EWF Guideline for
Internationlal Metal AM Supervisor

PERSONNEL WITH QUALIFICATION FOR METAL ADDITIVE MANUFACTURING

Minimum Requirements for the Qualification and Examination

IAMQS-QUAL-012r1-21

MINIMUM REQUIREMENTS FOR
QUALIFICATION AND EXAMINATION

International Metal Additive Manufacturing Supervisor (I MAM S)

Guideline - General information for the public and organizations that implement this qualification

For more information regarding the Qualifications System, the Management Team or the IAMQS ANB should be contacted
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Preface

The present document consists in International Metal AM Supervisor Guideline, developed by EWF.

This guideline for the European education, training, examination and qualification of additive manufacturing personnel has been prepared, evaluated and formulated by the EWF International Additive Manufacturing Qualification Council (IAMQC). Contains general information for the public and organizations that implement this qualification.

Copies of this document can be downloded from EWF website: www.ewf.be, requested to IAMQS Authorized Nominated Bodies for Metal Additive Manufacturing (IAMQS ANBs) or Management Team.

MINIMUM REQUIREMENTS FOR THE EDUCATION, TRAINING, EXAMINATION AND QUALIFICATION OF PERSONNEL

Introduction

This guideline covers the minimum requirements for education and training, which have been agreed upon by all IAMQS ANBs, in terms of Learning Outcomes (Knowledge and Skills) and the recommended contact (teaching) hours to be devoted to achieving them. It will be revised periodically by EWF IAMQC to take into account changes to reflect the "state of the art".

Students successfully completing examinations will be expected to be capable of applying the achieved learning outcomes at a level consistent with the qualification diploma level.

The modular course contents are given in the following structure (overview):

COMPETENCE UNITS	I MAM C	
	Recommended Contact Hours*	Expected Workload**
CU 00: Additive manufacturing Process Overview	3,5	7
CU 01: DED-Arc Process	14	28
CU 08: DED-LB Process	14	28
CU 15: PBF-LB Process	14	28
CU 46: Quality Assurance for Metal AM Processes	14	28
CU 47: HSE for Metal AM Processes	14	28
CU 48: Powder Handling	7	14
TOTAL	**80**	**160**

* Contact Hours are the minimum recommended teaching hours for the Standard Routes. A 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.

Within EWF´s qualifications, there are two types of Competence Units:

Cross-cutting Competence Unit - A competence unit whose learning outcomes are not directly linked with one job function since the knowledge and skills achieved will be mobilized in several job functions and activities.

Functional Competence Unit - A competence unit whose learning outcomes are directly linked with at least one job function and in which the knowledge and skills achieved will be mobilized in specific job functions and related activities.

The expected learning outcomes are described in two ways: generic outcome descriptors organized in knowledge, skills, autonomy and responsibility; and in detail for each competence unit, organized in job functions and related activities, knowledge and skills corresponding to a specific proficiency level within EWF´s Systems Framework levels (see Appendix III).

On each Competence Unit, objectives and scope are defined for a specific depth of knowledge and skills.

Recommended contact hours are distributed between theoretical (A), assigned projects/exercises (B), practical workshop training(C), as showed in the following example:

Qualification: Example 1	
CONTACT HOURS	**X= (SUM A:C)**
Subject Contents	A + B + C

Professional Profile

International Metal AM Supervisors are the professionals with the specific knowledge, skills, autonomy and responsibility to supervise AM production on shop floor, being its main tasks to:

- Implement Quality Procedures
- Ensure Health & Safety Environment Procedures
- Record the essential information during the AM manufacturing process

1 Routes to Qualification

Two distinct routes to gaining the qualifications described in this document have been agreed.

1. The Standard Route
2. Blended Learning Route

1.1 The Standard Route

The Standard Route requires successful completion of EWF approved courses which are designed to meet all the requirements in this Guideline. This is the route recommended by EWF as offering the fastest, most comprehensive manner in which the detailed knowledge may be covered.

1.2 Blended Learning Route

The Blended Learning Route will depend on the type of Competence Units (Cross-cutting or Functional). The Cross-Cutting Competence Units (theoretical knowledge and skills) may be taught using Distance Learning Programs under the control of the AM ANB and all the Functional Competence Units (practical knowledge and skills) must be taught at the Authorized Training Bodies for Metal Additive Manufacturing (AM ATB) facilities.

2. General Access Conditions

The defined access conditions approved by IAMQC are given in detail for all countries participating in the EWF system.
The access conditions to International Metal AM Supervisor Qualification admission are the following:

- National compulsory school diploma
- Basic knowledge and skills related with Quality Assurance and HSE
- At least 1 year of experience in Quality and Safety supervision in manufacturing activities is recommended

3 Special Requirements

3.1 Standard Route

Applicants shall satisfy the access conditions, to be accepted for the attendance of a training course conducted by an IAMQS ATB.

There will be written, oral and practical examinations (where applicable) for the award of the applicable EWF Diploma.

It is not obligatory to follow exactly the order of the Competence Units given in this guideline and choice in the arrangement of the detailed knowledge is permitted, with the exception that **the first Competence Unit to be provided must be CU 00: Additive manufacturing Process Overview.**

In the case of attendance and evaluation of the optional competence unit, **CU26: Introduction to Materials**, this shall be done before lecturing any of the CUs numbered from 27 to 33.

The rules for the conduct of the examinations by the IAMQS ANB are prescribed under Examination and Qualification in each Competence Unit guideline.

Complementary to the Competence Units that are required for the purpose of the International Metal AM Supervisor Diploma issuing, a set of optional Competence Units that can also be of added value for the student and can be implemented by the IAMQS ATB as a supporting training and education offer.

For these optional Competence Units, separate Records of Achievement will be issued after examination approval. Whenever these optional Competence Units are considered mandatory for a certain EWF Qualification, they can be recognized for the purpose of such Qualification Diploma.

The examination of any Competence Unit for the purpose of being validated individually, not included in a Qualification course, shall be completed within a period of 1 year from the starting day of the Competence Unit.

If the Competence Unit “A” is done as a part of a qualification course, the examination shall be completed within a period of 4 years from the date of the completion of the first Competence Unit from the qualification where Competence Unit “A” is integrated in. Failure in the examination shall require re-examination.

Each Competence Unit has a period of validity of 4 years. When applying for a Qualification course, the period of validity of the completed CUs are at discretion of the IAMQS ANB.

3.2 Section I: Theoretical and Practical Education – Qualification Descriptors and Learning Outcomes

I.1. Qualification Outcome Descriptors

QUALIFICATION	EWF LEVEL	KNOWLEDGE	SKILLS	AUTONOMY AND RESPONSIBILITY
International Metal AM Supervisor	**INDEPENDENT**	Factual and broad concepts in the field of Metal additive manufacturing processes, qualit,y health and safety assurance in shop floor.	Fundamental cognitive and practical skills on simple and specific of Metal additive manufacturing problems required to: • develop proper solutions related with quality, health and safety in shop floor • application of procedures and tools related with quality, health and safety	Self-manage of professional activities and simple standard applications of Metal AM manufacturing in predictable contexts but subject to change. Take responsibility for supervising routine Metal AM production, machines and related personnel.

I.2. Mandatory Competence Units Learning Outcomes

Competence Unit 00: Additive Manufacturing Processes Overview

CU 00: Additive Manufacturing Processes Overview	CONTACT HOURS
SUBJECT TITLE	
Directed energy deposition	0,5
Powder bed fusion	0,5
Vat photopolymerization	0,5
Material jetting	0,5
Binder jetting	0,5
Material extrusion	0,5
Sheet lamination	0,5
Total	3,5
WORKLOAD	**7**

Learning Outcomes – CU00: Additive Manufacturing Processes Overview	
KNOWLEDGE	Basic factual knowledge of: – Directed energy deposition – Powder bed fusion – Vat photopolymerization – Material jetting – Binder jetting – Material extrusion – Sheet lamination
SKILLS	Distinguish parts produced by different AM processes List the advantages and limitations of AM processes from a manufacturing process chain point of view Name the applicability of different AM processes, according to the characteristics of each process

Competence Unit 01: DED-Arc Process

CU01: DED-Arc Process SUBJECT TITLE	RECOMMENDED CONTACT HOURS
DED-Arc System (Hardware & Software)	5
DED-Arc Physical Principles, Processes and Parameters	5
DED-Arc Build platform, feedstock and other consumables	3
Post processing operations	1
Total	14
WORKLOAD	**28**

Learning Outcomes – CU01: DED-Arc Process	
KNOWLEDGE	Factual and broad knowledge of: – DED-Arc systems – Arc physics – Processable materials with DED-Arc – Processing atmosphere requirements with DED-Arc – Sensors and process controls with DED-Arc
SKILLS	Describe the DED–Arc systems, including the components and their functions Distinguish different types of feedstock Associate the interaction of the process heat source with the feedstock Recognise the DED–Arc parameters and the influence of their adjustment on the as built part (e.g. deformation) Recognise the characteristics of the DED–Arc build platform, feedstock and other consumables Identify the problems associated with inadequate preparation and set-up of the build platform, handling and storage of feedstock and application of the gases used in DED–Arc

Competence Unit 08: DED-LB Process

CU 08: DED-LB Process SUBJECT TITLE	RECOMMENDED CONTACT HOURS
DED-LB System (Hardware & Software)	5
DED-LB Physical Principles	2
DED-LB Parameters	3
Build platform, feedstock and other consumables	3
Post processing operations	1
Total	14
WORKLOAD	**28**

Learning Outcomes – CU08: DED-LB Process	
KNOWLEDGE	Factual and broad knowledge of: – DED-LB systems – Laser Characteristics – Build platform – Powder/wire – Gases – Processable materials with DED-LB
SKILLS	Describe the DED-LB systems, including the components and their functions Distinguish different types of feedstock Associate the interaction of the process heat source with the feedstock Recognise the DED-LB parameters and the influence of their adjustment on the as built part (e.g. deformation) Recognise the characteristics of the DED-LB build platform, feedstock and other consumables Identify the problems associated with inadequate preparation and set-up of the build platform, handling and storage of feedstock and application of the gases used in DED-LB Recognise the basic principles of 3D CAD systems and machine control software

Competence Unit 15: PBF-LB Process

CU 15: PBF-LB Process SUBJECT TITLE	RECOMMENDED CONTACT HOURS
PBF-LB Process Principles	2
PBF-LB System – Hardware and Software	4
PBF-LB Parameters	3
PBF-LB Feedstock	2
PBF-LB Consumables	2
Post Processing	1
Total	14
WORKLOAD	**28**

Learning Outcomes – CU15: PBF-LB Process	
KNOWLEDGE	Factual and broad knowledge of: – PBF-LB systems – Laser characteristics – Build platform – Powder – Gases – Processable materials with PBF-LB
SKILLS	Describe the PBF-LB systems, including the components and their functions Recognise the characteristics of the PBF-LB build platform, feedstock and other consumables Recognise the PBF-LB parameters and the influence of their adjustment on the as built part Recognise the interaction of the process heat source with the feedstock Identify the problems associated with inadequate preparation and setup of the build platform, handling and storage of feedstock and application of the gases used in PBF-LB

Competence Unit 46: Quality Assurance for Metal AM Processes

CU 46: Quality Assurance for Metal AM Processes	RECOMMENDED CONTACT HOURS
SUBJECT TITLE	
Quality Assurance and Quality Control	5.5
QA for different energy source machine	3.5
Wire vs Powder Parts QA	3.5
Communication workflows	1.5
Total	14
WORKLOAD	28

CU	EQF/ EWF LEVEL	JOB FUNCTION	JOB REQUIRED ACTIVITIES	RECOMMENDED CONTACT HOURS	WORKLOAD
CU 46 – Quality Assurance for Metal AM Processes	**4 / INDEPENDENT**	Supervise Quality Assurance Procedures on the Shop Floor	Ensuring the implementation of QA/QC procedures and instructions (e.g. feedstock storage and handling);	**14**	**28**
			Monitoring the compliance of the AM production process and the AM parts with the relevant documents (e.g. standards, product specifications, legislation);		
			Implementing preventive actions to avoid defects;		
			Implementing corrective actions to eliminate defects;		
			Providing guidance to AM operators in the day-to-day activities;		
			Assigning tasks to AM operators based on job requirements.		

LEARNING OUTCOMES – CU 46 - Quality Assurance for Metal AM Processes	
KNOWLEDGE	Factual and broad knowledge of: - Quality Assurance (QA) principles - Metal AM Systems QA - Quality Control (QC) in the manufacturing chain
SKILLS	Prepare the daily work and tasks distribution based on production plans. Compare DED-Arc, DED-LB and PBF-LB processes QA/QC procedures identifying each process' QA/QC specific requirements. Name the most common standards used for Metal AM production, Metal AM operator's qualification, Metal AM procedures approval and Metal AM systems qualification. Provide technical inputs to improve QA/QC procedures and instructions related to handling and storage of feedstock, AM systems and part production. Verify if parts' production on the shop floor complies with Quality Control procedures and Additive Manufacturing Procedure Specification (APS).

Competence Unit 47: HSE for Metal AM Processes

CU 47: HSE for Metal AM Processes	RECOMMENDED CONTACT HOURS
SUBJECT TITLE	
HSE in facilities	5
HSE for different energy sources	4.5
HSE for different types of feedstock	4.5
Total	14
WORKLOAD	28

CU	EQF/ EWF LEVEL	JOB FUNCTION	JOB REQUIRED ACTIVITIES	RECOMMENDED CONTACT HOURS	WORKLOAD
CU 47 HSE for Metal AM Processes	**4 / INDEPENDENT**	Supervise HSE on the Shop Floor	Ensuring compliance with HSE requirements and instructions featuring Metal AM processes and systems;	**14**	**28**
			Providing support to management and operational teams in all aspects of safety, health, and environmental issues;		
			Implementing corrective actions to avoid hazardous risks.		

LEARNING OUTCOMES – CU 47 HSE for Metal AM Processes	
KNOWLEDGE	Factual and broad knowledge of: - HSE requirements and instructions featuring Metal AM processes manufacturing - Infrastructures/Facility Requirements featuring Metal AM processes manufacturing
SKILLS	Identify HSE training requirements for personnel operating at the shop floor. Describe the HSE hazards occurring on shop floor naming the different specifications applicable to the main metal AM systems. Describe HSE procedures for handling and storage of metal AM feedstock naming the differences between wire and powder materials' procedures. Describe metal AM HSE applicable legislation and standards ensuring that personnel follows all the applicable HSE regulations on the shop floor. Verify if safety metal AM work procedures are properly followed monitoring personnel operations at the shop floor. Interpret Risk Assessment plans applying appropriate prevention and protection measures for reducing incidents at the shop floor. Produce incident/accident reports describing all the relevant factors related with the event.

Competence Unit 48: Powder Handling

CU 48: Powder Handling	RECOMMENDED CONTACT HOURS
SUBJECT TITLE	
Overview of Powder Manufacturing Processes	1
Chemical Composition and Physical Properties	2
Particle Size Distribution	0,5
Powder storage, handling, ageing and documentation	1,5
Powder reusability	1
HSE procedures	1
Total	7
WORKLOAD	14

CU	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	RECOMMENDED CONTACT HOURS	WORKLOAD
Power Handling	**4 / INDEPENDENT**	Manage powders for Metal AM	Implementing procedures for powder delivery and storage	14	28
			Preparing and analysing powder according to technical documentation		
			Performing powder reconditioning (e.g. sieving) after build cycle		
			Following HSE procedures		

Learning Outcomes – CU 48: Powder Handling	
KNOWLEDGE	Factual and broad knowledge of: – Powder handling, storage and reconditioning
SKILLS	Complete technical documentation related to powders for metal AM Characterise powders according to instructions from the engineer Ensure powder conditioning according to the AM Procedure Specification Control the reusability of powders Handle powders according to HSE procedures

Appendix I: EWF Systems Framework

FIELD OF ACTIVITIY		EQF LEVELS	EWF PROFICIENCY LEVEL	KNOWLEDGE	SKILLS	AUTONOMY AND RESPONSIBILITY
COORDINATORS/MANAGERS	WELDERS & OPERATORS	7	EXPERT	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.
		6	ADVANCED	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.
		5	SPECIALIZED	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.
		4	INDEPENDENT	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.
		3	BASIC	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.
		2	ELEMENTARY	Elementary principles of welding, joining and related technologies	Able to check and follow the information on the welding procedure or adhesive bounding 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.