AM Qualifications & Workforce Development

David Hardacre, Lloyd‘s Register

Project title: **C**reating know**L**edge and skil**L**s in **A**dd**I**tive **M**anufacturing

Reference number: 2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA

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Project title: Creating knowLedge and skilLs in AddItive Manufacturing
Reference number: 2017-3309/591838-EPP-1-2017-1-ES-EPPKA2-SSA

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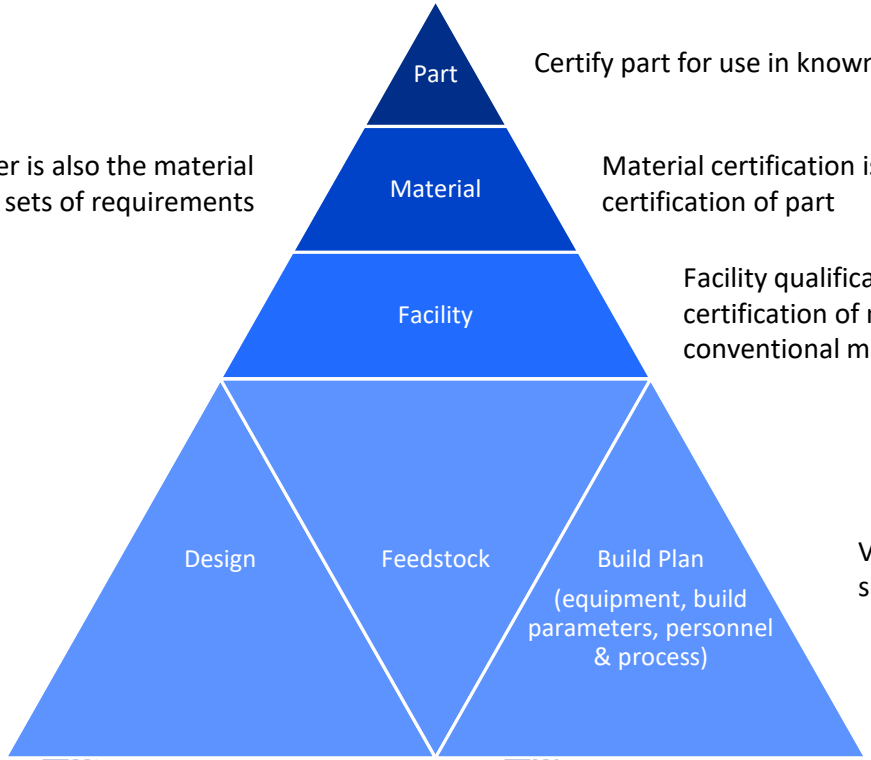
Additive manufacturing certification



Certify part for use in known application

In AM, the part manufacturer is also the material provider so needs to satisfy both sets of requirements

Material certification is pre-requisite for certification of part

Facility qualification is pre-requisite for certification of material (comparable with conventional material forming methods)

Various under-pinning aspects for successful qualification of the facility

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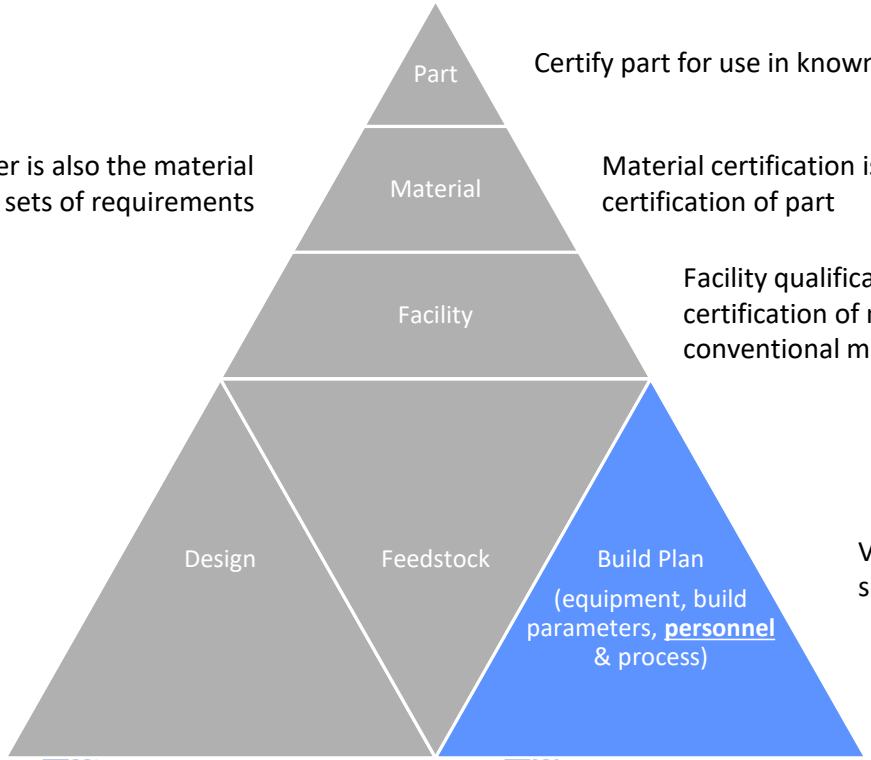

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Why do we need personnel qualifications?

Material specifications require it:

- EN 764-5 (metallic materials for pressure equipment)

e) The competent body shall evaluate by interviews or by the examination of documents:

1) that the manufacturing equipment and the equipment controlling the essential parameters are available. They shall be capable of permitting the consistent delivery of products in the required quality;

2) that competent personnel are available for operating and maintaining the equipment and supervising the manufacturing and inspection and testing activities;

Product standards require it:

- EN 13445-1 (unfired pressure vessels - general)

— the welder or welding operator shall be qualified, see 7.4 of EN 13445-4:2009.

- EN 13445-5 (inspection)

All inspections shall be carried out by qualified personnel.

- EN 13445-3 (design)

Due to the advanced methods applied, until sufficient in-house experience can be demonstrated, the involvement of an independent body, appropriately qualified in the field of DBA, is required in the assessment of the design (calculations) and the potential definition of particular NDT requirements.

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of an independent body, appropriately qualified in the field of DBA, is required in the assessment of the design
(calculations) and the potential definition of particular NDT requirements.

Additive Manufacturing cannot offer a loophole against existing regulations and requirements for conventionally-produced materials and parts

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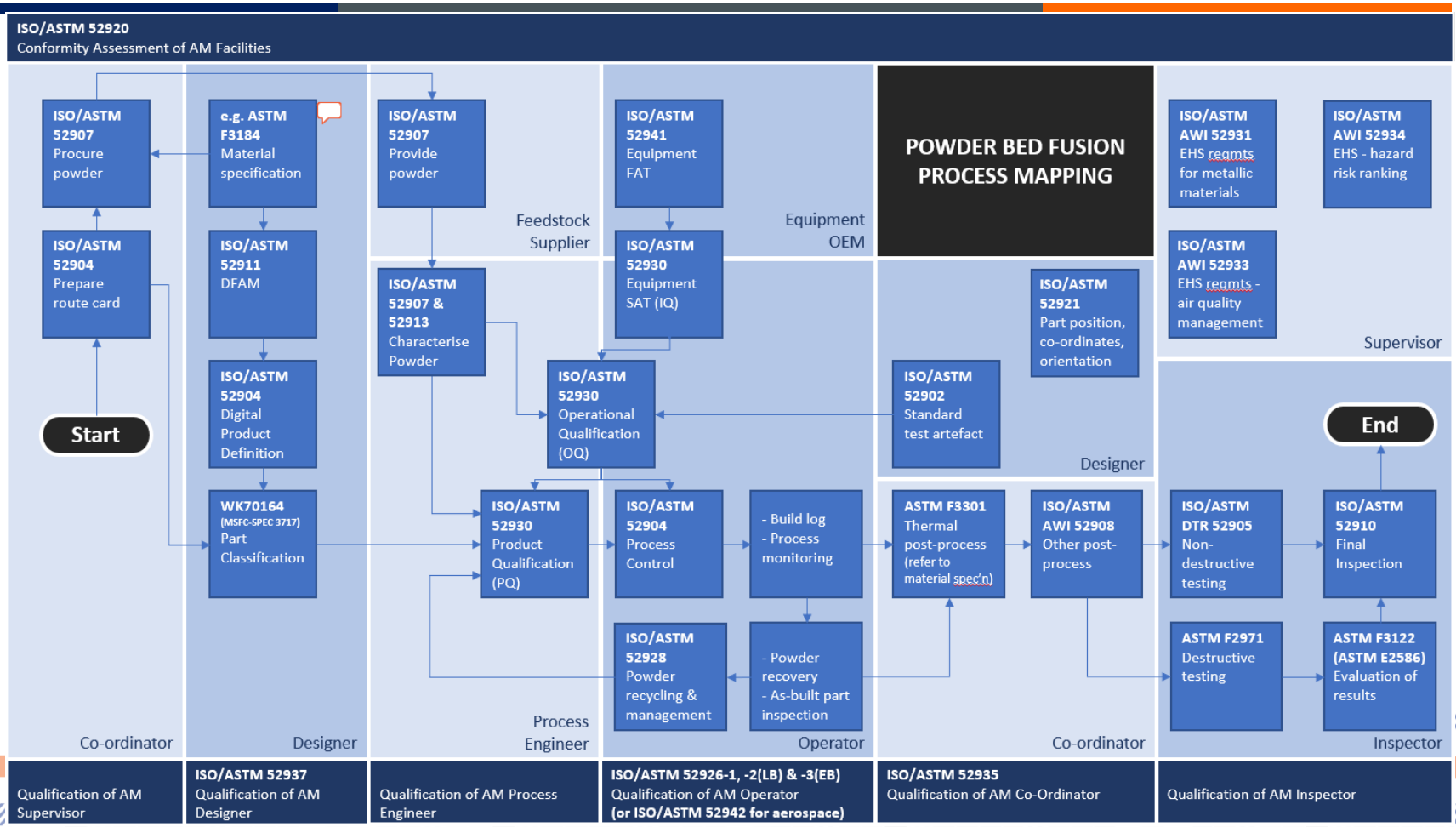
Which standards? What are the roles?



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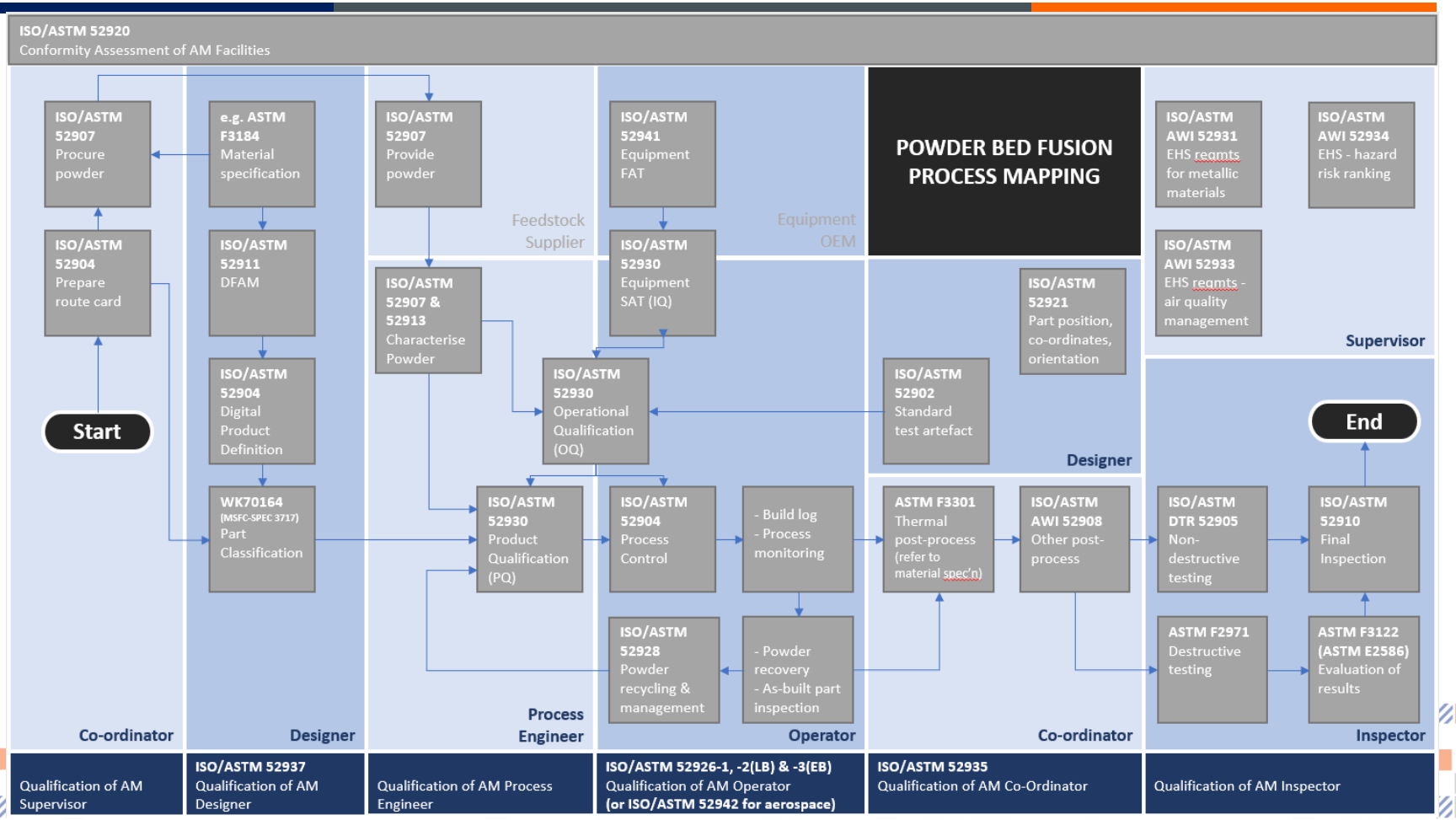

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Identify the roles

ADMIRE

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- Directed Energy Deposition - Arc
- Directed Energy Deposition - Laser Beam
- Powder Bed Fusion - Laser Beam
- Powder Bed Fusion - Electron Beam
- Vat photopolymerization
- Material jetting
- Binder jetting

- Polymers
- Composites

http://www.skills4am.eu/index.html

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Modular structure & process-specific

	Operator DED-Arc	Operator DED-LB	Operator PBF-LB	Operator PBF-EB
AM processes overview	CU00	CU00	CU00	CU00
Specific process overview	CU01	CU08	CU15	CU22
Quality assurance for specific process	CU02	CU09	CU16	CU23
HSE for specific process	CU03	CU10	CU17	CU24
Hardware/software/build files for specific process	CU04	CU11	CU18	CU50
Monitoring & managing for specific process	CU05	CU12	CU19	CU51
Post-processing for specific process	CU06	CU13	CU20	CU52
Maintenance for specific process	CU07	CU14	CU21	CU53
Powder handling		CU48	CU48	CU48
Laser beam characterisation		CU49	CU49	

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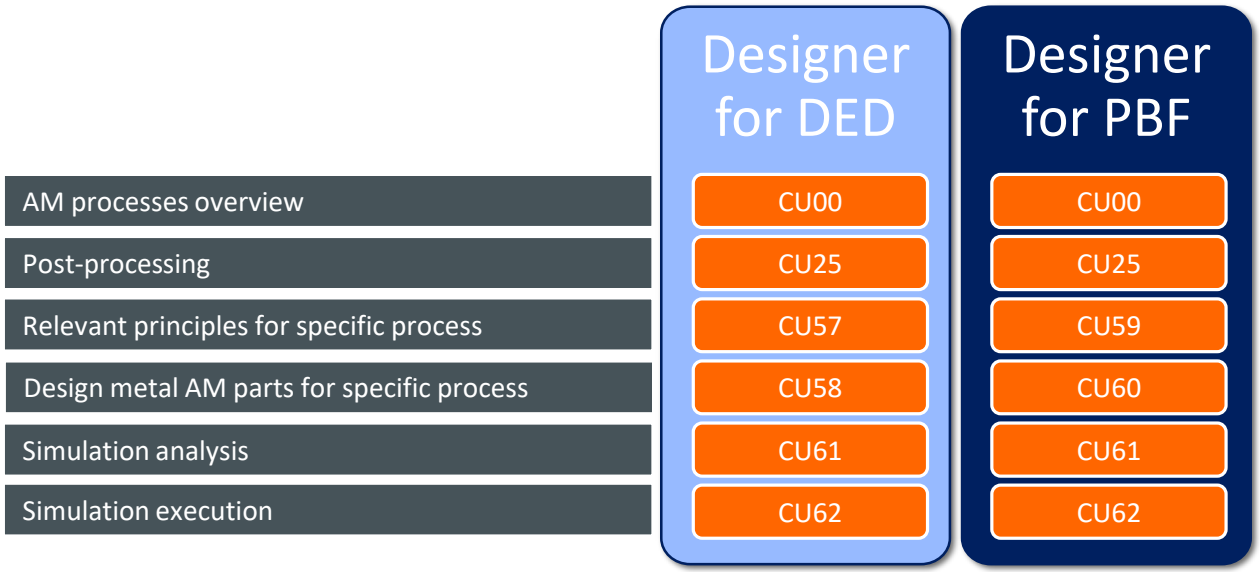

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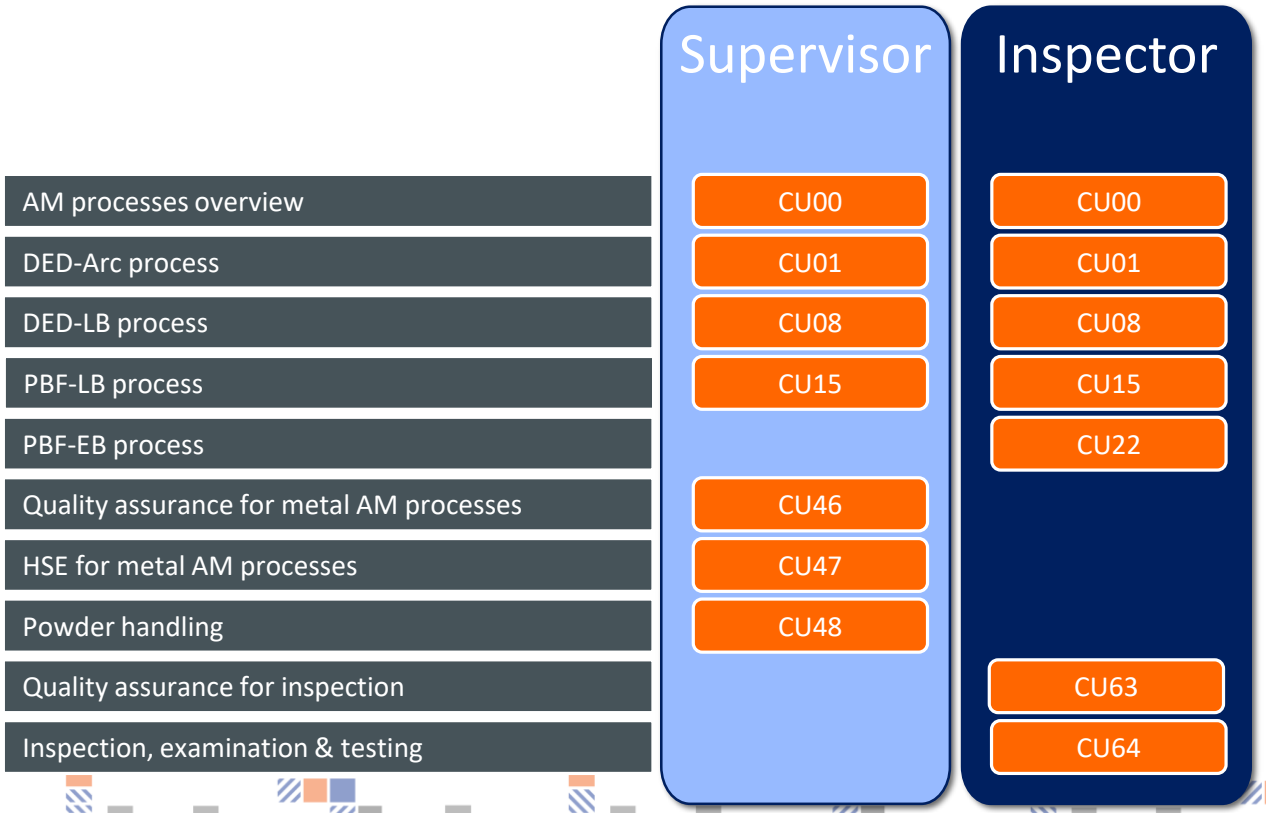

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Modular structure & process-specific

Process Engineer

CU00	CU31
CU01	CU32
CU08	CU33
CU15	CU34
CU25	CU35
CU26	CU36
CU27	CU43
CU28	CU44
CU29	CU45
CU30	

- AM processes overview
- DED-Arc process
- DED-LB process
- PBF-LB process
- Post-processing
- Introduction to materials
- AM with steel feedstock (excluding Stainless)
- AM with stainless steel feedstock
- AM with aluminium feedstock
- AM with nickel feedstock
- AM with titanium feedstock
- AM with tungsten feedstock
- Biomedical metallic materials
- Process selection
- Metal AM integration
- Coordination activities
- Production of PBF-LB parts
- Conformity of PBF-LB parts
- Conformity of facilities featuring PBF-LB

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Routes to qualification

Standard route

- Classroom and practical or blended learning (where theoretical sessions are delivered online)
- Final assessment

Recognition of previous learning (RPL) route

- Interview replaces training
- Final assessment

Work based learning (WBL) route

- On-the-job training
- Final assessment

Profiles:

Metal AM Operator

- DED-arc
- DED-LB
- PBF-LB
- PBF-EB

Metal AM Designer

- Designer for DED Processes
- Designer for PBF Processes

Metal AM Supervisor

- CU00
- CU01
- CU08
- CU15
- CU46
- CU47
- CU48

Metal AM Inspector

- CU00
- CU01
- CU08
- CU15
- CU22
- CU63
- CU64

DED: Direct Energy Deposition
LB: Laser Beam
PBF: Powder Bed Fusion
EB: Electron Beam

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Pilots run on CLLAIM project

Metal AM Inspector

CU00	CU01	CU08	CU15	CU22	CU63	CU64
AM Processes Overview	Metal AM Processes DED-Arc, DED-LB, PBF-LB, PBF-EB				Quality Assurance & Quality Control	Inspection, Examination & Testing
Overview of seven AM process categories	Process principles System, parameters, case studies Build platform, feedstock, consumables & post processing				General QA & QC QA & QC for AM AM standards Equipment qualification Certification of parts Personnel requirements Measurement control	Imperfections in AM Thermal treatments Microscopy & metallurgy Destructive testing NDE Metrology Final inspection
Recommended contact	7 hours	14 hours	14 hours	14 hours	14 hours	28 hours	38.5 hours
Expected Workload	14 hours	28 hours	28 hours	28 hours	28 hours	56 hours	101 hours

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AM Observatory through SAM project

JOIN SAM GROUPS!

All Students, Trainees and Jobseekers in AM are invited to join SAM project groups.

Sector Skills Strategy in Additive Manufacturing

https://www.linkedin.com/groups/12231279

Students, Trainees & Jobseekers in AM

https://www.linkedin.com/groups/8918566

3D Printing Channel

https://www.youtube.com/channel/UCO-PfDXv5ReiELtkvyVbtHA

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