TOFD	MS, w	-	**1 / 2023**	**MATOUŠEK**

INTRODUCTION

Purpose of Ultrasonic Testing TOFD technique (UT-TOFD), which stands for Time-Of-Flight-Diffraction, is detection of mainly internal and back-wall (root side) defects in industrial parts and components using advanced UT technique.

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

Training is suitable for currently certified conventional UT2 and UT3 personnel. It focuses on **gaining knowledge and essential skills** to be further strengthened when collecting experience. Duration and content of the training **depends on** the **product or industrial sector selected** (e.g. welding, casting, multisector applications etc.).

Training are designed to prepare participants for all examination parts to the technique – **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

- UT – Ultrasonic Testing, Level 1, 2 (ATG handbook)
- UT-TOFD – Ultrasonic Testing TOFD (ATG handbook)
- UT – Collections of formulas (published by ATG)

Other publications

- Personnel Training Publications: Ultrasonic Testing (UT) Programmed Instruction Series (ASNT handbook)
- Level III Study Guide: Ultrasonic Testing Method (UT) (ASNT handbook)
- Relevant Discontinuities – Ultrasonic Testing (UT) (ASNT handbook)
- Nondestructive Testing Handbook, Third Edition: Volume 7, Ultrasonic Testing (ASNT handbook)

SYLLABUS COVERAGE

Training provides theoretical and practical training to understand Ultrasonic Testing TOFD (UT-TOFD) technique principles, be familiar with various types of equipment, accessories, and other aids, and handling of tested parts and components to perform safely Ultrasonic TOFD Testing, report and evaluate results of the testing.

TRAINING DURATION

SECTOR		LEVEL I	LEVEL II	LEVEL III
MS	Multisector	N/A	5 d (40 h)	N/A
w	Welds	N/A	5 d (40 h)	N/A

BODY OF KNOWLEDGE – GENERAL PART

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
1	**Introduction**			
1.1	Personnel requirements	☐	☑	☐
1.2	History of TOFD	☐	☑	☐
1.23	Terminology of UT (EN ISO 5577) and TOFD	☐	☑	☐
1.4	Refresh of fundamentals of ultrasonic testing	☐	☑	☐
1.5	Defects related with manufacturing process - summary	☐	☑	☐
2	**Basic Principles**			
2.1	Basic principal of TOFD technique	☐	☑	☐
2.2	Advantages and disadvantages of TOFD	☐	☑	☐
2.3	The types of scanning for data acquisition	☐	☑	☐
2.4	Testing surface condition	☐	☑	☐
2.5	Limitation of TOFD technique	☐	☑	☐
3	**Equipment and Accessories**			
3.1	Requirements for ultrasonic equipment	☐	☑	☐
3.2	Probes	☐	☑	☐
3.2.1	Parameters of TOFD probes	☐	☑	☐
3.2.2	Plexi wedges for probes	☐	☑	☐
3.2.3	Probe selection	☐	☑	☐
3.2.4	PCS determination	☐	☑	☐
3.3	Manipulators and scanners	☐	☑	☐
3.4	Couplant	☐	☑	☐
4	**Imaging**			
4.1	A-scan	☐	☑	☐
4.2	B-scan	☐	☑	☐
4.3	C-scan	☐	☑	☐
4.4	D-scan	☐	☑	☐
4.5	S-scan – sectorial for technique PA	☐	☑	☐
4.6	P-scan - projection	☐	☑	☐
4.7	TOFD image	☐	☑	☐
5	**Sensitivity Settings**			
5.1	Setting of time window for data acquisition, time conversion to the depth	☐	☑	☐
5.2	Types of sensitivity setting	☐	☑	☐
5.3	Checking of sensitivity	☐	☑	☐
5.4	Calibrations and references blocks	☐	☑	☐
5.5	Calibration scan	☐	☑	☐
5.6	Demonstration blocks and samples	☐	☑	☐
5.7	Setting of parameters before scanning	☐	☑	☐
5.8	Setting of parameters for data post processing	☐	☑	☐

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
6	**Examination and Data Collection**			
6.1	Examination in acc.to written instruction or procedure	☐	☑	☐
6.2	Geometry considerations and temperature	☐	☑	☐
6.3	Scanning surface preparation	☐	☑	☐
6.4	Establishing of datum and coordinates for scanning	☐	☑	☐
6.5	Range of scanning - examination coverage	☐	☑	☐
6.6	Overlap of scans	☐	☑	☐
6.7	Multiple zone and offset examination	☐	☑	☐
6.8	Gated region	☐	☑	☐
6.9	Data collection and scan increment	☐	☑	☐
6.10	Scanning speed, data sampling frequency and PRF	☐	☑	☐
6.11	Missing data lines	☐	☑	☐
6.12	Loss of coupling	☐	☑	☐
6.13	Reflectors transverse to the weld seam	☐	☑	☐
6.14	Supplemental shear wave examination	☐	☑	☐
6.15	Curved piece testing	☐	☑	☐
7	**Interpretation of TOFD Images**			
7.1	Phase relationship	☐	☑	☐
7.2	Defects characterization - category	☐	☑	☐
7.3	Interpretation of TOFD images	☐	☑	☐
7.4	Typical problems with TOFD interpretation	☐	☑	☐
8	**Evaluation of Indications**			
8.1	Performing of demonstration scan and demonstration block	☐	☑	☐
8.2	Process of flaw interpretation and evaluation	☐	☑	☐
8.3	Determination of geometrical indications	☐	☑	☐
8.4	Determination of relevant indication	☐	☑	☐
8.5	Classification/Sizing System	☐	☑	☐
8.6	Surface connected flaws	☐	☑	☐
8.7	Embedded flaws	☐	☑	☐
8.8	Multiple defects	☐	☑	☐
8.9	Defect sizing	☐	☑	☐
8.10	Software measurement tool	☐	☑	☐
8.11	Sensitivity and resolution at TOFD technique	☐	☑	☐
8.12	Measurement of TOF of signals, conversion	☐	☑	☐
8.13	Deviations at determination of defect position	☐	☑	☐
8.14	Flaw depth and flaw height determination	☐	☑	☐
8.15	Flaw length determination	☐	☑	☐
8.16	Detailed analysis	☐	☑	☐
8.17	Evaluation of defects against acceptance criteria	☐	☑	☐
8.18	Offline data evaluation	☐	☑	☐

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
9	**Applications**			
9.1	Typical application of TOFD technique	☐	☑	☐
9.2	Scanning surface condition	☐	☑	☐
9.3	Selection of the TOFD testing parameters in acc. to tested part and expected detects	☐	☑	☐
9.4	Method of weld examination – butt welds	☐	☑	☐
9.5	Testing of welded joints with two different thickness	☐	☑	☐
9.6	Testing of welded joints on the curved parts	☐	☑	☐
9.7	Testing possibilities of T-welds	☐	☑	☐
9.8	Testing of wrought products and forgings	☐	☑	☐
9.9	Examination data storage and archiving	☐	☑	☐
9.10	Recording of results	☐	☑	☐

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.

	STANDARD	LEVEL I	LEVEL II	LEVEL III
1	**General Methodology**			
EN ISO 16828	Non-destructive testing - Ultrasonic testing - Time-of-flight diffraction technique as a method for detection and sizing of discontinuities	☐	☑	☐
EN ISO 10863	Non-destructive testing of welds - Ultrasonic testing - Use of time-of-flight diffraction technique (TOFD)	☐	☑	☐
EN ISO 15626	Non-destructive testing of welds - Time-of-flight diffraction technique (TOFD) - Acceptance levels	☐	☑	☐
EN ISO 5817	Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections	☐	☑	☐
EN ISO 17635	Non-destructive testing of welds - General rules for metallic materials	☐	☑	☐

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 an specimens are representative for given product sectors.

	SUBEJCT	LEVEL I	LEVEL II	LEVEL III
1	**General**			
1.1	Using of TOFD devices	☐	☑	☐
1.2	Set-up of instrument parameters	☐	☑	☐
1.3	Selection of suitable probes, wedges and PCS	☐	☑	☐
1.4	Calibration and checking on blocks	☐	☑	☐
1.5	Selection of proper testing class and acceptance level in acc.to EN ISO 5817 and EN ISO 17635	☐	☑	☐

	SUBEJCT	LEVEL I	LEVEL II	LEVEL III
1.6	Using of evaluation TOFD software for analysis	☐	☑	☐
1.7	Determination of flaw position from TOFD images	☐	☑	☐
1.8	Determination of flaw height and length from TOFD images	☐	☑	☐
1.9	Practical testing of welds in according EN ISO 10863	☐	☑	☐
1.10	Evaluation of welds in acc. to EN ISO 15626	☐	☑	☐
1.11	Recording of results into weld report	☐	☑	☐
1.12	Practical testing of wrought material in according EN ISO 16828	☐	☑	☐
1.13	Interpretation of indications from wrought material	☐	☑	☐
1.14	Recording of results into wrought material report	☐	☑	☐
2	**Testing According To Instructions**			
2.1	Welds	☐	☑	☐
2.2	Wrought materials	☐	☑	☐

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	☐	☑	☐