

**EWF Guideline for
International AM Polymer Operator**

**PERSONNEL WITH QUALIFICATION FOR METAL ADDITIVE
MANUFACTURING**



**Minimum Requirements for the Qualification and
Examination**

EWF



IAMQS

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MINIMUM REQUIREMENTS FOR
QUALIFICATION AND EXAMINATION

**International Additive Manufacturing Polymer Operator
(I AM PO)**

**Guideline - General information for the public and organizations that imple-
ment this qualification**

For more information regarding the Qualifications System, the Management Team
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Preface

The present document consists in International AM Polymer Operator 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 downloaded 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 AM PO	
	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 75: Material Extrusion (MEX) Process	3,5	7
CU 76: Powder Bed Fusion (PBF-LB/P) Process	3,5	7
CU 77: Material Jetting (MJT) Process	3,5	7
CU 78: Vat Photopolymerization Process	3,5	7
CU 79: Manufacturing of MEX parts	7	14
CU 80: Manufacturing of PBF-LB/P parts	7	14
CU 81: Manufacturing of MJT parts	7	14
CU 82: Manufacturing of Vat parts	7	14
CU 83: Quality Assurance of AM Polymer parts	3,5	7
TOTAL	52,5	105

COMPETENCE UNITS	I AM PO	
	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 83: Quality Assurance of AM Polymer parts	3,5	7
TOTAL	10,5	21
Polymer Processes – Theoretical CUs***		
CU 75: Material Extrusion (MEX) Process	3,5	7
CU 76: Powder Bed Fusion (PBF-LB/P) Process	3,5	7
CU 77: Material Jetting (MJT) Process	3,5	7
CU 78: Vat Photopolymerization Process	3,5	7
Polymer Processes – Practical CUs***		
CU 79: Manufacturing of MEX parts	7	14
CU 80: Manufacturing of PBF-LB/P parts	7	14
CU 81: Manufacturing of MJT parts	7	14
CU 82: Manufacturing of Vat parts	7	14

* 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.

***To successfully complete the qualification, at least one CU must be selected from each of the lists 'Polymer Processes – Theoretical CUs' and 'Polymer Processes – CUs'. The modules selected from these two lists must relate to the same polymer processes.

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

AM Polymer Operators are the professionals with the specific knowledge, skills, autonomy and responsibility to operate machines using polymeric AM based processes. Their main tasks are to:

- Operate polymeric based machines for AM, including the fitting and setting up, post processing and maintenance.
- Prepare the AM polymeric machine to manufacture the part(s) – including routine maintenance procedures;
- Self-manage the handling of feedstock (approval, storage, contamination, traceability);
- Develop solutions on basic and specific problems related with polymeric AM machines and processes;
- Perform the required post-processing operations.

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 the International AM Polymer Operator Qualification admission are the following:

- National compulsory school diploma

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.**

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 6 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 AM Polymer Operator	INDEPENDENT	Factual and broad concepts in the field of Polymer additive manufacturing process.	Fundamental cognitive and practical skills required to develop proper solutions and application of procedures and tools on simple and specific of Polymer Additive manufacturing problems	Self-manage of professional activities and simple standard applications of Polymer AM processes manufacturing in predictable contexts but subject to change.

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	RECOMENDED 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	Basic factual 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 75: Material Extrusion (MEX) Process

CU 75: Material Extrusion (MEX) Process	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
MEX Process Overview	2
Overview of Polymer Materials, their properties and applications	1,5
Total	3,5
WORKLOAD	7

Learning Outcomes – CU 75: Material Extrusion (MEX) Process	
KNOWLEDGE	Factual and broad of: – Material Extrusion (MEX) process and principles – Polymer Materials and characteristics and their effects on MEX additive manufacturing – Potential and limitations of Polymer MEX materials
SKILLS	Recognise the advantages and limitations of MEX over other AM Polymers processes, including its applicability according to the characteristics of the process Identify the main components of MEX equipment Identify Polymer Materials for MEX applications

Competence Unit 76: Powder Bed Fusion (PBF-LB/P) Process

CU 76: Powder Bed Fusion (PBF-LB/P) Process	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
PBF-LB/P Process Overview	1,5
Overview of Polymer Materials, their properties and applications	1
Quality Assurance	1
Total	3,5
WORKLOAD	7

Learning Outcomes – CU 76: Powder Bed Fusion (PBF-LB/P)	
KNOWLEDGE	Factual and broad of: – Powder Bed Fusion (PBF-LB/P) process and principles – Polymer Materials and characteristics and their effects on PBF-LB/P additive manufacturing – Potential and limitations of Polymer PBF-LB materials
SKILLS	Recognise the advantages and limitations of PBF-LB over other AM Polymers processes, including its applicability according to the characteristics of the process Identify the main components of PBF-LB/P equipment Identify Polymer Materials for PBF-LB applications

Competence Unit 77: Material Jetting (MJT) Process

CU 77: Material Jetting (MJT) Process	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
MJT Process Overview	2,5
Overview of Polymer Materials, their properties and applications	1
Total	3,5
WORKLOAD	7

Learning Outcomes – CU 77: Material Jetting (MJT) Process	
KNOWLEDGE	Factual and broad of: – Material Jetting (MJT) process and principles – Polymer Materials and characteristics and their effects on MJT additive manufacturing – Potential and limitations of Polymer MJT materials
SKILLS	Recognise the advantages and limitations of MJT over other AM Polymers processes, including its applicability according to the characteristics of the process Identify the main components of MJT equipment Identify Polymer Materials for MJT applications

Competence Unit 78: Vat Photopolymerization Process

CU 78: Vat Photopolymerization Process	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
Vat Process Overview	2,5
Overview of Polymer Materials, their properties and applications in the context of VAT process	1
Total	3,5
WORKLOAD	7

Learning Outcomes – CU 78: Vat Photopolymerization Process	
KNOWLEDGE	Factual and broad of: – Vat Photopolymerization (Vat) process and principles – Polymer Materials and characteristics and their effects on Vat additive manufacturing – Potential and limitations of Polymer Vat materials – Steps required for the VAT process
SKILLS	Recognise the advantages and limitations of Vat over other AM Polymers processes, including its applicability according to the characteristics of the process Identify the main components of Vat equipment Identify Polymer Materials for Vat applications

Competence Unit 79: Manufacturing of MEX parts

CU 79: Manufacturing of MEX parts	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
MEX Equipment and its components	1,5
Feedstock used in the MEX process	1
Type of files and work documentation	1
Post processing operations for MEX	1
Maintenance procedures for MEX machines	1,5
Health, Safety and Environmental procedures	1
Total	7
WORKLOAD	14

CU	EQF/ EWF LEVEL	JOB FUNCTION	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
Manufacturing of MEX parts	4 Independent	Manufacture MEX parts	Fitting and setting up the machine	7	14
			Conducting Post Processing operations		
			Maintaining & cleaning the MEX system		

Learning Outcomes – CU 79: Manufacturing of MEX parts	
KNOWLEDGE	Factual and broad of: – MEX Equipment and its components – Feedstock used in the MEX process – Type of files and work documentation – Post processing operations for MEX – Maintenance procedures for MEX machines – Health, Safety and Environmental procedures for MEX process
SKILLS	Prepare the MEX system following all the operational steps required Remove the parts from the build plate Remove the supports (if needed) from the part and post-process the parts Comply with Health, Safety and Environmental procedures Maintain the MEX system

Competence Unit 80: Manufacturing of PBF-LB/P parts

CU 80: Manufacturing of PBF-LB/P parts	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
PBF-LB/P System – Hardware	1
PBF-LB/P machine set-up requirements	1
Consumables, feedstock & substrate	1
Type of files and work documentation	1
Powder and parts removal processes	1
Post Processing	1
Health, Safety and Environmental procedures	1
Total	7
WORKLOAD	14

CU	EQF/ EWF LEVEL	JOB FUNCTION	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
Manufacturing of PBF-LB/P parts	4 Independent	Manufacture PBF-LB/P parts	Fitting and setting up the machine	7	14
			Conducting Post Processing operations		
			Maintaining & cleaning the PBF-LB/P system		

Learning Outcomes – CU 80: Manufacturing of PBF-LB/P parts	
KNOWLEDGE	Factual and broad of: – PBF-LB/P Equipment and its components – Feedstock used in the PBF-LB/P process – Type of files and work documentation – Post processing operations for PBF-LB/P – Maintenance procedures for PBF machines – HSE for PBF-LB/P process
SKILLS	Confirm print readiness of the PBF-LB/P system (according to the machine indication) Remove the build chamber and transfer to the post-processing station Extract the part from the build chamber (in the post processing station) Vacuum the excess powder from the parts and post processing station Storage and mixing of recovered & new powder adequately selecting the mix ratio Place the powder container on the integrated mixer Perform post processing operations (media blaster, sand blasters ...) Perform maintenance procedures (e.g.: build platform; optical windows; x-axis lead screw; IR sensor; recoater, cleaning of filters and exhaust hose)

Competence Unit 81: Manufacturing of MJT parts

CU 81: Manufacturing of MJT parts	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
Material Jetting Equipment	1,5
Consumables, Feedstock & Substrate	1,5
Type of files and work documentation	1
Post Processing Operations	1
Maintenance Procedures	1
Health, Safety and Environmental procedures	1
Total	7
WORKLOAD	14

CU	EQF/ EWF LEVEL	JOB FUNCTION	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
Manufacturing of MJT parts	4 Independent	Manufacture MJT parts	Fitting and setting up the machine	7	14
			Conducting Post Processing operations		
			Maintaining & cleaning the MJT system		

Learning Outcomes – CU 81: Manufacturing of MJT parts	
KNOWLEDGE	Factual and broad of: – MJT Equipment and its components – Feedstock used in the MJT process – Type of files and work documentation – Post processing operations for MJT – Maintenance procedures for MJT machines – HSE for MJT process
SKILLS	Confirm print readiness of the MJT system (according to the machine indication) Remove the build chamber and transfer to the post-processing station Extract the part from the build chamber (in the post processing station) Vacuum the excess powder from the parts and post processing station Storage and mixing of recovered & new powder adequately selecting the mix ratio Perform post processing operations (media blaster, sand blasters ...) Perform maintenance procedures (e.g.: Replace and aligning a print head; Replace a clean head cleaning roll, Refilling the Storage Tank; Vacuum the Sieve; Replacing a Material Cartridge; Scrape the Fusing Lamp Replacing a Heating Lamp; Replacing the External Tank ; Replacing the Vacuum Pump Filter)

Competence Unit 82: Manufacturing of Vat parts

CU 82: Manufacturing of Vat parts	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
Vat Equipment and its components	1,5
Materials used in the Vat process	1,5
Type of files and work documentation	1
Post processing operations for Vat	1
Maintenance procedures for Vat machines	1
Health, Safety and Environmental procedures	1
Total	7
WORKLOAD	14

CU	EQF/ EWF LEVEL	JOB FUNCTION	JOB REQUIRED ACTIVITIES	CONTACT HOURS	WORKLOAD
Manufacturing of Vat parts	4 Independent	Manufacture Vat parts	Fitting and setting up the machine	7	14
			Conducting Post Processing operations		
			Maintaining & cleaning the Vat system		

Learning Outcomes – CU 82: Manufacturing of Vat parts	
KNOWLEDGE	Factual and broad of: – Vat Equipment and its components – Materials used in the Vat process – Type of files and work documentation – Post processing operations for Vat – Maintenance procedures for Vat machines – HSE for Vat process
SKILLS	Prepare the Vat system Remove the build plate from the machine Remove the parts from the build plate Immerse the parts in IPA (isopropyl alcohol) Cure the parts (with UV light) Remove the supports from the part and post-process the parts Remove the excess of resin from the Vat and prepare it for the next use Check the Vat screen to ensure no resin was split to the reverse side Remove the excess resin from the resin tank/Vat (use a funnel and a latex paint filter) Remove the remaining resin with a spatula Clean the Vat with alcohol and “towels” Apply lubricant to the Vat (to ensure no resin sticks when printing the next parts) Comply with Health, Safety and Environmental procedures

Competence Unit 83: Quality Assurance of AM Polymer parts

CU 83: Quality Assurance of AM Polymer parts	RECOMENDED CONTACT HOURS
SUBJECT TITLE	
Quality Assurance in MEX processes	0,5
Quality Assurance in PBF-LB/P processes	0,5
Quality Assurance in MJT processes	0,5
Quality Assurance in Vat processes	0,5
QA procedures	1,5
Total	3,5
WORKLOAD	7

Learning Outcomes – CU 83: Quality Assurance of AM Polymer parts	
KNOWLEDGE	Factual and broad of: – Quality Assurance – QA Procedures
SKILLS	Identify QA principles for MEX processes Identify QA principles for PBF-LB/P processes Identify QA principles for MJT processes Identify QA principles for Vat processes Perform QA verification

Appendix I: EWF Systems Framework

FIELD OF ACTIVITY		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 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.