LEAK TESTING

Qualification training according to the ISO 9712

LT

PROCESS	SYSTEM	METHOD	LEVEL / TECHNIQUE	SECTOR	CODE	VALID FROM	PREPARED BY
NDT	**ISO 9712**	LT	1, 2, 3 – P, TG	MS	-	**1 / 2023**	**KORANDA**

INTRODUCTION

Purpose of Leak Testing method (LT) is detection of leaks from industrial parts and components.

LT 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 **techniques used** (Pressure Change and Tracer Gas techniques).

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

- LT – Leak Testing – Pressure Technique, Level 1, 2 (ATG handbook)
- LT – Leak Testing – Tracer Gas Technique, Level 1, 2 (ATG handbook)
- LT – Collections of formulas (published by ATG)

Other publications

- Personnel Training Publications: Visual Testing (LT) Programmed Instruction Series (ASNT handbook)
- Level III Study Guide: Visual Testing Method (LT) (ASNT handbook)
- Nondestructive Testing Handbook, Third Edition: Volume 2, Leak Testing (ASNT handbook)

SYLLABUS COVERAGE

Training provides theoretical and practical training to understand Leak Testing (LT) principles, be familiar with various types of equipment, accessories, and other aids, and handling of tested parts and components to perform safely Leak 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 – Pressure Technique	3 d (24 h)	5 d (40 h)	6 d (48 h)
MS	Multisector – Tracer Gas Technique	3 d (24 h)	5 d (40 h)	

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BODY OF KNOWLEDGE – GENERAL PART

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
1	**Introduction to NDT**			
1.1	History of Leak testing	☑	☑	☑
1.2	Reasons for Leak testing	☑	☑	☑
1.3	Terminology EN 1330-8	☑	☑	☑
1.4	Leak and leak detection: principles, choice of method, EN 1779	☑	☑	☑
1.5.	Proper selection of leak testing as method choice	☐	☐	☑
1.6	Fundamental terminology: Leakage terms EN 1330-8	☑	☑	☑
2	**Physical Principles**			
2.1	Physical behavior of matter	☑	☑	☑
2.2	Structure of matter (fundamental)	☐	☑	☑
2.3	Perfect and real gases	☐	☐	☑
2.4	Pressure	☑	☑	☑
2.4.1	Fundamentals, units	☑	☑	☑
2.4.2	Relationship between different measurement units Standard and normal conditions	☐	☑	☑
2.4.3	Kinetic theory, relationship between mean free path and pressure, perfect gas law	☐	☐	☑
2.4.4	Perfect gas law, equitation for leakage calculation	☐	☐	☑
2.5	Pressure range in vacuum	☑	☑	☑
2.5.1	Different range	☑	☑	☑
2.5.2	Relationship between mean free path and vacuum range	☐	☐	☑
2.6	Flow in vacuum	☑	☑	☑
2.6.1	Definition, Leakage as s flow	☑	☑	☑
2.6.2	Flow types, flow parameters	☐	☑	☑
2.6.3	Flow and kinetic theory, capillary permeation, Reynolds number vs. Knudsen number and others parameters	☐	☐	☑
2.7	Leakage measurement	☑	☑	☑
2.7.1	Units and relationships	☑	☑	☑
2.7.2	Conductance in vacuum: definition, monograph, formulas	☐	☑	☑
2.7.3	Conductance calculation, flow in conductance	☐	☐	☑
2.8	Degassing	☑	☑	☑
2.8.1	Practical implications	☑	☑	☑
2.8.2	Practical concept and fundamentals	☐	☑	☑
2.8.3	Pumping speed (definition, calculation), different gas behavior	☐	☐	☑
2.9	Virtual and real leak	☑	☑	☑
2.9.1	Concept and difference	☑	☑	☑
2.9.2	Source of real and virtual leaks pressure	☐	☑	☑
2.9.3	Calculation on virtual leak, influence in pressure change tests, time	☐	☐	☑

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
2	**Product Knowledge And The Capabilities Of The Method**			
3.1	Type of Leak	☑	☑	☑
3.1.1	Location, Leak measurement, pass/fail test, Leakage monitoring	☑	☑	☑
3.1.2	Specification and sensitivity	☐	☑	☑
3.2	Object preparation	☑	☑	☑
3.2.1	Object cleanness, Cleaning procedures and effects on leak detection measurements	☑	☑	☑
3.2.2	Sealed object with or without tracer gas, Object inaccessible from one or both sides; Object working above or below the atmospheric pressure	☐	☑	☑
3.3	Specifications and method capabilities	☑	☑	☑
3.3.1	Bubble emission methods: principles, immersion technique	☑	☑	☑
3.3.1	Bubble emission : liquid application technique, physical principles EN 1593	☐	☑	☑
3.4	Pressure change method EN 13184	☑	☑	☑
3.4.1	Fundamentals	☑	☑	☑
3.4.2	Principles of detection for the pressure change methods	☐	☑	☑
3.4.3	Difference between the pressure testing and the vacuum testing considering the perfect gas law, terminology for pressure testing	☐	☐	☑
3.5	Tracer gas method EN 13185	☑	☑	☑
3.5.1	Principles, detectors, flow into/out of the object	☑	☑	☑
3.5.2	Chemical or physical properties of detectors, principle of detection (Group A, Group B)	☐	☑	☑
3.6	Fundamentals of test method choice EN 13625	☑	☑	☑
4	**Equipment**			
4.1	Vacuum gauges	☑	☑	☑
4.1.1	Choice of gauges for different pressures, total pressure and partial pressure gauges	☑	☑	☑
4.1.2	Absolute and differential gauges, primary and secondary gauges, physical properties involved for the different sensor type	☐	☑	☑
4.2	Mechanical gauges	☑	☑	☑
4.2.1	Pressure reading techniques for bourdon gauge, diaphragm gauge;	☑	☑	☑
4.2.2	Bourdon gauge, diaphragm gauge, capacitance manometer gauge, accuracy for the different sensors	☐	☑	☑
4.2.3	Accuracy for the different sensors	☐	☐	☑
4.3.	U-tube manometers and Mc Leod	☑	☑	☑
4.3.1	Pressure reading techniques	☑	☑	☑
4.3.2	Principles and behavior	☐	☑	☑
4.4	Pirani and thermocouple gauges	☑	☑	☑
4.4.1	Pressure reading techniques, assembly criteria	☑	☑	☑
4.4.2	Principles and behavior of different gases	☐	☑	☑
4.4.3	Accuracy and calibration for different gases	☐	☐	☑
4.5	Cold and hot ion gauges	☑	☑	☑

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
4.5.1	Pressure reading techniques, assembly criteria	☑	☑	☑
4.5.2	Principles and behavior of different gases	☐	☑	☑
4.5.3	Accuracy and calibration for different gases	☐	☐	☑
4.6	Vacuum pumps	☑	☑	☑
4.6.1	Types of pump for different vacuum ranges ,	☑	☑	☑
4.6.2	Classification and selection of vacuum pumps	☐	☑	☑
4.6.3	Physical principle involved	☐	☐	☑
4.7	Rotary and piston pumps	☑	☑	☑
4.7.1	Performance Maintenance, Gas ballast	☑	☑	☑
4.7.2	Pump-down times calculation for different volumes	☐	☑	☑
4.7.3	Physical principle involved, Pump-down times calculation for different volumes including conductance influence	☐	☐	☑
4.8	Roots pump	☑	☑	☑
4.8.1	Performance Maintenance	☑	☑	☑
4.8.2	Size evaluation, mounting	☐	☑	☑
4.8.3	Physical principle involved, Pump-down times calculation for different volumes including conductance influence	☐	☐	☑
4.9	Diffusion pumps	☑	☑	☑
4.9.1	Performance Maintenance	☑	☑	☑
4.9.2	Size evaluation for different application, Size evaluation for the backing pump, Mounting	☐	☑	☑
4.9.3	Physical principle involved	☐	☐	☑
4.10	Turbomolecular pumps	☑	☑	☑
4.10.1	Performance Maintenance	☑	☑	☑
4.10.2	Size evaluation for different application, Size evaluation for the backing pump, Mounting	☐	☑	☑
4.10.3	Physical principle involved	☐	☐	☑
4.11	Valves	☑	☑	☑
4.11.1	Type of valves used for leak detection application Maintenance Mounting	☑	☑	☑
4.11.2	Choice of valve for leak testing application, performance	☐	☑	☑
4.12	Fittings	☑	☑	☑
4.12.1	Assembly criteria, maintenance	☑	☑	☑
4.12.2	Choice of right fittings for leak detection; Diameter and length calculation and influence	☐	☑	☑
4.12.3	Material: Choice for different vacuum ranges, Metallic, plastic, glass, Oil and grease, Project criteria	☐	☐	☑
5	**Information Prior Testing**			
5.1	Existing documentation analysis	☐	☑	☑
5.2	Written procedures — Interpretations	☑	☑	☑
5.2.1	Acceptance and rejection criteria, leak interpretation evaluation	☑	☑	☑

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
5.2.2	Design versus ,working conditions, pressure and temperature control, test method and sensitivity, required Preparation of leak test specification	☐	☑	☑
5.3	Data report, Tracer gas detector/instruments performance factor, preparation of written instructions	☐	☑	☑
6	**Testing**			
6.1	Bubble testing practice and techniques	☑	☑	☑
6.1.1	General requirement, test fluid	☑	☑	☑
6.1.2	Selection of test fluids from the points of view of physical properties	☐	☑	☑
6.1.3	Weather effects and lighting	☐	☐	☑
6.2	Immersion technique	☑	☑	☑
6.2.1	Pressurization of test specimen, Knowledge for creating pressure differential, elevated temperature test fluid, vacuum box technique	☑	☑	☑
6.2.2	Physical principles involved	☐	☑	☑
6.3	Liquid application technique	☑	☑	☑
6.3.1	Pressurization of test specimen, Vacuum technique for non-pressurized objects	☑	☑	☑
6.3.2	Physical principles involved	☐	☑	☑
6.4	Pressure change techniques and practice	☑	☑	☑
6.4.1	General requirements	☑	☑	☑
6.4.2	Pressure change method: principles, perfect gas law	☐	☑	☑
6.4.3	Pressure change method	☐	☐	☑
6.5	Pressure decay technique	☑	☑	☑
6.5.1	Temperature and pressure gauges, System set up, Reference vessel technique (fundamental)	☑	☑	☑
6.5.2	Apparatus and test set-up, Choice of pressure and temperature gauges, Effect of temperature change/ water vapour pressure/barometric pressure change, calculation of leakage rate, Reference vessel technique, leakage rate calculation	☐	☑	☑
6.5.3	Accuracy of equipment, gauge calibration accuracy, accuracy of test calculations	☐	☐	☑
6.6	Pressure rise technique	☑	☑	☑
6.6.1	Effect of virtual leak, system set up	☑	☑	☑
6.6.2	Leakage rate calculation, choice of vacuum gauges an system, effect of virtual leak on pressure-time relationship	☐	☑	☑
6.6.3	Calibration, evaluation of virtual leak on pressure time relationship, accuracy test calculation	☐	☐	☑
6.7	Bell pressure change technique	☑	☑	☑
6.7.1	General requirements	☑	☑	☑
6.7.2	Air flow into the object, air flow out of the object, choice of gauge, Calculation of leakage rate	☐	☑	☑
6.7.3	Calibration , calculation of leakage rate, accuracy test calculation	☐	☐	☑
6.8	Flow measurements technique	☑	☑	☑
6.8.1	General requirements	☑	☑	☑

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
6.8.2	Air flow into the object, air flow out of the object, choice of gauge, calculation of leakage rate	☐	☑	☑
6.8.3	Calibration, Accuracy test calculation	☐	☐	☑
6.9	Tracer gas practice and techniques			
6.9.1	Tracer gas method, calculation of leakage rate, choice of tracer gas and suitable detector, selection criteria of the technique for different application	☐	☑	☑
6.9.2	Tracer gas method	☐	☐	☑
6.10	Mass spectrometers	☑	☑	☑
6.10.1	Fundamental principles	☑	☑	☑
6.10.2	Physical principles involved	☐	☑	☑
6.10.3	Mass spectrometry: qualitative and quantitative; magnetic or quadrupole	☐	☐	☑
6.11	Halogen ion diode	☑	☑	☑
6.11.1	Fundamental principles, detectors, testing equipment, operation, cleaning the sensing element, replacing the sensing element, calibration leaks, refrigerant tracer gas	☑	☑	☑
6.11.2	Physical principles, sensitivity capabilities, selection criteria for different application, detector probe “sniffer” speed, properties of refrigerant tracer gas, calibration, evaluation of test sensitivity	☐	☑	☑
6.12	Thermal conductivity gauges	☑	☑	☑
6.12.1	Fundamental principles	☑	☑	☑
6.12.2	Physical principles involved Sensitivity capabilities of the techniques with this detector	☐	☑	☑
6.12.3	Pirani and thermocouple working principles	☐	☐	☑
6.13	Reactive tracers	☑	☑	☑
6.13.1	Physical principles involved, sensitivity capabilities of the technique	☐	☑	☑
6.13.2	Radioactive gases	☐	☐	☑
6.14	Gas analysis apparatus (gas chromatography etc.)	☑	☑	☑
6.14.1	Physical principles involved	☐	☑	☑
6.14.2	Gas chromatography, etc.	☐	☐	☑
6.15	Tracer gas flows into the objects — Group A techniques	☑	☑	☑
6.15.1	All techniques: general requirement, initial set-up and procedure, object preparation	☑	☑	☑
6.15.2	All techniques: sensitivity, calibration; calculation of leakage rate	☐	☑	☑
6.16	Tracer gas flows out of the objects — Group B techniques	☑	☑	☑
6.16.1	All techniques: general requirement, initial set-up and procedure, object preparation	☑	☑	☑
6.16.2	All techniques: sensitivity, calibration; calculation of leakage rate	☐	☑	☑
6.17	Chemical detection with ammonia	☑	☑	☑
6.17.1	Reagent application, posttest cleaning	☑	☑	☑
6.17.2	Physical principles involved, type of reagent	☐	☑	☑
6.18	Vacuum box using internal tracer gas	☑	☑	☑

	SUBJECT	LEVEL I	LEVEL II	LEVEL III
6.19	Vacuum box applying the tracer gas in the opposite side	☑	☑	☑
6.20	Pressure technique by accumulation	☑	☑	☑
6.21	Sniffing test	☑	☑	☑
6.21.1	Object surface scanning	☑	☑	☑
6.21.2	Calibration (when applicable)	☐	☑	☑
6.21.3	Calculation of leakage rate	☐	☐	☑
6.22	Fundamental on pressurization-evacuation test (bombing): Object preparation, initial set up and procedure	☐	☑	☑
6.23	Vacuum chamber technique	☑	☑	☑
7	**Evaluation And Reporting**			
7.1	Results analysis and evaluation on the base of acceptability criteria and applicable proceeding	☐	☑	☑
7.2	Test data report filling	☑	☑	☑
7.2.1	Leak test procedures compilation	☑	☑	☑
7.2.2	Reference standards and other documents	☐	☑	☑
7.2.3	Technique proceeding and module related to drafting	☐	☐	☑
8	**Assessment**			
8.1	Analysis through alternative techniques or methods	☐	☑	☑
8.1.1	Acceptability criteria assessment in collaboration with project engineer specialist and manufacturing managers	☐	☐	☑
8.2	Ergonomic analysis through alternative techniques or methods	☐	☐	☑
9	**Quality aspects**			
9.1	Personnel qualification (according to EN ISO 9712	☐	☑	☑
9.2	Equipment verification	☐	☑	☑
9.3	Written instructions	☐	☑	☑
9.4	Traceability of documents	☐	☑	☑
9.5	A review of applicable NDT application	☐	☑	☑
9.6	Format of working procedures	☐	☑	☑
9.7	Traceability of documents	☐	☑	☑
9.8	Other NDT qualification and certification	☐	☑	☑
10	**Quality aspects**			
10.1	Special industrial installation	☐	☑	☑
10.2	New development for industrial R&D applications	☐	☐	☑

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 1330-8	Nondestructive testing – Terminology – Part 8: terms used in leak tightness testing	☑	☑	☑
EN ISO 6520-1	Welding and allied processes – Classification of geometric imperfection in metallic materials – Part 1:Fusion welding	☑	☑	☑
EN 1593	Nondestructive testing – Leak testing – Bubble emission techniques	☑	☑	☑
EN 1779	Nondestructive testing – Leak testing – Criteria for method and technique selection	☐	☑	☑
EN 13184	Nondestructive testing – Leak testing – Pressure change method	☑	☑	☑
EN 13185	Nondestructive testing – Leak testing – Tracer gas method	☑	☑	☑
EN 13625	Nondestructive testing – Leak testing – Guide to the selection of instrumentation for the measurement of gas leakage	☐	☑	☑
ASTM E515	Leaks Using Bubble Emission techniques	☐	☑	☑
ASTM E1603	Leakage Measurement Using the Mass Spectrometer Leak Detector or Residual Gas Analyzer in the hood Mode	☐	☐	☑
ASME	ASME Code V,10	☐	☐	☑

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	**General**			
1.1	Vacuum box using internal tracer gas	☑	☑	☑
1.2	Liquid application technique	☑	☑	☑
1.3	Bubble testing practice and techniques	☑	☑	☑
1.4	Pressure decay technique	☑	☑	☑
1.5	Pressure rise technique	☑	☑	☑
1.6	Mass spectrometers	☑	☑	☑
1.6.1	Helium by pressure	☑	☑	☑
1.6.2	Helium by vacuum	☑	☑	☑

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	☐	☑	☑
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	☐	☐	☑