



HIMACROW

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

O1 Guideline on the European Macroscopic and Microscopic Metallographic Examination Personnel

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1. Executive Summary

Output one (O1) addresses the development of an improved Guideline for the Qualification of Macro and Microscopic Metallographic Examination of Structural Materials and their Welded Joints Personnel. The main tasks in O1 deal with the shift from the existing Special Course (based on EWF guideline_627-07 (approved: July 2007) into a Qualification and the establishment of the necessary modifications according to the current market needs. This Qualification will allow professionals who work or want to work in the field of macro and microscopic examination to acquire a diploma (requested by the industry) that will prove they are qualified in this field, considering that without the diploma is not easy to prove they have the skills required to perform this type of examinations. It will, also, lead to an added value to the curricula covered by the Inspector Qualification, considering it will bring an intricate analysis, especially in case of failures related to advanced materials/processes. Considering that the Microscopic and Macroscopic Personnel have more in-depth training on how to perform the micro and macroscopic examinations, unlike the Inspector, who interprets the results of the micro and macroscopic analyses.

This revision will address the increasing market need, for example requests (in Romania), for this type of examinations, to external entities, from multinational companies in the field of automotive, naval construction, welding construction (manufacturing), (etc.), since they don't have professionals qualified to perform them, in their organisations, especially focusing on the understanding of the root causes of the mechanical failure, aging process of the material, creep, corrosion, fatigue (among others); as well as how the different structures perform according to the heat treatment.; and the existing lack of harmonised training and qualification in the field of macroscopic and microscopic metallographic examination of structural materials and their joints. Also, partners will make use of Learning Outcomes (LOs) approach and ECVET¹ to allow transparency and the common understanding of the qualifications and facilitate mobility of workers among different European countries.

Shifting towards LOs, according to CEDEFOP handbook "Defining, writing and applying learning outcomes", will facilitate the process of orienting the teaching/learning process, since these "(...) support the initial choice of education and training; (...) help to orient the

¹ European Credit System for Vocational Education and Training



learning process itself; (...) clarify what to expect during assessment or validation (...) – and – clarify the area of learning being assessed, indicating what is relevant and not.” Therefore, LOs simplify “(...) what a learner is **expected to know** and be **able to do and understand**, having completed a learning sequence, a module, a programme or a qualification.” Additionally, considering the revision and update of the Special Course into a Qualification, shifting into a LOs approach will establish “(...) the basis for systematic dialogue with labour market and society stakeholders regarding evolving skills needs.” Thus, adopting this point of view allows (..) to clarify how it relates to and/or overlaps with other courses/programmes and qualifications – and – (...) provide an important reference point for quality assurance and close dialogue with end-users.” Consequently, employing LOs “(...) increase accountability, offering a better basis for judging whether education and training institutions deliver according to needs and expectations.” (CEDEFOP, Defining, writing and applying learning outcomes, A European Handbook – second edition 2022), contributing towards a Learner Centred Approach.

The development of O1 aiming to develop the Guideline for the European Macroscopic and Microscopic Metallographic Examination Personnel is led by the European Federation for Welding, Joining and Cutting (EWF – Belgium), in close collaboration with the remaining HIMACROW project partners, Institutul National de Cercetare Dezvoltare in Sudura si Incercari de Materiale (ISIM TIMISOARA – Romania), Istituto Italiano Della Saldatura Associazione (IIS – Italy), Magyar Hegesztéstechnikai és Anyagvizsgáló Egyesülés (MHTE – Hungary), SC WELD-CONS SRL (Romania) during a period of 11 months.

EWF (www.ewf.be) is a European umbrella organisation, representing the manufacturing community in Europe - along with its 31 European members, the National Welding Institutes. EWF manages the Welding harmonised qualification and training system, ensuring that trainees gain minimum knowledge of the appropriate welding processes and the material's behaviour, in alignment with the relevant industrial requirements. The training guideline and professional profile are recognised by the European industry and relevant stakeholders worldwide.

2. Introduction

The update of the Special Course on Personnel with the responsibility for Macroscopic and Microscopic Metallographic Examination of Base Materials and their Joints Prepared/Produced by Welding and Allied Techniques (EWF Guideline_627-07 (latest version)) into a Qualification has been identified as necessary due to the shortage of harmonised training and qualification in the field of macroscopic and microscopic metallographic examination of structural materials and their joints, leading to the increasing market need for professionals qualified in that field.

The metallographic examination is widely used to determine both macro and microstructure of metals and their alloys. Therefore, it enables to assess the influence of various kinds of processes and technological treatment, for instance metallurgical processes, plastic working, welding and allied processes, heat treatment (etc.), on changes occurring in the structure of metals and their alloys. The increasing need to develop design solutions that allow the production of new items, at lower costs and where the product lifetime is determinant for competitiveness created a high need for personnel capable of offering such solutions. The requirements of these examinations grow around 10% per year, what clearly indicates the need of having a common harmonized qualification system effectively implemented. Hence, leading to the necessity to develop a series of new training courses and evaluation to ensure the required competences. These competencies should be achieved in the frame of harmonised training courses at European level.

The EWF Guideline_627-07 (latest version) for Macroscopic and Microscopic Metallographic Examination of Structural Materials and their Joints is currently implemented in few countries, needing to be improved accordingly, to fit the new raised demands of the industry. The current Guideline provides methods for both theoretical and practical education and training at three levels: COMPREHENSIVE LEVEL: “Advanced techniques in metallographic examination of structural materials and their joints prepared/produced by welding and allied techniques”; STANDARD LEVEL: “Macro- and microscopic examination of structural materials and their joints prepared/produced by welding and allied techniques”; and BASIC LEVEL: “Specimens preparation for macro- and microscopic examination of structural materials and their joints prepared/produced by welding and allied techniques”.



In O1 it was proposed the following changes:

- Define two professional profiles for the European Macroscopic and Microscopic Metallographic Examination Personnel, corresponding to a specialised and advanced proficiency levels).
- Review the access conditions for each level of qualification.
- Define the descriptors for the Qualifications, using the learning outcomes descriptors.
- Review the structure and content of the training programme, ensuring a modular and cumulative approach.
- Define learning outcomes for the Competence Units.
- Review the examination procedures.



3. Scope

Mechanical, physical and chemical properties of metals and alloys are determined essentially by their structure. Therefore, the metallographic examination is widely used for determination of both macro- and microstructure of metals and their alloys. Metallographic examination enables to assess the influence of various kinds of processes and technological treatment, for instance metallurgical processes, plastic working, welding and allied processes, heat treatment (etc.) on changes occurring in the structure of metals and their alloys.

Metallographic examination belongs to the group of **destructive tests** because the preparation of suitable specimen is connected inherently with the injury to the whole of the test element.

In the present-day, welding technology, in relation to welded joints and those made by allied techniques, employee's metallographic examination on a very large scale, namely:

- a) in characterization of metal alloy (grain dimension, intermetallic compounds, metallographic structure, etc.),
- b) in testing of weldability of materials appropriated for welding,
- c) in verification of welding personnel qualifications (welders, welding operators),
- d) in development of welding consumables (filler metals, fluxes, etc.),
- e) in development of new methods of welding, surfacing, brazing, soldering and thermal cutting,
- f) in determination of optimum conditions of welding, weld surfacing, brazing, soldering and thermal cutting,
- g) in current control of welding processes (in testing of joints or test elements),
- h) in final control of welded, brazed or the like products,
- i) in testing of conditions of arising of welding defects and imperfections,
- j) in determination of reasons of failures of structures and products made by welding and allied methods.

This Guideline covers the minimum requirements for education, training and qualification of Personnel with the responsibility for Macroscopic and Microscopic Metallographic Examination of Base Materials and their Joints Made by Welding and Allied Techniques. Students having successfully completed this qualification will be expected to be



capable of applying preparation and assessment of specimens for metallographic investigations as covered by this Guideline.

This Guideline is designed to provide the core education and training in Macroscopic and Microscopic Metallographic Examination of Structural Materials and their Joints Prepared/Produced by Welding and Allied Techniques required by those responsible for performing these tasks at various levels. It is possible that additional training and/or experience may be necessary beyond the core education and training to meet the requirements of specific applications or job functions or local requirements or legislation.

The modular qualification contents are given in the following structure (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

* Contact Hours are the minimum teaching hours for the Standard Routes. One contact hour shall contain at least 50 minutes of direct teaching time.

** Workload is calculated in hours, corresponds to an estimation of the time students typically need to complete all learning activities required to achieve the defined learning outcomes in formal learning environments plus the necessary time for individual study (outside classroom context).

4. Definitions

For the scope of this Guideline, the following definitions apply:

- **Education and training:** A process of instruction in relevant theory and practice that takes the form of courses of an approved syllabus and periods of practical work under qualified supervision (but shall not include the use of specimens used in the practical examination). All educational courses leading to the award of qualification covered by this Guideline shall be approved by the EWF Authorised Nominated Body (ANB).
- **Qualification:** A demonstration in accordance with the EWF Guidelines and rules, conducted by the Authorised Nominated Body, involving an examination of the knowledge and skill related to specified criteria. Success in this examination leads to the issue of the related EWF diploma gained. Such diplomas remain valid for the lifetime of the holder.
- **Relevant experience:** Apart from a secondary technical and scientific education, candidates of the STANDARD LEVEL can also apply if they have at least 3-years of professional practice corresponding to the course subject-matter.

5. Macroscopic and Microscopic Personnel Role

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

- Prepare the sample (test specimen) for analysis 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,
- aluminium and copper alloys,
- titanium alloys,
- nickel alloys,
- thermoplastics.

The type or types of base materials are chosen upon the request of students for the course.

6. Reports

The Macroscopic and Microscopic Examiner must collate the findings, checklists, and results into a report (ISO17639:2022, latest version) that is structured to meet the needs of the client, a jurisdiction, or a code. This report is the document of reference, which could allow the tracing of a production parameter that proves after years of service to be contributing to a failure. It allows the tracing of responsibility to a specific supplier or contractor.

One or more interim reports might well be necessary to show progress during a long or complicated construction project. Reports must detail the examination stages, parameters, and results, including corrective actions if required. It is important to identify quality related problems as early as possible. Interim reports and findings are extremely valuable as they provide information, they might not otherwise be aware of. The examiner's findings might highlight quality problems that could, perhaps, be remedied by design or production changes if found early enough. The examiner should remember to quantify findings where possible.



7. Levels of Macroscopic and Microscopic Metallographic Examination Personnel

There are two levels of the European Macroscopic and Microscopic Metallographic Examination Personnel (EMMMEP):

- **COMPREHENSIVE LEVEL** which deals with “Advanced techniques in metallographic examination of base materials and their joints prepared/produced by welding and allied techniques”.
- **STANDARD LEVEL** which deals with “Macro- and microscopic examination of base materials and their joints prepared/produced by welding and allied techniques”.

7.1. Comprehensive Level

A candidate completing the “Comprehensive” level of training under this programme shall possess an **advanced knowledge** of advanced testing techniques. This knowledge will enable him/her to interpret the macroscopic and microscopic examination results of base materials and their joints.

7.2. Standard Level

A candidate completing the “Standard” level of training under this programme shall possess a **specialized knowledge** of the characteristics of defects in joints prepared by welding or allied processes according to the standards. This knowledge will enable him/her to interpret the results of macro and microscopic examination, as well as to assess of joints quality using macro- and microscopical examination. To this end, pieces of both homogeneous material and their joints of chosen base materials will be performed.



GENERAL DESCRIPTION OF PROFESSIONAL PROFILE	
EMMMEP_C	<p>The EMME-C level is the person responsible for interpreting macroscopic and microscopic examination results in compliance with the relevant acceptance criteria.</p> <p>His/her main tasks and responsibilities related to the examination of base materials and welded joints are the following:</p> <ul style="list-style-type: none"> -Check and approve the test report; -Develop microscopic test report; -Supervise microscopic examination; -Supervise the preparation of tests specimens for microscopic examination; -Interact and communicate with the client.
EMMMEP_S	<p>The EMME-S level is the person responsible for presenting macroscopic and microscopic examination results.</p> <p>His/her main tasks and responsibilities related to the examination of base materials and welded joints are the following:</p> <ul style="list-style-type: none"> -Fulfill the macroscopic test report; -Prepare the test specimens for macroscopic examination; -Supervise the test specimens' preparation for metallographic examination.



8. General Description Of The Qualification

Section I: General Description of the Qualification

QUALIFICATION LEVEL	KNOWLEDGE	SKILLS	AUTONOMY & RESPONSIBILITY	EFW PROFICIENCY LEVEL	EQF LEVEL
COMPREHENSIVE	Advanced knowledge and critical understanding of the theory, principles and applicability of advanced Microscopic and Macroscopic Techniques	Advanced problem-solving skills, including critical evaluation, and development of solutions, allowing to develop the knowledge of metal alloys and their joints.	Manage the applications of macroscopic and microscopic examination in a laboratory; Has autonomy to make the final decision in case there is doubts or there isn't an agreement within the team about the procedure to be taken; Has additional skill and competence for e.g., Scanning Electron Microscopy (SEM); Drafts, tests and supervise in unpredictable situations (e.g., different material than expected where you have to perform the test again, preparation problems, such as unclear sample, etc.) Supervises and evaluates professionals in the STANDARD LEVEL; Manages the clients' requests; Approve the test reports made by the professionals in the STANDARD LEVEL.	ADVANCED	6
STANDARD	Specialised, factual and theoretical of theory, principles and applicability of Microscopic and Macroscopic Techniques	Specialised range of cognitive and practical skills, allowing to develop solutions or choose the appropriate methods for the preparation and examination of macrographic and micrographic examination.	Choose the appropriate material and process (mounting, grinding, polishing and etching) for the sample preparation; Prepare the sample for examination; Perform and analyse the macrographic and micrographic structures of metals, alloys and their joints, according to the standards and product specifications; Prepare test reports about the results of the examinations.	SPECIALIZED	5
BASIC	-	-	-	INDEPENDENT	4

9. Section II: Minimum requirements

9.1. Introduction

The Guideline seeks to achieve harmonisation in the education, training, examination and qualification of macro- and microscopic examination of joints in Europe.

The national welding organisations, being members of EWF, mutually acknowledge the Qualification awarded by any Authorised National Body approved to implement this Guideline. This "Authorised National Body" (ANB) will normally be the National Welding and Joining Organisation but may be another organisation with the agreement of the EWF Member.

Education must have followed this EWF guideline Section I, and the examination and approval tests must have been conducted by the National Body authorised by the EWF for this purpose.

9.2. Route from Standard to Comprehensive²

Candidates of the STANDARD LEVEL shall possess, at least, secondary technical and scientific education. The candidates with at least 3-year professional practice corresponding the course subject-matter are also admitted.

Candidates of the COMPREHENSIVE LEVEL shall possess an engineering technical degree or similar.

The candidates for the COMPREHENSIVE LEVEL course, who have completed the STANDARD LEVEL course, shall attend the remaining modules (e.g., corresponding to 27 hours of training) corresponding to the COMPREHENSIVE LEVEL course, as long as they comply with the access conditions for the COMPREHENSIVE LEVEL.

Whenever applicable, Competence Units and Qualifications are designed in a way that enhances and allows upskilling pathways, either within the same field of activity or among different specialisation areas comprehending the assignment of levels of increasing complexity in learners understanding of subjects, that can be resumed as follows:

- The progression of levels is made from the lowest to the highest level in building blocks;

² This Guideline doesn't address the BASIC LEVEL of this Qualification.



- The highest levels start the training courses along with the lowest levels ensuring the development of solid fundamental knowledge and skills of concepts and principles;
- Upon successful completion of the lowest levels, learners start more complex levels.

9.3. Requirements for candidates

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

9.4. Requirements for training centers

Requirements for teachers and instructors, examiners, training establishments, courses are documented in the doc. EWF 416 (latest edition).

9.5. Admission to the Examination

Admission to the examination shall be denied for those who failed to attend 90% of the training program.

9.6. Examination procedures

The examination procedures described below are designed to simulate the practical situations of macro- and microscopic evaluation of joints in industry. The examination comprises written and practical parts. The examination covers all subjects of IO2 Harmonised curriculum for the macro and microscopic metallographic examination of structural materials.

9.6.1. Written examination

The examination shall consist of a series of multiple-choice questions covering the whole field of the subject. The time devoted to the written examination is minimum 2 hours for each level.

9.6.2. Oral examination

The oral examination will be optional at the discretion, except in borderline cases where it will be mandatory.

9.7. Evaluation of performance

To pass the examination candidates must achieve at least 60% of the maximum possible mark in each evaluation (written and practical).

9.8. Practical examination

COMPREHENSIVE LEVEL: Advanced techniques in metallographic examination of base materials and welded joints

Practical examination consists of three stages:

Stage 1:

Every course participant draws a sheet containing information about a specimen subject to procedure. Introductory information received by the examinee is as follows:

- a) type (grade) of specimen material
- b) size of specimen (shape and dimensions)
- c) type of testing e.g., whether macro- or microscopic
- d) test objective e.g., revealing austenite structure in non-weathering (anticorrosive) steel
- e) laboratory equipment and device types e.g., cut-off machine, press for mounting the specimen, grinding and polishing machine, device for electrolytic etching, metallographic microscope etc.
- f) range of consumables e.g., types of resins for mounting the specimen, range of gradation for abrasive papers, polishing cloths and diamond suspensions or pastes etc.

The examinee develops the procedure for the specimen preparation.

The examinee is provided with standards containing information and sets of etching agents for macro- and microscopic metallographic tests as well as supporting documents.

Stage 2:

Every course participant draws from a pool, a set of three scanning photographs presenting various types of fractures in steel specimens. The examination objective consists in independent and individual identification of a given type of fracture presented in the scanning photograph. To pass, the examinee should properly identify at least two out of three types of fractures.

Stage 3:

Each of the examinees draws from a pool, a set of three photographs revealing different microstructures characteristic for areas of the base material and/or welded or allied joints in metals/alloys. The purpose of this stage of the examination is unaided identification of the



microstructure type by the examinee on the drawn photographs. For passing the examination, it is required to correctly identify two microstructures from among three ones.

STANDARD LEVEL: Macro- and microscopic examination of base materials and welded joints

Practical examination consists of two stages:

Stage 1:

Each of the examinees carries out the quality assessments of a selected at random fragment with the surface prepared previously as a specimen for macroscopic examination. The examinee performs the assessment according to the defined criteria and makes the report of the macroscopic examination. During the examination each examinee has at his disposal all necessary accessories, such as a magnifying glass, weld gauge, slide calliper and a scale.

Stage 2:

Each of the examinees draws from a pool, a set of three photographs revealing different microstructures characteristic for areas of base materials and/or welded or allied joints in metals/alloys. The purpose of this stage of the examination is unaided identification of the microstructure type by the examinee on the drawn photographs. For passing the examination, it is required to correctly identify at least two microstructures from among three ones.

9.9. Re-examination

Failure in any individual module of the examination shall require re-examination only in the module failed. Examinations shall be retaken within 2 weeks to 15 months of the initial examination, and, in the case of a second failure, one further attempt is permitted within 1 to 15 months from the date of the second examination. If a candidate fails three times, he/she must retake the classes of the course and the exams.

The remaining procedures are covered in the doc. EWF416 (latest version).

10. Diploma of the European Welding Federation

After successful examination the Authorised National Body awards the candidates the diploma of the EUROPEAN PERSONNEL WITH RESPONSIBILITY FOR MACROSCOPIC AND MICROSCOPIC METALLOGRAPHIC EXAMINATION – Comprehensive Level or Standard Level (Appendix B).

The ANB maintains records of successful and unsuccessful candidates.

11. Appeals procedure

Candidates who feel they have been unfairly treated during the examination procedure have the right to appeal to the Authorised National Body.

The remaining procedures are covered in the doc. EWF416 (latest version).

12. Transition arrangements

An Authorised National Body (ANB) can offer Transitional Arrangements for a period of up to three years from the implementation of the guideline by the Authorised Training Body (ATB).

Practicing personnel in a member state will be eligible for the award of the European Diploma if they can demonstrate to the ANB that their combination of education, training and experience has provided a level of knowledge and practical skills equivalent to the current EWF requirements. If, in the judgement of the ANB, the candidate has not received an adequate level of formal training in macroscopic and microscopic examination, shall be required to attend a professional interview or examination conducted by an assessment Committee of the Authorised National Body.

Three additional general rules must be observed when applying transition arrangements.

1. Applicants must possess the basic technical access qualification as outlined for the country concerned in this guideline.

2. Only the country from which the applicant received his qualification or in which he is currently practicing can award the diploma under the transitional arrangements.



3. Qualifications (diplomas) from countries outside the EWF member states cannot be used to justify the award of a diploma under the transition arrangements.

For each country specific transition arrangements will be approved by the EWF Technical Committee, as necessary and may be obtained from the Authorised National Body.

13. Appendix I. Requirements for ANBs and ATBs to run the training courses

Specific Requirements for Training Centres

A.1 General

The training of the Personnel with the responsibility for Macroscopic and Microscopic Metallographic Examination of Base Materials and their Joints Made by Welding and Allied Techniques is a professional upgrading course strongly orientated to practical application. The theoretical basis and know-how in the training course is specialized in a practical as well as in a theoretical part for the qualification of a European Macroscopic and Microscopic Metallographic Examination Personnel. Therefore, special requirements are necessary to be fulfilled by the Training Centers in respect to equipment, facility and specially qualified instructing personnel.

A.2 Facilities and technical equipment

Facilities and technical equipment should be of a national/international recognized standard, and follow the grinding and polishing machine, device used for electrolytic etching, fume cupboard or chemical storage cabinet, metallographic microscope, and measuring instruments.

A.2.1 Other equipment

Mechanical testing, metallurgical examination and Non Destructive Testing (NDT) equipment must be available for both demonstration and laboratory work purposes.

A.2.2 Specimens

A reference collection of well documented weld specimens, polished and etched, should reflect the processes covered by the Guideline and, as a minimum, one specimen per process is required. Preferably the specimens should cover several materials and thicknesses, national/international safety rules and regulations. Specimens' materials: low alloy steels, alloy steels, cast irons and aluminium, copper, titan, nickel and their alloys and plastics.

A.3 Qualification of instructing personnel

The Training Centers must provide the following specially qualified instructing personnel to guarantee a substantial training and education for the trainees:



A.3.1 Experienced Welding Supervisor (e.g., Welding Engineer, Technologist) with excellent theoretical and practical experience and knowledge in macroscopic and microscopic metallographic examination – technical university; specialization welding or material engineering, at least 3-year professional practice corresponding to the course subject-matter.

A.3.2 Experienced instructor trained and certified as a welding specialist with excellent knowledge and skill, and long-term practical experience in preparing and examination of macroscopic and microscopic metallographic specimens – at least secondary technical education, in mechanical ranch and at least 3-year professional practice corresponding to the course subject-matter.



14. Appendix II: EWF Welding Qualifications Framework

FIELD OF ACTIVITY		EFW LEVEL	EQF LEVEL	KNOWLEDGE	SKILLS	AUTONOMY AND RESPONSIBILITY	EFW QUALIFICATION SYSTEM	
INSPECTORS & SUPERVISORS / COORDINATORS / MANAGERS	WELDERS & OPERATORS	EXPERT	7	Highly specialised and forefront knowledge including original thinking, research and critical assessment of theory, principles and applicability of metal additive manufacturing or welding related technologies.	Highly specialised problem- solving skills including critical and original evaluation, allowing to define or develop the best technical and economical solutions, when applying metal additive manufacturing or welding related technologies, in complex and unpredictable conditions	Manage and transform the metal additive manufacturing or welding and related technologies processes in a highly complex context. Fully responsible for the definition and revision of personnel's tasks.	WELDING	AM
		ADVANCED	6	Advanced knowledge and critical understanding of the theory, principles and applicability of metal additive manufacturing or welding and related technologies.	Advanced problem-solving skills including critical evaluation, allowing to choose the proper technical and economical solutions, when applying metal additive manufacturing or welding and related technologies, in complex and unpredictable conditions	Manage the applications of metal additive manufacturing or welding and related technologies in a highly complex context. Act autonomously in decision making and definition in the definition of the metal additive manufacturing or welding and related personnel's tasks.		
		SPECIALIZED	5	Specialised, factual and theoretical of theory, principles and applicability of metal additive manufacturing or welding and related technologies	Specialised range of cognitive and practical skills, allowing to develop solutions or choose the appropriate methods, when applying metal additive manufacturing or welding and related technologies, in common/regular problems.	Manage and supervise common or standard metal additive manufacturing or welding applications and related technologies, in an unpredictable context. Take responsibility in standard work and supervise the metal additive manufacturing or welding and related personnel's tasks.		
		INDEPENDENT	4	Factual and broad concepts in the field of metal additive manufacturing or welding technology	Fundamental cognitive and practical skills required to develop proper solutions and application of procedures and tools on simple and specific metal additive manufacturing or welding problems.	Self-manage of professional activities and simple standard applications of metal additive manufacturing or welding and related technologies in predictable contexts but subject to change. Supervise routine tasks and similar function workers, as well as take responsibility for decision making in basic work.		
		BASIC	3	Basic facts, principles, processes and general concepts of welding, joining and related technologies	Be able to check and follow the information on the welding procedure specification, to produce butt and fillet welds in plates and or tubes, and or profiles in a variety of geometries and positions to the required quality and of specified dimensional accuracy	Work under supervision, taking personal responsibility for own actions and for the quality and accuracy of the work produced.		
		ELEMENTARY	2	Elementary principles of welding, joining and related technologies	Able to check and follow the information on the welding procedure or adhesive bonding specification, and to produce weld/joints in a variety of geometries and positions to the required quality and of specified dimensional accuracy	Work under supervision.		

General reference descriptors transversal to all qualifications. Each Qualification has its own specific descriptors in terms of Knowledge, skills, autonomy and responsibility.



15. Appendix III: Curriculum Capitalisation

EFW Guideline_627-07 (latest version) for macroscopic and microscopic metallographic examination of structural materials and their joints

Color Scheme	
GREEN: Specific subjects to the BASIC LEVEL	PURPLE: CU1: Introduction to Macro and Microscopic Metallographic Examination Includes subjects nº 1 (B+S+C), nº 2 (B+S+C), nº 3 (B+S+C) and nº 4 (B+S+C)
YELLOW: Specific subjects to the STANDARD LEVEL	
ORANGE: Specific subjects to the COMPREHENSIVE LEVEL	GREY: CU2: Specific Methods for Sample Preparation for Macro and Microscopic Examination Includes subjects nº 6 (C), nº 7 (C), nº 9 (C), nº 10 (C), nº 11 (C) and nº 12 (C)
BROWN: Common subjects to the BASIC and STANDARD LEVELS	
AQUA: Common subjects to the STANDARD and COMPREHENSIVE LEVELS	PINK: CU3: Demonstrations in Macro and Microscopic Examination Includes subjects nº 5 (S+C), nº 8 (S+C), nº 15 (S), nº 16 (S), nº 17 (S), nº 18 (S) and nº 19 (S)
BLUE: Common subjects to the BASIC, STANDARD and COMPREHENSIVE LEVELS	

Nº.	Subject	Number of theoretical teaching hours	Number of practical teaching hours	Subject	Number of theoretical teaching hours	Number of practical teaching hours	Subject	Number of theoretical teaching hours	Number of practical teaching hours
LEVEL		COMMON TO ALL LEVELS (BASIC, STANDARD, COMPREHENSIVE)							
1	The types of metallographic examination; work safety conditions during the preparation of specimens for metallographic examinations	-	-	-	-	-	-	1	-
2	Methods of specimen preparation for macro- and microscopic examination	-	-	-	-	-	-	3	-
3	Macroscopic examination and its application in welding technology	-	-	-	-	-	-	0,5	-
4	Microscopic examination and its application in welding technology	-	-	-	-	-	-	0,5	-



LEVEL		COMMON TO COMPREHENSIVE + STANDARD LEVELS					BASIC LEVEL			
5	Demonstration of specimen preparation manners for metallographic examination	-	2	-	-	2	13 Practical training in preparation of specimens for metallographic examination	-	24	
LEVEL		COMPREHENSIVE LEVEL		COMMON TO BASIC + STANDARD LEVELS						
6	Electrolytic polishing, chemical polishing, colored etching – purpose and application	5	-	14 Presentation of the EN 1321 standard	-	-		1	-	
LEVEL		COMPREHENSIVE LEVEL		STANDARD LEVEL						
7	Demonstration of electrolytic polishing and colored etching	-	3	15 Practical training in specimen preparation	-					4
LEVEL		COMMON TO COMPREHENSIVE + STANDARD LEVELS								
8	Demonstration of different kinds of microscopic structures	-	1	-	-					1
LEVEL		COMPREHENSIVE LEVEL		STANDARD LEVEL						
9	Image analysis as a tool in metallographic examination	6	-	16 Presentation of standards relating to the quality assessment of joints made by welding and allied techniques	16					-



LEVEL		COMPREHENSIVE LEVEL			STANDARD LEVEL				
10	Demonstration of capabilities of the program for image analysis	-	4	17 Demonstration of assessment of macroscopic specimens of joints	-	3			
LEVEL		COMPREHENSIVE LEVEL			STANDARD LEVEL				
11	Introduction to scanning microscopy	5	-	18 Practical training in unaided identification of welding imperfections on macroscopic specimens	-	6			
LEVEL		COMPREHENSIVE LEVEL			STANDARD LEVEL				
12	Demonstration of scanning microscope capabilities	-	4	19 Practical training in unaided identification of structures in microscopic specimens	-	2			
Practical examination		-	3	-	-	3	-	-	3
Written (test) examination		2	-	-	2	-	-	2	-
Total		23	22		24	21		8	27