
the next generation of
European Training
for Manufacturing
International Additive Manufacturing Qualifications System – IAMQS
Session focused on presenting the structure and Qualifications of the 1st Additive Manufacturing Qualification System
18th November 2020
11h – 12h CET
Event organised in the framework of the
57th Meeting of the EWF General Assembly
EWF

International Additive Manufacturing Qualifications System

Time	Topic	Moderated by
11h30	IAMQS - International Additive Manufacturing Qualifications System	Beatriz Lopez
11h45	CLLAIM International AM Guidelines	Francisco Barros

International Additive Manufacturing Qualification System

Francisco Sousa Barros
Project Manager EWF

This project has been funded with support from the European Commission. This communication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

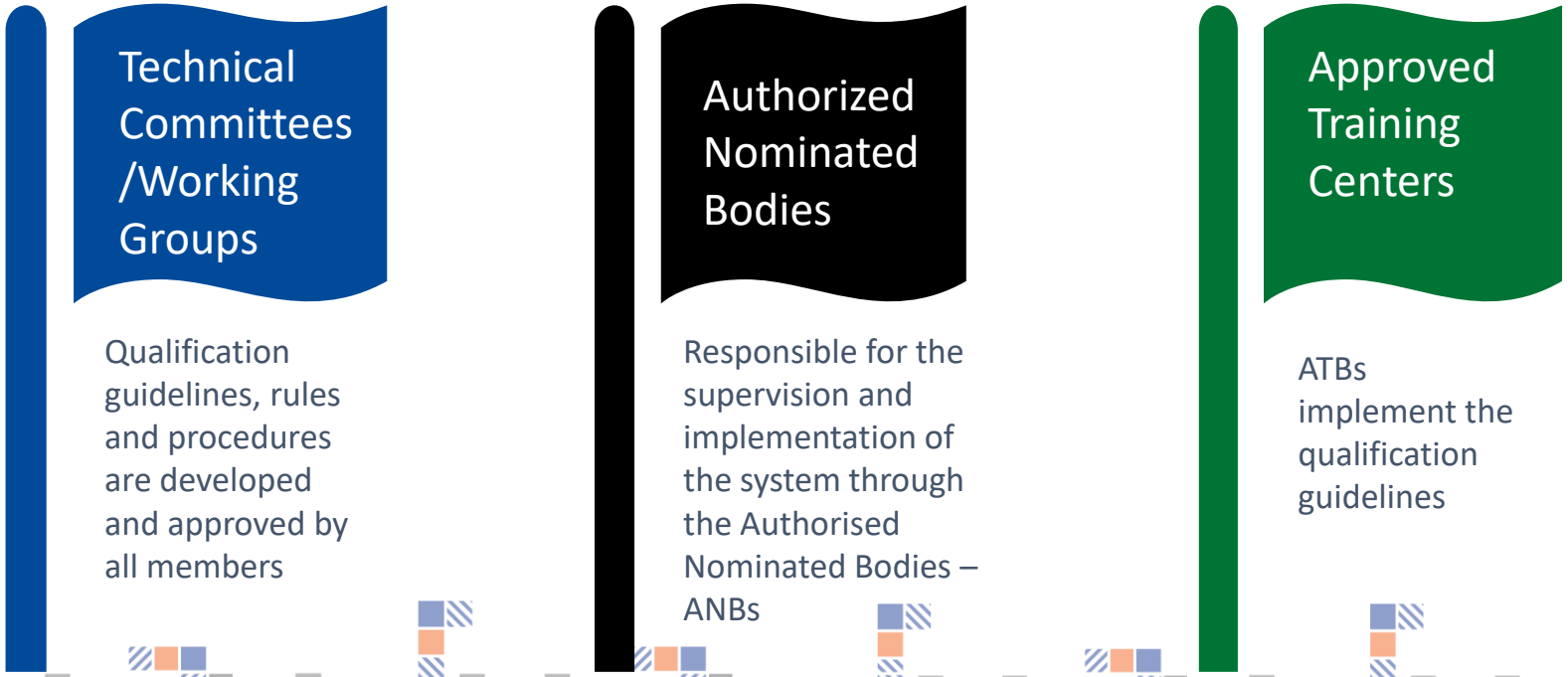
Co-funded by the Erasmus+ Programme of the European Union

Additive Manufacturing Goal

Create and Implement an International Additive Manufacturing Qualification System

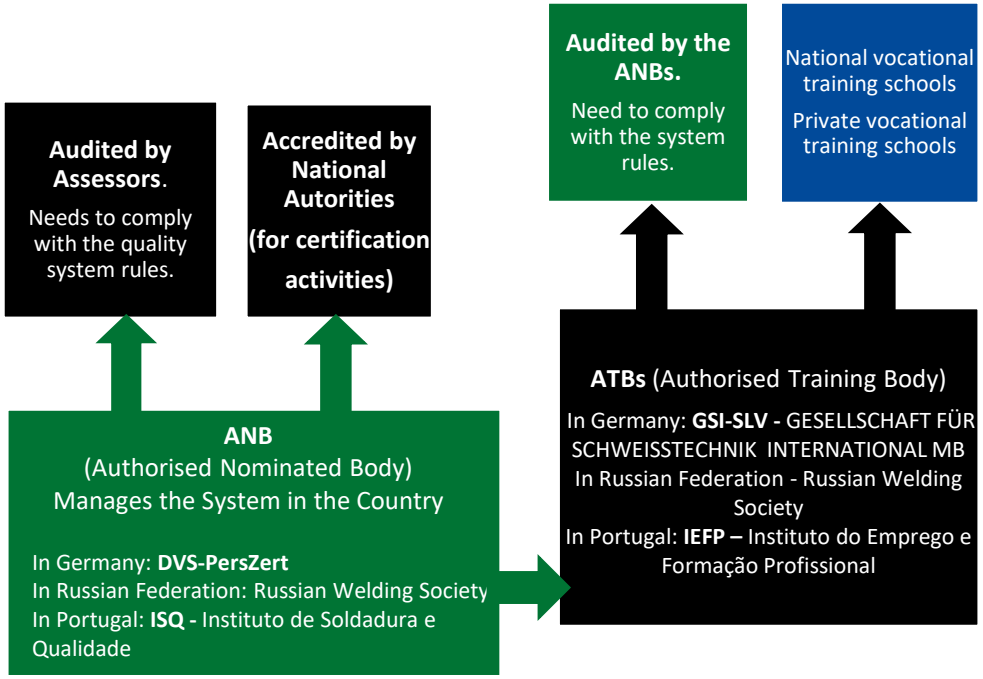
IAMQS Pillars

IAMQS Quality Assurance



The three major pillars of IAMQS Quality Assurance System

IAMQS Quality Assurance



Based on ISO 17024

AM Projects Relation

Creation of IAMQS; Qualifications; Training Methodologies

CLLAIM

ADMIRE

AM Engineer Qualifications; AM Coordinator Qualification; Training Methodologies; Interactive AM Platform

SAM
SECTOR SKILLS STRATEGY IN ADDITIVE MANUFACTURING

Erasmus+

What is IAMQS?

- Set of Harmonized Qualifications all over the world (AM Guidelines)
- Quality Assurance Mechanisms to sustain the Quality of Training Centres within the Qualification System
- Constant Qualification updates
- Harmonized examination
- Award an International Diploma Recognized by Industry
- Mechanisms for application of Innovative Training Methodologies (WBL, PBL, RPL)

IAMQS Qualifications

- Directed Energy Deposition - Arc
- Directed Energy Deposition - Laser Beam
- Powder Bed Fusion - Laser Beam
- Powder Bed Fusion - Electron Beam

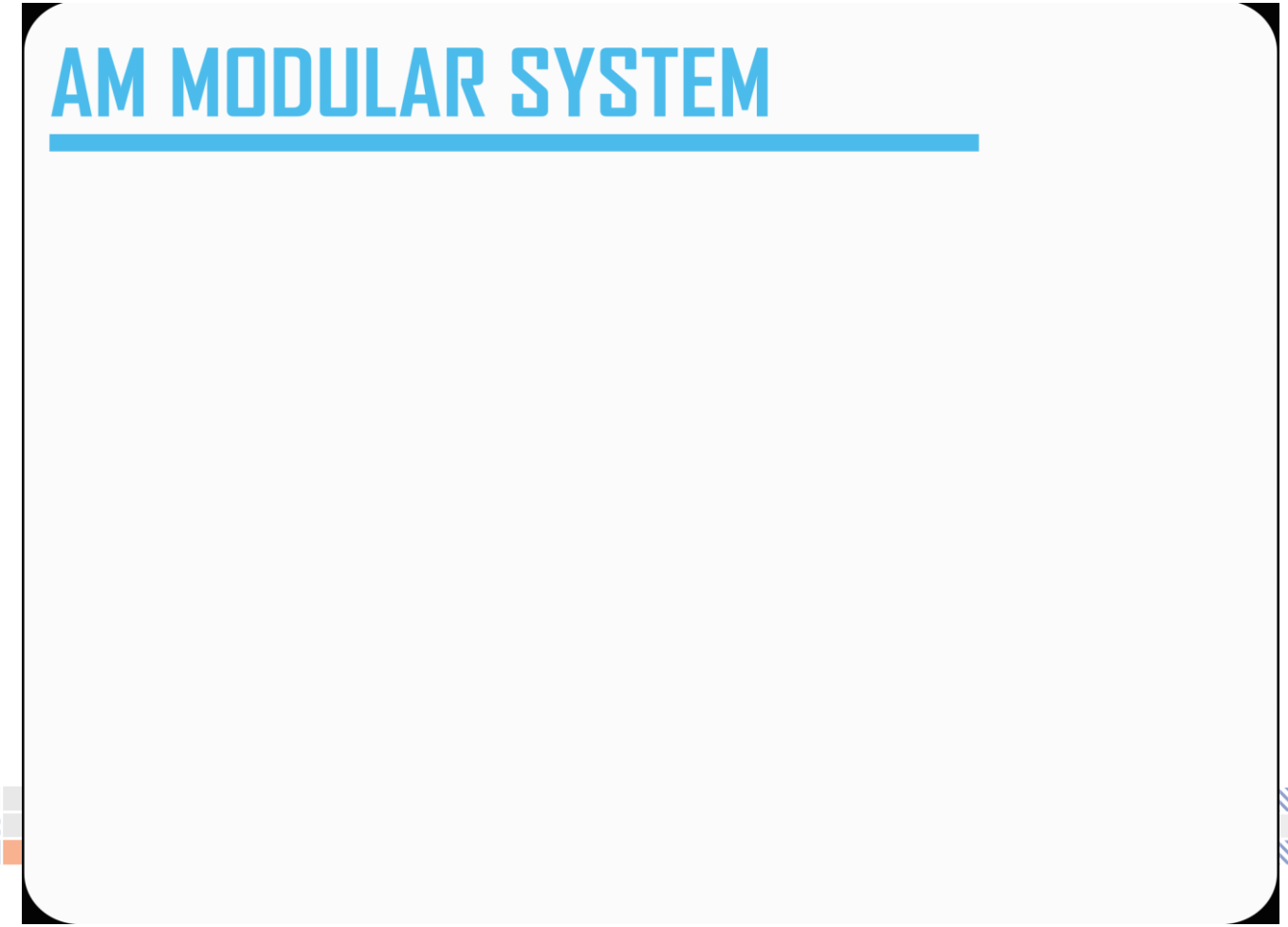
IAMQS Future Qualifications

SECTOR SKILLS STRATEGY IN ADDITIVE MANUFACTURING

Future Short Term Skills (until 2021):

- Certification and Validation
- Standards
- Numericall Modelling
- Materials (Eng level)
- Polymers
- Entrepeneurship
- Digital and Green skills

It is a Modular System!



It is a Modular System!

Modularity

Flexible Learning

Learning Outcomes

European AM Engineer for PBF-LB

European AM Operator for PBF-LB

+ *x hours*

+ *Modules*

Relevance of IAMQS in AM World

Collaborative Network

Qualification Levels

Quality Qualifications

Industry and Education Gap

International Diploma

How to be involved?

- Participation in Surveys
- Participation in Interviews
- Participation in AM Workshops
- SAM Project Associated Partners
- Joining Pool of Experts of AM System
- Participation in Training Activities (contact EWF at ewf@ewf.be)

Become a IAMQS Training Centre

AM ATB APPROVAL

After assessment and AM ANB approval, the Training Center fulfils all requirements for delivering training in accordance with AM Guidelines, under a specific scope of authorization.

ASSESSMENT CONDITIONS

There are two stages:

Stage 1 – Documental Review

- Evaluate own scope,
- Conformity with AM Syllabus,
- Facilities and Equipment
- Health and Safety requirements,
- Appropriate quality classrooms,
- Good quality visual aids,
- Teaching staff,
- AM capability.

Stage 2 – Audit to verify the compliance with AM Rules requirements.

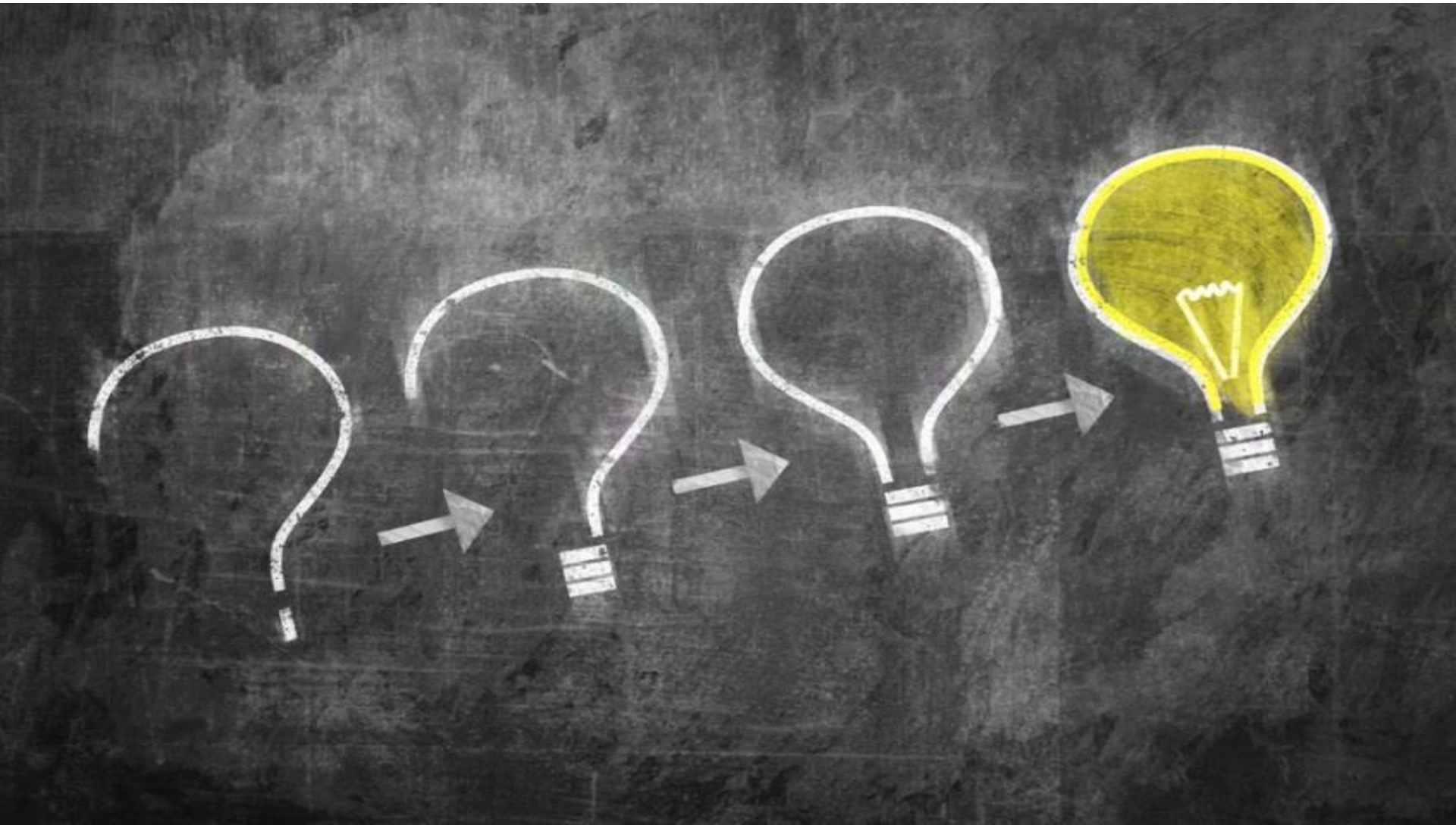
TRAINING CENTER'S APPLICATION

The Training Center selects an AM ANB to which presents its application to become an AM ATB.

PROCEDURES FOR APPROVING AM ATB

The AM ANB assesses the application based on conditions set by procedures elaborated and updated by EAMQC (AM Rules).

Questions?



IAMQS Qualifications

AM OPERATOR

- DED-Arc Operator
- DED-LB Operator
- PBF-LB Operator

AM DESIGNER

- PBF Processes
- DED Processes

AM PROCESS ENGINEER

+ Specialisation

- DED-Arc Engineer
- DED-LB Engineer
- PBF-LB Engineer

INTERNATIONAL AM QUALIFICATION GUIDELINES

Minimal Requirements for the Qualification and Examination

Qualification Guideline

- Description of Professional Profile
- Routes to Qualification
- Access conditions
- Qualification overview – Mandatory & Optional Competence Units

Competence Units Guidelines

- Education and Training – Learning Outcomes
- Detailed knowledge Competence Units
- Examination procedures
- Written, oral and practical examination

Example of the AM Qualification Guideline

Professional Profile – general description of the Occupation

Overview on the structure (scope – Contact Hours and Workload)

Professional Profile

PBF-LB Process Engineers are the professionals with the specific knowledge, skills, autonomy and responsibility to implement PBF-LB process in the manufacturing chain assuring the efficient production and post-processing of additively manufactured parts. His/her's main tasks are to:

- Evaluate manufacturing suitability for customers' requests defining which processes are fit for the request, based on the application, material, design and cost of the part.
- Apply a wide variety of engineering techniques, contributing to projects in a teaming environment and compare, investigate, transfer, and adapt procedures, techniques, or methods to new applications.
- Develop and execute PBF-LB plans including validation of design, implementation, pre and post processing operations, assurance of parts conformity and identification of the causes and the corrective actions of technical production problems;
- Coordinate the tasks distribution between the operators according to the workplan as well as manage the link between them and the management-

COMPETENCE UNITS	E/IE PBF-LB	
	Recommended Contact Hours*	Expected Workload**
CU 00: Additive manufacturing Process Overview	7	14
CU 01: DED-Arc Process	42	84
CU 08: DED-LB Process	35	70
CU 15: PBF-LB Process	35	70
CU 25: Post Processing	14	28
CU 34: Process selection	28	56
CU 35: Metal AM integration	21	42
CU 36: Coordination activities	7	14
CU 43: Production of PBF-LB parts	21	42
CU 44: Conformity of PBF-LB parts	35	70
CU 45: Conformity of facilities featuring PBF-LB	14	28
TOTAL	259	518
Optional CUs		
CU 26: Introduction to materials	14	28
TOTAL	273	546
Materials CUs* **		
CU 27: AM with steels feedstock (excluding Stainless Steel)	21	42
CU 28: AM with Stainless Steel feedstock	14	28
CU 29: AM with Aluminium feedstock	7	14
CU 30: AM with Nickel feedstock	7	14
CU 31: AM with Titanium feedstock	14	28
CU 32: AM with Tungsten feedstock	3,5	7
CU 33: Biomedical metallic materials	7	14

Example of the AM Qualification Guideline

Qualification defined in Learning Outcomes – what students will learn about ?

Competence Unit 00: Additive Manufacturing Processes Overview

CU 00: Additive Manufacturing Processes Overview	CONTACT HOURS
SUBJECT TITLE	
Directed energy deposition	1
Powder bed fusion	1
Vat photopolymerization	1
Material jetting	1
Binder jetting	1
Material extrusion	1
Sheet lamination	1
Total	7
WORKLOAD	14

Contact hours

Learning Outcomes – CU 00: Additive Manufacturing Processes Pverview	
KNOWLEDGE	Factual and broad knowledge of theory, principles and applicability 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 Recognise the advantages and limitations of AM processes from a manufacturing process chain point of view Identify the applicability of different AM processes, according to the characteristics of each process

Learning outcomes

INTERNATIONAL AM QUALIFICATION GUIDELINES

Minimal Requirements for the Qualification and Examination

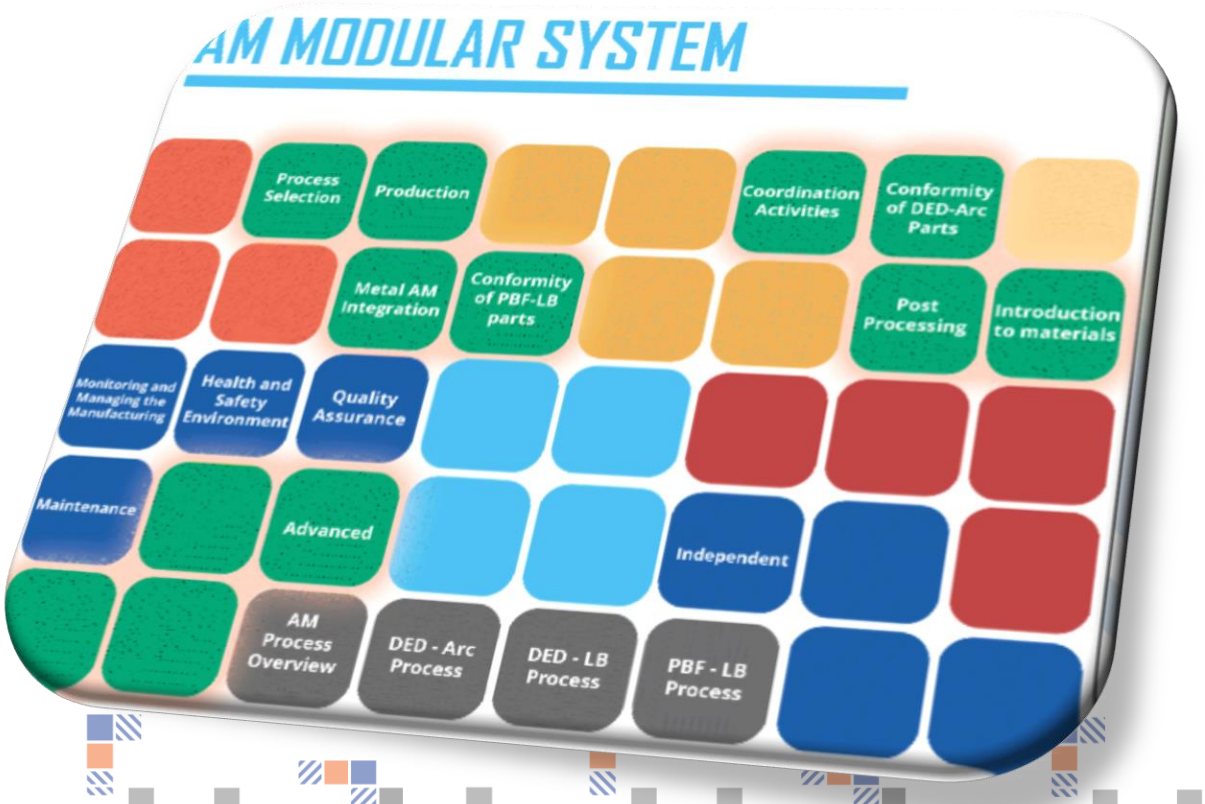
Qualification Guideline

- Description of Professional Profile
- Routes to Qualification
- Access conditions
- Qualification overview – Mandatory & Optional Competence Units

Competence Units Guidelines

- Education and Training – Learning Outcomes
- Detailed knowledge Competence Units
- Examination procedures
- Written, oral and practical examination

Cumulative System & Common CUs

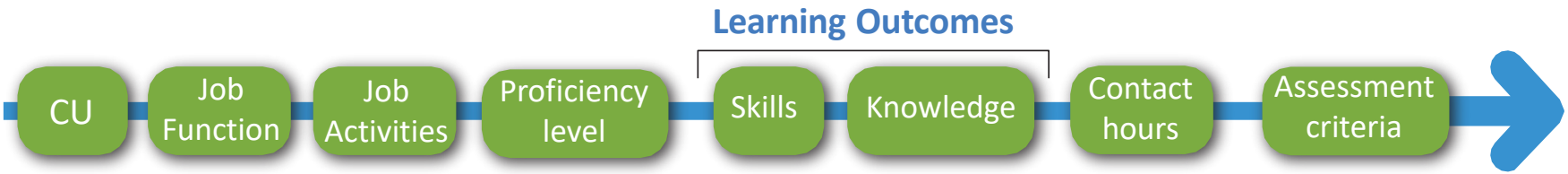


MOBILIZED AUTONOMOUSLY
OR
FEED ONE /SEVERAL
QUALIFICATIONS

CUMULATIVE FROM
LOWER TO HIGHER LEVELS

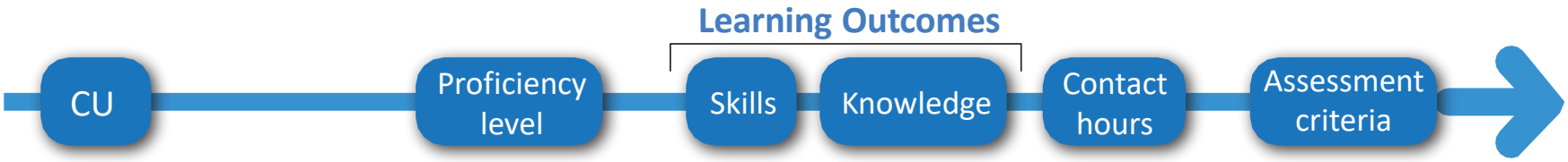
COMPETENCE UNITS STRUCTURE

- **Functional**



DIRECT LINK TO SPECIFIC JOB FUNCTIONS & REQUIRED ACTIVITIES

- **Cross-cutting**



INDIRECT LINK TO JOB FUNCTIONS & REQUIRED ACTIVITIES

Example of the CU Guideline

Overview of the Scope of a specific Competence Unit (Subject Title)

CU 01 DED–Arc Process	RECOMENDED CONTACT HOURS	
LEVEL	INDEPENDENT (I) (applied to Operators and Engineers)	ADVANCED (A) (applied only for Enginners)
DED–Arc System (Hardware & Software)	5	0
DED–Arc Physical Principles, Processes and Parameters	5	0
DED–Arc Build platform, feedstock and other consumables	3	0
Post processing operations	1	0
DED–Arc Processes	0	14
DED–Arc Build platform, feedstock and other consumables	0	5
DED–Arc Equipment and accessories	0	3
DED–Arc Manufacturing strategy	0	6
Subtotal Per Level	**14**	**28**
Cumulated Subtotal	**14**	**42**
		WORKLOAD
PER LEVEL	28	56
CUMULATED	**28**	**84**

Example of the CU Guideline

LEARNING OUTCOMES – CU 01: DED–Arc Process		
LEVEL	**INDEPENDENT (applied to Operators and Engineers)**	**ADVANCED (applied only for Enginners)**
KNOWLEDGE	Factual and broad of: – DED–Arc systems – Arc physics – Processable materials with DED–Arc – Processing atmosphere requirements with DED–Arc – Sensors and process controls with DED–Arc	Advanced knowledge and critical understanding of the theory, principles and applicability of: – DED–Arc equipment, accessories, including build platform, feedstock and other consumables – DED–Arc process parameters and variables, including post processing operations
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	Assess the possibility of manufacturing a specific part with DED-Arc based on the characteristics and limitations of the process Relate the influence of the process parameters, build platform, feedstock and other consumables with the properties of the as built part. Implement different methodologies related with to process parameters and deposition strategies for reducing distortion of as built parts Distinguish the different regimes and processes of failure and describe the factors controlling them and the boundaries and limits between them. Select specific materials for different applications to meet part requirements. Identify specific metallurgical aspects of DED-Arc parts Define DED-Arc parameters for manufacturing specific parts Adjust process parameters, manufacturing strategy and set up to prevent part defects and process related issues

DETAILED KNOWLEDGE: CU01 DED–Arc Process		
*DEPTH**	I	A
CONTACT HOURS PER LEVEL	14	14
	CONTACT HOURS PER SUBJECT	
Dimensional control of as built part Repair of DED–Arc parts Heat treatment Subtractive manufacturing (e.g. machining, turning, hole drilling and tapping) Surface finishing		
DED–Arc Processes		12 + 2 + 0
Influence of these variables in the process and parts MIG/MAG and their variants (131/135) 6h – Power source characteristics – Current type and polarity: DC (+), DC (-), AC and pulsed – Voltage – Inductance – Contact tip to work distance – Travel speed – Gas type and flow rate – Wire feed speed and deposition rate – Wire diameter – Torch orientation – Metal transfer modes – Variants (e.g. tandem, CMT®, number of wires)	Influence of these variables in the process and parts TIG (141) 3h – Power source characteristics – Current type and polarity: DC (+), DC (-), AC and pulsed – Voltage – Arc length – Travel speed – Gas type and flow rate – Electrode shape, sharpening angle, chemical composition and diameter – Wire position and its height – Wire feed speed and deposition rate – Wire diameter – Torch orientation – Variants (e.g. number of wires, hot wire)	Influence of these variables in the process and parts PAW (15) 4h – Power source characteristics – Current type and polarity: DC (+), DC (-), AC and pulsed – Voltage – Arc length – Travel speed – Plasmogenic and shielding gas type and flow rate – Electrode shape and sharpening angle, chemical composition and diameter – Nozzle orifice – Wire position and its height – Wire feed speed and deposition rate – Wire diameter – Torch orientation – Arc types (e.g. transferred and non-transferred arc) – Variants (e.g. number of wires, hot wire)	
Definition of parameters process optimization AM process capability to execute or not certain design features (e.g. complex geometries, internal channels, overhangs) Specific requirements for different materials Influence of modifying process parameters and part temperature on layer height, shape and characteristics Considerations for machining allowance Standards (ISO, CEN and National) Typical DED–Arc process issues (e.g. defects) and how to solve/avoid them (not material specific)		

IAMQS CLLAIM

Competence Unit defined in Learning Outcomes – which detailed knowledge will students gain?

Example of the CU Guideline

How will be student be assessed ?

- Written examination
- Oral examination
- Practical examination (for specific Cus)

The time devoted to assessment shall be aligned with the number of recommended contact hours (1 Contact hour = 1 question)

For Advanced levels, the oral examination is required

Thank You

For more information please contact:
Beatriz Lopez - amlopez@ewf.be
Francisco Sousa Barros - frbarros@ewf.be