



HIMACROW

Harmonized Personnel Training for Macro and Microscopic
Metallographic Examination of Structural Materials

O2 Harmonised Curriculum for the European Macroscopic and Microscopic Metallographic Examination Personnel

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Personnel with the Responsibility for Macroscopic and Microscopic Metallographic Examination of Base Materials and Their Joints Made by Welding and Allied Techniques

Professional Profile General Description

The Personnel with the responsibility for Macroscopic and Microscopic Metallographic Examination of Base Materials and their Joints Made by Welding and Allied Techniques is responsible for the following activities:

- Prepare the sample (test specimen) for Macroscopic and Microscopic Metallographic Examination;
- Perform Macroscopic and Microscopic Metallographic Examination;
- Evaluate and develop a Report on the identified findings (e.g., imperfections) according to the relevant standards.

These professionals are also responsible for the application of metallographic examination of joints of the following structural materials:

- non-alloy and alloy steels,
- cast irons,
- aluminum and copper alloys,
- titanium alloys,
- nickel alloys,
- thermoplastics.

Entry Requirements/Access Conditions

- All candidates shall provide evidence of a satisfactory visual test in accordance with the requirements of the standard EN ISO 17637 (latest edition).

Job Functions

- Perform material preparation.

Job required activities

- Describe the step by step of the sample preparation.
- Select the right process according to the materials used for the sample preparation.
- Prepare the specimen according to the chosen technique (image analysis and scanning microscopy).
- Adjust the polishing or etching techniques to achieve a proper metallographic analysis or overcome any challenges that might arise when performing the macro and microscopic examination.
- Stay up to date with the latest welding codes and standards, as well as any changes or updates in the field of metallographic examinations, concerning the industry requirements and technology, to ensure that the material preparation is conducted accordingly.



COMPETENCE UNITS

The curriculum for the European Macroscopic and Microscopic Metallographic Examination Personnel is structured as follows (overview):

COMPETENCE UNITS	MINIMUM CONTACT HOURS ¹	EXPECTED WORKLOAD ²
STANDARD LEVEL		
CU1: INTRODUCTION TO MACRO AND MICROSCOPIC METALLOGRAPHIC EXAMINATION	14	28
CU2: SPECIFIC METHODS FOR SAMPLE PREPARATION FOR MACRO AND MICROSCOPIC EXAMINATION	24.5	49
CU3: DEMONSTRATIONS IN MACRO AND MICROSCOPIC EXAMINATION	28	56
TOTAL	66.5	133
COMPREHENSIVE LEVEL		
CU3: DEMONSTRATIONS IN MACRO AND MICROSCOPIC EXAMINATION	7	14
TOTAL	7	14

CU/ULO – CU1: INTRODUCTION TO MACRO AND MICROSCOPIC METALLOGRAPHIC EXAMINATION	
LEVEL	EQF 4 – EWF INDEPENDENT (BASIC)
SUBJECT TITLE	MINIMUM CONTACT HOURS
The types of metallographic examination; work safety conditions during the preparation of specimens for metallographic examinations	3.5 (T)
Methods of specimen preparation for macro- and microscopic examination	3.5 (T)
Macroscopic examination and its application in welding technology	3.5 (T)
Microscopic examination and its application in welding technology	3.5 (T)
TOTAL	14
EXPECTED WORKLOAD	28

LEARNING OUTCOMES – CU1: INTRODUCTION TO MACRO AND MICROSCOPIC METALLOGRAPHIC EXAMINATION	
LEVEL	EQF 4 – EWF INDEPENDENT (BASIC)
KNOWLEDGE	Factual and broad knowledge of: -Work safety conditions -Health and safety rules -Types of metallographic examination - Methods of specimen preparation -Macroscopic examination and its application in welding technology -Microscopic examination and its application in welding technology



LEARNING OUTCOMES – CU1: INTRODUCTION TO MACRO AND MICROSCOPIC METALLOGRAPHIC EXAMINATION	
LEVEL	EQF 4 – EWF INDEPENDENT (BASIC)
SKILLS	<ul style="list-style-type: none"> -Use the appropriated material for hot mounting in accordance with the safety rules when performing macro and microscopic examination -Prepare mounting materials in accordance with the manufacturing order when performing macro and microscopic examination -Choose the materials for performing grinding to the macro and microscopic examination samples -Perform grinding and polishing by hand of the macro and microscopic examination samples -Use the grinding and polishing machine for preparing the macro and microscopic examination samples -Identify the visual characteristics of a weld when performing macroscopic examination -Determine if the weld meets the standard requirements when performing macroscopic examination

CU2: SPECIFIC METHODS FOR SAMPLE PREPARATION FOR MACRO AND MICROSCOPIC EXAMINATION	
LEVEL	EQF 6 – EWF ADVANCED (COMPREHENSIVE)
SUBJECT TITLE	MINIMUM CONTACT HOURS
Electrolytic polishing, chemical polishing, colored etching – purpose and application	7 (T)
Demonstration of electrolytic polishing and colored etching	3.5 (P)
Image analysis as a tool in metallographic examination	3.5 (T)
Demonstration of capabilities of the program for image analysis	3.5 (P)
Introduction to scanning microscopy	3.5 (T)
Demonstration of scanning microscope capabilities	3.5 (P)
TOTAL	24.5
EXPECTED WORKLOAD	49

LEARNING OUTCOMES – CU2: SPECIFIC METHODS FOR SAMPLE PREPARATION FOR MACRO AND MICROSCOPIC EXAMINATION	
LEVEL	EQF 6 – EWF ADVANCED
KNOWLEDGE	<p>Advanced knowledge of:</p> <ul style="list-style-type: none"> -The etching and the resulting color as a function of the microstructure -Electrolytic polishing, chemical polishing, colored etching – purpose, application and demonstration -The main metallographic analysis tools (optical microscope and scanning electron microscope) -The potential of the software for metallographic analysis (e.g., image acquisition, image processing, specific application for grain size measurement, phases quantification, inclusion evaluation) -Scanning Electron Microscope (SEM) and its potentiality (images obtained by secondary or back scattering signals) -Principles of the EDS microanalysis and introduction to other type of probes available (EBSD, WDX) -Fractography examination and main morphology of the damages and fracture mechanism (brittle or ductile fracture, fatigue, intergranular fracture)



LEARNING OUTCOMES – CU2: SPECIFIC METHODS FOR SAMPLE PREPARATION FOR MACRO AND MICROSCOPIC EXAMINATION

LEVEL EQF 6 – EWF ADVANCED

SKILLS

- Support the process of electrolytic polishing and coloured etching for welded metallic materials
- Describe the specific application of electrolytic polishing, chemical polishing and coloured etching, while explaining their differences, in material preparation and analysis
- Match the process for polishing and etching with the metallic materials and their welded joints
- Explain the differences between electrolytic, chemical and coloured etching in terms of surface finish and microstructure of the sample when choosing the examination process
- Explain the functioning of the optical microscope and its potential for the study of metal alloys when performing macro and microscopic examination
- Explain SEM and its potential for the study of metal alloys and their welded joints

CU/ULO – CU3: DEMONSTRATIONS IN MACRO AND MICROSCOPIC EXAMINATION

	LEVEL	EQF 5 – EWF SPECIALIZED (STANDARD)	EQF 6 – EWF ADVANCED (COMPREHENSIVE)
SUBJECT TITLE		MINIMUM CONTACT HOURS	MINIMUM CONTACT HOURS
Demonstration of assessment of macroscopic specimens of joints		3.5 (P)	-
Practical training in unaided identification of welding imperfections on macroscopic specimens		7 (P)	-
Practical training in specimen preparation		3.5 (P)	-
Standards for the quality assessment of joints made by welding and related techniques		3.5 (T)	-
Practical training for microscopic specimen structure identification		3.5 (P)	-
Demonstration of different kinds of microscopic structures		3.5 (P)	3.5 (P)
Demonstration of specimen preparation manners for metallographic examination		3.5 (P)	3.5 (P)
	TOTAL	28	7
	EXPECTED WORKLOAD	56	14



LEARNING OUTCOMES – CU3: DEMONSTRATIONS IN MACRO AND MICROSCOPIC EXAMINATION		
LEVEL	EQF 5 – EWF SPECIALIZED (STANDARD)	EQF 6 – EWF ADVANCED (COMPREHENSIVE)
KNOWLEDGE	<p>Comprehensive and specialized knowledge of:</p> <ul style="list-style-type: none"> -Test specimen preparation method for macro and microscopic examination -Etching processes -The standard related to the quality assessment of the welded joints -Capability of failure determination with reference image (standard) comparison -Assessment of the macro and microscopic aspects of specimens and their welded joints -Identification of welding imperfections on macroscopic specimens -Identification of structures in microscopic specimens 	<p>Advanced knowledge of:</p> <ul style="list-style-type: none"> -Classification of the main kind of metallographic structures (e.g., ferrite, austenite, martensite, etc.) observed by optical microscope -Interpretation of the different regions of a welding joint (parent metal, heat affected zone, weld zone) in the different metal alloys (carbon and low alloy steel, stainless steel, aluminum alloy, copper alloy, titanium alloy) -Colored etching applied to classification of the special metallographic structures (image analysis and percentage of the metallographic structure) -Identification of specific characteristics (e.g., sulfite, carbide, oxide) in precipitation (e.g., size, number)
SKILLS	<ul style="list-style-type: none"> -Prepare the test specimen for the macroscopic examination according to the type of material (metal or polymer) -Prepare the test specimen for the microscopic examination -Analyse a macroscopic specimen of a welded joint from metallic material -Explain the quality of the weld based on the visual characteristics of the weld aspect in correlation with the requirements of the welding standard (according to WPS) -Analyse a macroscopic sample of a weld -Identify the welding imperfection and establish its cause present in the macroscopic sample specimen according to the quality standard (ISO 6520 and ISO 5817) 	<ul style="list-style-type: none"> -Determine the principles of the micrographic preparation (cutting, grinding, polishing and etching) when performing the metallographic examination -Interpret the metallographic structures of the main metal alloys (carbon and low alloy steel, stainless steel, aluminium alloy, copper alloy, titanium alloy) according to the material and the condition of the material -Explain the metallurgical transformation that occurred in welding joint when performing metallographic examination -Explain the main critical issues that occurred in welding joint when performing metallographic examination -Explain the functioning of the optical microscope when performing metallographic examination -Explain the SEM potential for the study of metal alloys when performing metallographic examination