1 REASON FOR LATEST REVISION

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00	Development document	All	06.05.2020	Ch.Dürager

2 SCOPE OF APPLCATION

This document contains the information about the training syllabus for the NDT training course "Thermographic Testing – Aerospace Applications" provided by IMITec NDT Training School.

The training course is offered for Level1 (L1), Level 2 (L2), and Level 3 (L3) personnel which are intend to qualify for Non-destructive Testing personnel based on the standard EN4179 (Aerospace applications).

The syllabus covers the required course content for the general part based on the EN4179 and in some points the requirements for the specific and practical part. However, it may be necessary to adapt the specific part to the specific reequipments of the candidate's company.

2.1 Information for the reader

In principle the syllabus is provided for the different Levels. Level 3 candidates, however, are expected to have already learned and tested a large part of the theory material in the Level 2 course. These parts are required for the Level 3 course and will be tested during the final exam.

Some parts of the teaching material will be covered in the course and will be dealt with in more detail in a further course. To explain:

X = Teaching the basic knowledge,

X = Teaching of the in-depth knowledge.

3 REFERENCE DOCUMENTS

Document	Addition	Remarks / Description
Thermographic Testing for Aerospace Applications	2020	Training course book IMITec Training School
EN4179	2017	Aerospace series – Qualification and approval of personnel for non-destructive testing
EN 17119	2018	Non-destructive testing – Thermographic testing – Active thermography
ASNT Level III Study Guide Infrared and Thermal Testing Method	2019	ASNT
Handbook for ThermaCamE300	NA	FLIR System
Infrared thermography to monitoring mechanical tests on composite materials: Experimental procedure and data analysis	2016	PhD thesis, Simone Boccardi
Syllabus -Thermographic Testing	2019	NANDTB-Germany
Thermografie – Handbuch für Bau Anwendungen und Erneuerbare Energien.	NA	FLIR System

4 SYLLABUS EDDY CURRENT TESTING

Chapter	Training Content		L1	L2	L3
Introduction		General Information	X	**X**	**X**
		Inspection tasks in the aerospace industry	X	**X**	**X**
		Sample inspection tasks	X	**X**	**X**
Basic physical information	Basic principle of thermography		X	**X**	**X**
	Vibrations	Amplitude	X	**X**	**X**
		Period duration	X	**X**	**X**
		Frequency	X	**X**	**X**
		Phase	X	**X**	**X**
	Waves	Transverse waves	X	**X**	**X**
		Longitudinal waves	X	**X**	**X**
		Standing waves	X	**X**	**X**
		Wave, particle, duslism			**X**
		Reference to Thermography			**X**
	Thermography terminology	Systems	X	**X**	**X**
		Temperature (true, calculated, background, ambient, and object environment temperature)	X	**X**	**X**
		Heat	X	**X**	**X**
		Heat transition	X	**X**	**X**
		Thermal conduction	X	**X**	**X**
		Convection	X	**X**	**X**
		Heat radiation (infrared radiation)	X	**X**	**X**
		Convection	X	**X**	**X**
		Heat radiation	X	**X**	**X**
		Heat capacity	X	**X**	**X**
	Radiation laws	Planck's law of radiation	X	**X**	**X**
		Stefan-Bolzmann's law of radiation	X	**X**	**X**
		Wien's displacement law	X	**X**	**X**
		Net total radiation	X	**X**	**X**
		Emission/emissivity	X	**X**	**X**
		Absorption / absorptivity	X	**X**	**X**
		Transmission / transmission factor	X	**X**	**X**
		Reflectance	X	**X**	**X**
		Specular reflection, diffuse reelection / reflectance	X	**X**	**X**
	Radiation laws	Radiant flux	X	**X**	**X**

Chapter	Training Content		L1	L2	L3
		Kirchhoff's law of radiation	X	**X**	**X**
	Excitation by ultrasonic				**X**
	Excitation by induction				**X**
	Excitation by radiation		X	**X**	**X**
	Full radiator / Selective radiators		X	**X**	**X**
	Thermography, influences and defect sources	Atmospheric window	X	**X**	**X**
		Object-to-detector distance	X	**X**	**X**
		Specular reflections	X	**X**	**X**
		Moving disturbing source			**X**
		Temporally altered disturbing source			**X**
		Influence by people			**X**
	Thermography in NDT	Passive thermography	X	**X**	**X**
		Active thermography	X	**X**	**X**
		Comparative thermography	X	**X**	**X**
		Quantitative Thermography	X	**X**	**X**
		Test setup		**X**	**X**
		Impulse		**X**	**X**
		Lock-in		**X**	**X**
		Transient		**X**	**X**
Thermography technique	Transient thermography	Test setup	X	**X**	**X**
		Measuring principle	X	**X**	**X**
	Impulse thermography	Test setup	X	**X**	**X**
		Measuring principle	X	**X**	**X**
	LockIn thermography	Test setup	X	**X**	**X**
		Measuring principle	X	**X**	**X**
	Ultrasonic excited thermography	Test setup	X	**X**	**X**
		Measuring principle	X	**X**	**X**
	Ultrasonic burst phase thermography	Test setup	X	**X**	**X**
		Measuring principle	X	**X**	**X**
	Pulse phase thermography	Test setup	X	**X**	**X**
		Measuring principle	X	**X**	**X**
	Thermoelastic stress analysis	Test setup	X	**X**	**X**
		Measuring principle	X	**X**	**X**
Thermography equipment	General Information		X	**X**	**X**
	Detectors		X	**X**	**X**
	Characteristics / equipment selection		X	**X**	**X**
	Cooling concepts		X	**X**	**X**
	Calibration		X	**X**	**X**
	Camera lenses and filter		X	**X**	**X**
	NUC, drift		X	**X**	**X**

Chapter	Training Content		L1	L2	L3
	Detectivity		X	**X**	**X**
	Measuring principle			**X**	**X**
	Calibration and adjustment				**X**
	Disturbing source				**X**
Excitation and loading techniques in practical applications	Pulsed thermography		X	**X**	**X**
	Optical Lock-in thermography		X	**X**	**X**
	Ultrasonic excited lock-in thermography				**X**
	Pulse phase thermography			**X**	**X**
	Mechanical excitation, power ultrasonic				**X**
	Laser excitation				**X**
	Continuous line radiator				**X**
	Quartz glass source, surface source, carbon source				**X**
	Inductive excitation				**X**
	IR radiator vs. optical radiator				**X**
Detectable types of flaws	Resolution limit		X	**X**	**X**
	Depth of penetration		X	**X**	**X**
Calibration	Requirements for calibration and reference blocks	Adjustment blocks	X	**X**	**X**
		Reference blocks	X	**X**	**X**
		Requirements for simulated flaws			**X**
Analysis, evaluation, and documentation	Analysis and evaluation	Documentation for the customer	X	**X**	**X**
		Documentation for the manufacturer	X	**X**	**X**
		Structure of a test report	X	**X**	**X**
		Test reports and component identification	X	**X**	**X**
		Test instruction	X	**X**	**X**
		Mathematical basics of quotient evaluation and phase evaluation			**X**
Industrial safety	Dangers arising from excitation sources	Optical radiation	X	**X**	**X**
		Magnetic fields	X	**X**	**X**
Industrial safety	Dangers arising from excitation sources	Hot surface	X	**X**	**X**
		Noise	X	**X**	**X**
		Damage of components	X	**X**	**X**
Standard, regulations	Standards	International standards		X	**X**
		National Standards		X	**X**

Chapter	Training Content		L1	L2	L3
and test instructions		General information on standards			**X**
		Process instruction			**X**
	Test instructions	Requirements for a test instruction		X	**X**
		Preparation of test instruction			**X**
	Case studies	Example of test instruction			**X**
Measuring system for practical training	Transient thermography	Description of the measuring system	X	**X**	**X**
		Description of the software			**X**
	Pulsed thermography system	Description of the measuring system	X	**X**	**X**
		Description of the software			**X**
		Performance of inspections	X	X	**X**
		Analyses		**X**	**X**
	Lock-in thermography system	Description of the measuring system	X	**X**	**X**
		Infrared camera	X	**X**	**X**
		Description of the software			**X**
		Performance of inspections	X	**X**	**X**
		Representation of phases/amplitudes for lock-in thermography			**X**
		Function of burst results			**X**
	Thermography system for measuring fluids inside honeycomb structures	Description of the measuring system	X	**X**	**X**
		Infrared cameras	X	**X**	**X**
		Monitor	X	**X**	**X**
		Hot air blower	X	**X**	**X**
Practical training exercises	Exercise 1	Basic test	X	**X**	**X**
	Exercise 2	Consideration of external disturbances	X	**X**	**X**
	Exercise 3	Influence through surface	X	**X**	**X**
	Exercise 4	Delamination on monolithic CFRP	X	**X**	**X**
	Exercise 5	Test for fluids in honeycomb structures	X	**X**	**X**
	Exercise 6	Capabilities of active thermography		**X**	**X**
	Exercise 7	CFRP components with stringers	X	**X**	**X**

Chapter	Training Content		L1	L2	L3
	Exercise 8	GFRP components with stringers		**X**	**X**
	Exercise 9	Inspection of repair	X	**X**	**X**
	Exercise 10	Sandwich structure with foam core		**X**	**X**
	Exercise 11	Determination of procedures			**X**
	Exercise 12	Selection of the correct type of excitation			**X**
	Exercise 13	Determination of error size			**X**
	Exercise 14	Phase evaluation			**X**