EWF Guideline for
Internationlal AM Designer for Polymers

PERSONNEL WITH QUALIFICATION FOR METAL ADDITIVE MANUFACTURING

Minimum Requirements for the Qualification and Examination

IAMQS-QUAL-013-21

MINIMUM REQUIREMENTS FOR
QUALIFICATION AND EXAMINATION

International Additive Manufacturing Designer for Polymers (I AM D P)

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 AM Designer for Polymers 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 PE PBF-LB	
	Recommended Contact Hours*	Expected Workload**
CU 00: Additive manufacturing Process Overview	3,5	7
CU 65: Overview on polymer materials and properties	3,5	7
CU 66: Designing Polymers Parts	21	42
CU 67: Post Processing for Polymers	3,5	7
CU 68: Design for Material Extrusion	10,5	21
CU 69: Design for Powder Bed Fusion of Polymers	10,5	21
CU 70: Design for Vat Photopolymerization	10,5	21
CU 71: Design for Material Jetting	10,5	21
TOTAL	**77**	**154**

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

Professional Profile

AM Designers for Polymers are the professionals with the specific knowledge, skills, autonomy and responsibility to design AM solutions for the main Polymers Processes.
His/her main tasks are:

His/her's main tasks are to:

- Create part design solutions for AM polymer processes ensuring that:
  - the design considers AM benefits
  - the part can be manufactured in a cost-effective and efficient way
  - post -processing can be applied
- Close polymer design proposals by verifying requirements for production, post-processing, quality control and process requirements with the project responsible, ensuring liaison with other technical areas to sign the drawings;
- Contribute to projects in cooperation with AM Team and costumers.

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 AM Desginer for Polymers Qualification admission are the following:

- Adequate skills in using 3D CAD tools, and
- Engineering degree in Mechanical, Materials, Aeronautic, or equivalent (EQF level 6)
- OR professional qualification in technical industrial design
- OR comparable professional experience of at least three years

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 AM Designer for Polymers 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 RESPONSI-BILITY
International AM Designer for Pol-ymers	**ADVANCED**	Advanced knowledge and critical understanding of the theory, principles and applicability of additive manufacturing design for polymers.	Advanced problem-solving skills including critical evaluation and design thinking, allowing to choose the proper technical and economical solutions, when desgining parts to be manufactured by additive manufacturing polymers processes, in complex and unpredictable conditions.	Manage complex AM polyemrs procsses desgin projects, taking responsability for decision-making in unpredictable AM polymers processes design applications.

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 65: Overview on polymer materials and properties

CU 65: Overview on polymer materials and properties	CONTACT HOURS
SUBJECT TITLE	
Type of Polymer materials	0.5
Polymer Materials properties	2
Case study on materials applications	1
Total	3,5
WORKLOAD	**7**

Learning Outcomes – CU 65: Overview on polymer materials and properties	
KNOWLEDGE	Factual and broad knowledge of: – Type of Polymers Materials – Polymers Materials properties – Materials applications
SKILLS	Identify types of polymer materials commonly used in AM Interpret polymer materials properties according to design and industrial requirements.

Competence Unit 66: Designing Polymers Parts

CU 26: Designing Polymers Parts SUBJECT TITLE	CONTACT HOURS
Think Additively	6
Design principles for AM	6
CAD files in AM	0,5
Simulation tools	5,5
Case study	3
Total	21
WORKLOAD	**42**

Learning Outcomes – CU 66: Designing Polymers Parts	
KNOWLEDGE	Advanced knowledge and critical understanding of: – AM design thinking – Design principles for AM – Simulation
SKILLS	Apply designing concept for AM parts production. Apply design principles when developing and CAD modelling a part Associate design considerations to design thinking in the development of AM Polymer parts Evaluate AM potentials and limitations when designing AM Polymers parts Select simulation tools to be used in the Design of AM Polymer parts Provide solution-based approaches to redefine design problems (Design thinking) Assessing design specific costs for AM different machines

Competence Unit 67: Post Processing for Polymers

CU27: AM with Steels feedstock (excluding Stainless Steel)	CONTACT HOURS
SUBJECT TITLE	
General considerations	0,5
Depowdering, cleaning and support removal methods	0,5
Surface smoothing methods	1
Coating operations	1
Practical application	0,5
Total	3,5
WORKLOAD	**7**

Learning Outcomes – CU 67:AM with Steels feedstock (excluding Stainless Steel)	
KNOWLEDGE	Factual and broad knowledge of: – Post processing methods (Depowdering, cleaning and support removal, surface smoothing and coating operations)
SKILLS	Recognise the need for post processing operations on as-built parts according to the required part properties, considering suitable sequences of operations. List different post processing methods for a variety of part geometries, materials and AM processes to: – improve surface properties such as roughness, chemical and/or physical resistance, haptics & colour. Recognize the requirements that AM parts need to comply with for each post process. Describe the workflow of post processing operations.

Competence Unit 68: Design for Material Extrusion

CU 68: Design for Material Extrusion	CONTACT HOURS
SUBJECT TITLE	
Overview of Machines, Process Capabilities and Limitations	1,5
Process related Materials	1
Specific Design Considerations	6
Case study	2
Total	10,5
WORKLOAD	**21**

CU	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
Design for Material Extrusion	**6 ADVANCED**	Design of Material Extrusion parts	Interpreting process specific part or assembly requirements	**10,5**	**21**
			Creating new or redesigning existing 3D models using CAD tools taking advantage of AM (e.g., freedom in shape, capable of structures, lattice, organic shapes, part orientation...) by considering all segments of the manufacturing value chain		
			Validating design with project responsible or project team or customer		
			Creating all necessary design files and part lists, and if necessary complementary documents		
			Closing design project.		

Learning Outcomes – CU 68: Design for Material Extrusion Erro! A origem da referência não foi encontrada.	
KNOWLEDGE	Advanced knowledge and critical understanding of: – State-of-the-art machines – Selection of the right machines for the purpose – Build size – Capabilities and limitations of process and influence on design – Design considerations required for MEX polymer part design – Specific materials and their achievable properties and how to select them – Post processing influences on design
SKILLS	Associate the degrees of freedom of a MEX machine to the possibilities in terms of design Relate the capabilities and limitations of MEX to design considerations Determine dimensional constraints and geometric tolerances required for MEX parts design Provide solution-based approaches to redefine design problems (Design thinking) within MEX processes and parts

Competence Unit 69: Design for Powder Bed Fusion of Polymers

CU 68: Design for Powder Bed Fusion of Polymers	CONTACT HOURS
SUBJECT TITLE	
Overview of Machines, Process Capabilities and Limitations	1,5
Process related Materials	1
Specific Design Considerations	6
Case study	2
Total	10,5
WORKLOAD	**21**

CU	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
Design for Powder Bed Fusion of Polymers	**6 ADVANCED**	Design PBF Polymers parts	Interpreting process specific part or assembly requirements	**10,5**	**21**
			Creating new or redesigning existing 3D models using CAD tools taking advantage of AM (e.g., freedom in shape, capable of structures, lattice, organic shapes, part orientation...) by considering all segments of the manufacturing value chain		
			Validating design with project responsible or project team or customer		
			Creating all necessary design files and part lists, and if necessary complementary documents		
			Closing design project.		

Learning Outcomes – CU 69: Design for Powder Bed Fusion of Polymers Erro! A origem da referência não foi encontrada.	
KNOWLEDGE	Advanced knowledge and critical understanding of: – State-of-the-art machines – Selection of the right machines for the purpose – Build size – Capabilities and limitations of PBF polymer process and influence on design – Design considerations required for PBF polymer part design – Specific materials for PBF and their achievable properties and how to select them – Post processing influences on design
SKILLS	Associate the degrees of freedom of a PBF machine to the possibilities in terms of design Relate the capabilities and limitations of PBF to design considerations Determine dimensional constraints and geometric tolerances required for PBF parts design Provide solution-based approaches to redefine design problems (Design thinking) within PBF processes and parts

Competence Unit 70: Design for Vat Photopolymerization

CU 68: Design for Vat Photopolymerization	CONTACT HOURS
SUBJECT TITLE	
Overview of Machines, Process Capabilities and Limitations	1,5
Process related Materials	1
Specific Design Considerations	6
Case study	2
Total	10,5
WORKLOAD	**21**

CU	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
Design for Vat Photopoly-merization	**6 ADVANCED**	Design of parts manu-factured through Vat Photopolymerization	Interpreting process specific part or assembly re-quirements	**10,5**	**21**
			Creating new or redesigning existing 3D models using CAD tools taking advantage of VPP and optimising the design considering all aspects of the manufacturing process		
			Validating design with project responsible or pro-ject team or customer		
			Creating all necessary design files and part lists, and if necessary complementary documents		
			Closing design project.		

Learning Outcomes – CU 70: Design for Vat Photopolymerization Erro! A origem da referência não foi encontrada.	
KNOWLEDGE	Advanced knowledge and critical understanding of: – State-of-the-art machines – Selection of the right machines for the purpose – Build size – Capabilities and limitations of VPP polymer process and influence on design – Design considerations required for VPP polymer part design – Specific materials for VPP polymer and their achievable properties and how to select them – Post processing influences on design
SKILLS	Effectively design products taking into account the specific limitations and design freedoms offered by VPP processes and equipment Determine dimensional constraints and geometric tolerances required for VPP parts design Provide solution-based approaches to redefine design problems (Design thinking) within VPP processes and parts Identify products and applications which are suitable to use VPP

Competence Unit 70: Design for Material Jetting

CU 68: Design for Material Jetting	CONTACT HOURS
SUBJECT TITLE	
Overview of Machines, Process Capabilities and Limitations	1,5
Process related Materials	1
Specific Design Considerations	6
Case study	2
Total	10,5
WORKLOAD	**21**

CU	EQF/ EWF LEVEL	JOB FUNCTIONS	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
Design for Material Jetting	**6 ADVANCED**	Design of Material Jetting parts	Interpreting process specific part or assembly requirements	**10,5**	**21**
			Creating new or redesigning existing 3D models using CAD tools taking advantage of AM by considering all segments of the manufacturing value chain		
			Validating design with project responsible or project team or customer		
			Creating all necessary design files and part lists, and if necessary complementary documents		
			Closing design project.		

Learning Outcomes – CU 70: Design for Material Jetting Erro! A origem da referência não foi encontrada.	
KNOWLEDGE	Advanced knowledge and critical understanding of: – State-of-the-art machines – Selection of the right machines for the purpose – Build size – Capabilities and limitations of process and influence on design – Design considerations required for Material Jetting part design – Specific materials and their achievable properties and how to select them – Post processing influences on design
SKILLS	Associate the degrees of freedom of a Material Jetting machine to the possibilities in terms of design Relate the capabilities and limitations of Material Jetting process and equipment to design considerations Determine dimensional constraints and geometric tolerances required for Material Jetting parts design Provide solution-based approaches to redefine design problems (Design thinking) within Material Jetting processes and parts

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.