CLLAIM

Project Partners: Lloyd‘s Register & TWI

Title: Piloting professional profiles - Inspector

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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Metal AM Inspector CLLAIM profile

Metal AM Inspectors are professionals with specific knowledge, skills, autonomy and responsibility to conduct inspections of Metal AM parts production. Their main tasks are:

- Carry out quality assessments of the AM process at various critical stages.
- Perform inspection of all equipment and work instructions to ensure adequate and controlled use.
- Conduct visual inspection to identify and evaluate imperfections in metal AM parts and assess against agreed acceptance criteria.
- Compile and verify completeness of the final inspection documentation package.
- Verify all metal AM related activities in production including, but not limited to, the following:
  - Verify data and adequacy of material certificates (base and filler materials).
  - Verify identification and traceability of the materials used during the manufacturing process.
  - Verify the compliance of feedstock against applicable regulations, standards, codes and/or specifications.

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Routes to qualification

Routes:

- **Standard route**
  - **Blended learning of classroom and practical**
  - **Final assessment**
- **Alternative route**
  - **Recognition of previous learning (RPL)**
  - **Final assessment**

Profiles:

Metal AM Operator	Metal AM Designer	Metal AM Supervisor	Metal AM Inspector
DED-arc	Designer for DED Processes	CU00	CU00
DED-LB	Designer for PBF Processes	CU01	CU01
PBF-LB		CU08	CU08
PBF-EB		CU15	CU15
		CU46	CU22
		CU47	CU63
		CU48	CU64

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

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Inspector modules

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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Standard route – pilot training

Metal AM Inspector

CU00	CU01	CU08	CU15	CU22	CU63	CU64
AM Processes Overview	DED-Arc process	DED-LB process	PBF-LB process	PBF-EB process	Quality Assurance & Quality Control	Inspect, Examine & Test
E-learning	*Classroom training*	*Classroom training*	*Classroom training*	*Classroom training*	*Classroom training*	*Classroom training*
24 hour online access	11 June 2020	18 June 2020	01 July 2020	02 July 2020	08-09 July 2020	15-16 July
Learning time (contact hours)						
7 hours	4.5 hours	4.5 hours	4.5 hours	4.5 hours	9.25 hours	12.75 hours

43 participants involved in the pilot training

Over 1100 slides delivered throughout the 40 hours of training!

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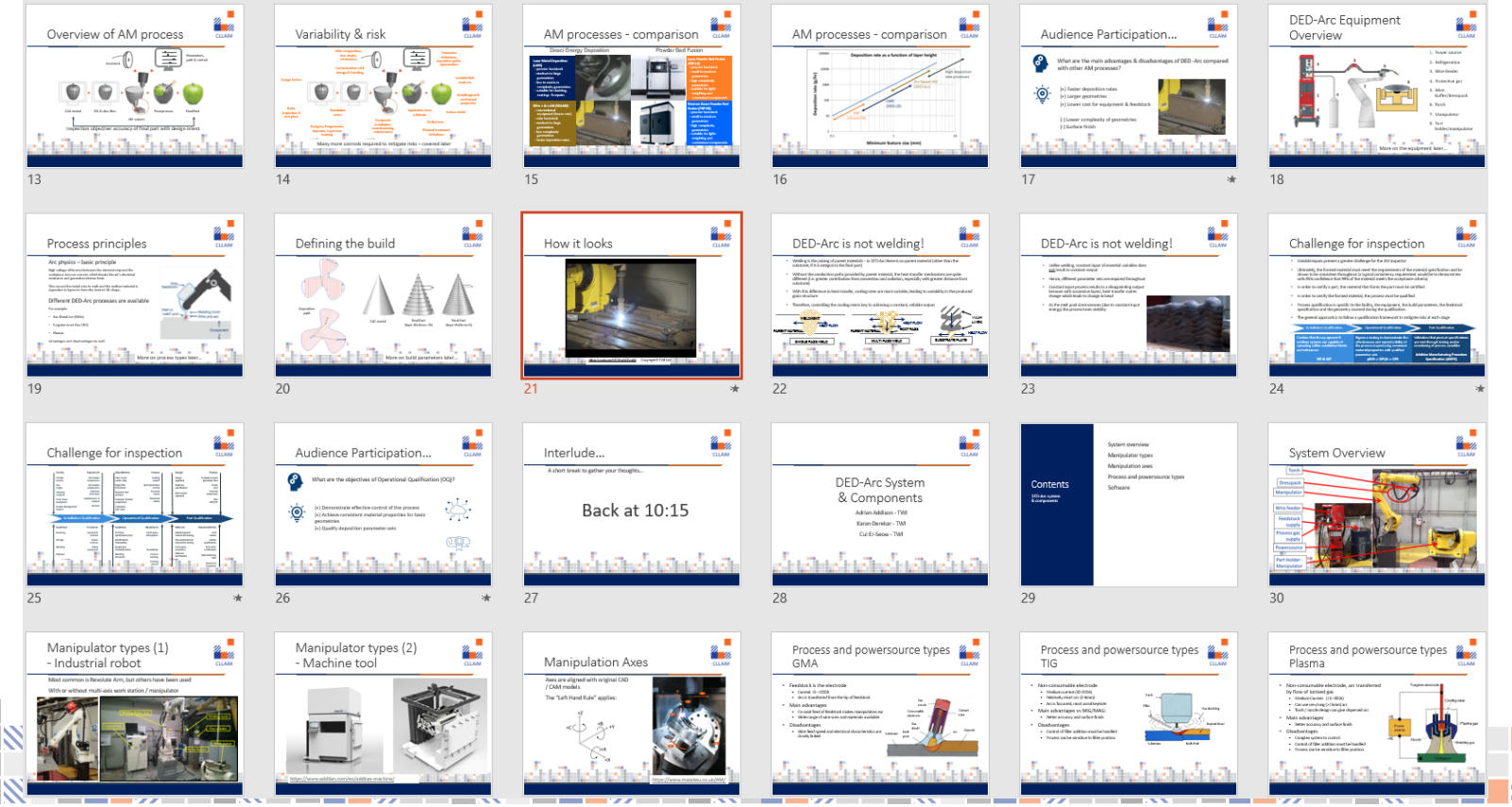
Standard route – pilot training

Course format



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Standard route – pilot training

Course format

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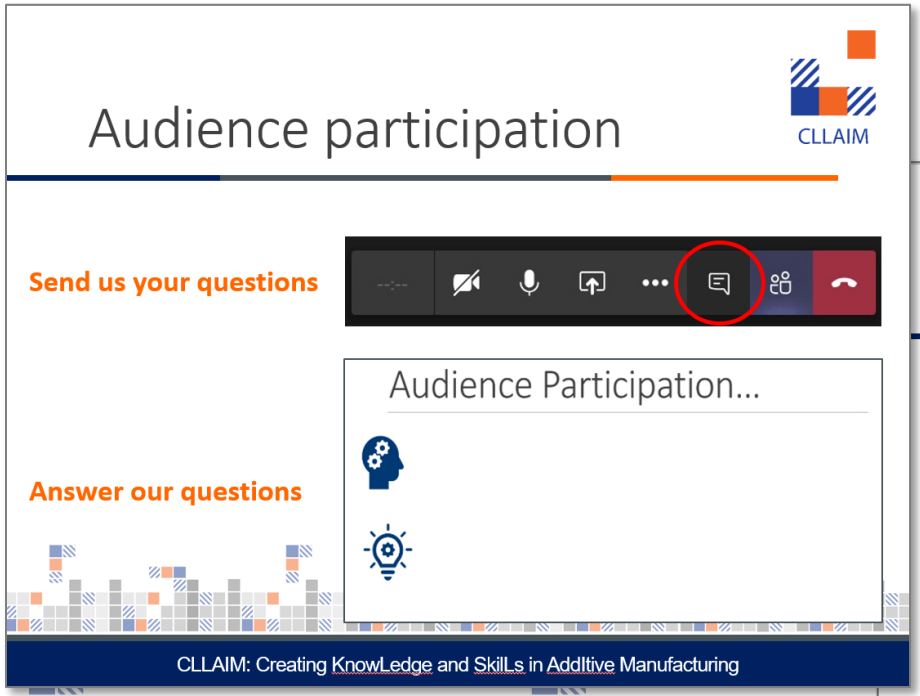
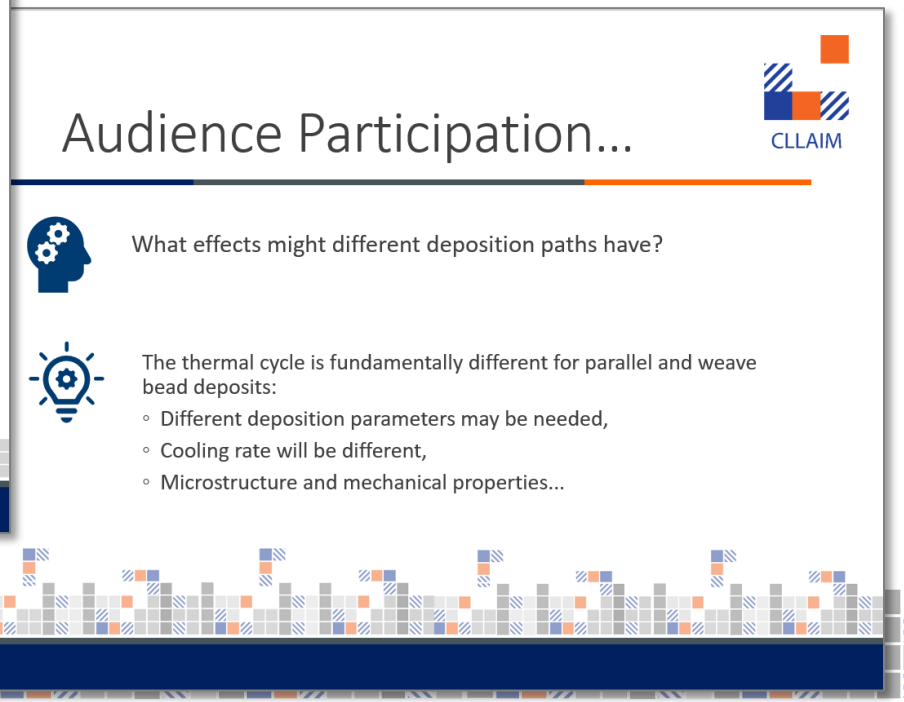
Standard route – pilot training

Course format



- **Check learning throughout delivery**



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Standard route – pilot training

Course tutors with specific experience in each area:












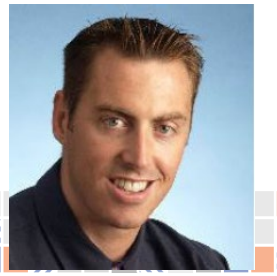
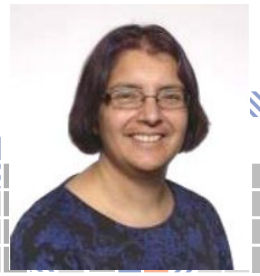

Standard route – pilot training

CERTIFICATE OF COMPLETION

ADDITIVE MANUFACTURING INSPECTOR QUALIFICATION PILOT

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THIS CERTIFICATE IS PROUDLY PRESENTED TO

Konstantinos Chronopoulos

COMPETENCE UNIT(S):

CU00: Additive Manufacturing Processes Overview
CU01: DED-Arc Process
CU08: DED-LB Process
CU15: PBF-LB Process
CU22: PBF-EB Process
CU63: Quality Assurance for Inspection
CU64: Inspection-Examination and Testing

DATE: 26TH AUGUST 2020

This certificate is awarded in recognition of the applicant support in CLLAIM Project Pilot Activities for Competence Units

DAVID HARDACRE, LEAD SPECIALIST
LLOYD'S REGISTER EMEA

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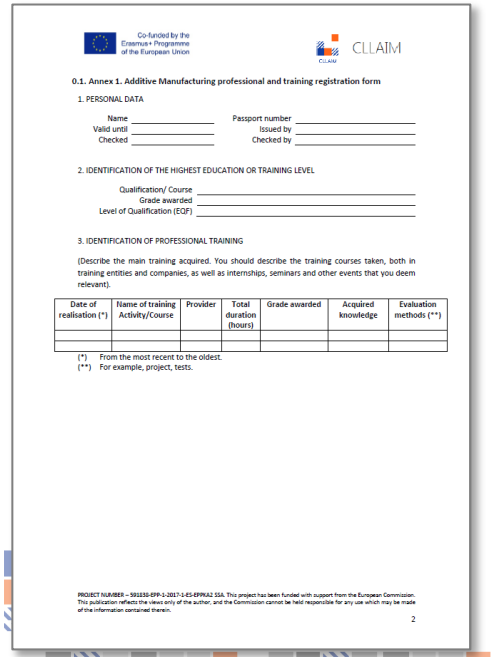
Alternative route – pilot

Recognition of previous learning (RPL):

Applicant Training Registration Form



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0.1. Annex 1. Additive Manufacturing professional and training registration form

1. PERSONAL DATA

Name _____ Passport number _____
Valid until _____ Issued by _____
Checked _____ Checked by _____

2. IDENTIFICATION OF THE HIGHEST EDUCATION OR TRAINING LEVEL

Qualification/ Course _____
Grade awarded _____
Level of Qualification (EQF) _____

3. IDENTIFICATION OF PROFESSIONAL TRAINING

(Describe the main training acquired. You should describe the training courses taken, both in training entities and companies, as well as internships, seminars and other events that you deem relevant).

Date of realisation (*)	Name of training Activity/Course	Provider	Total duration (hours)	Grade awarded	Acquired knowledge	Evaluation methods (**)

(*) From the most recent to the oldest.
(**) For example, project, tests.

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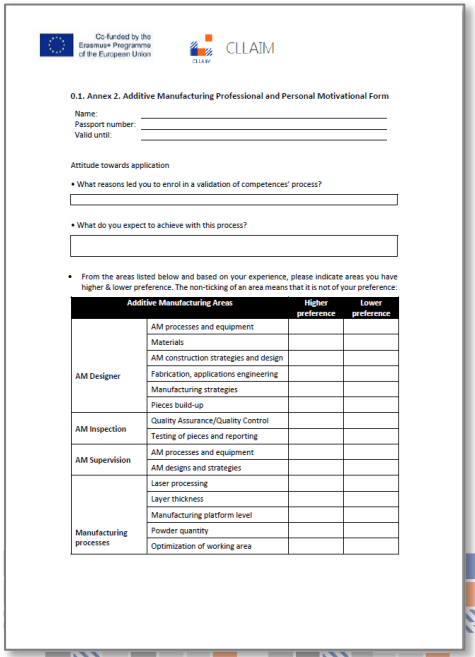
2

Applicant Personal Motivational Form



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0.1. Annex 2. Additive Manufacturing Professional and Personal Motivational Form

Name: _____
Passport number: _____
Valid until: _____

Attitude towards application

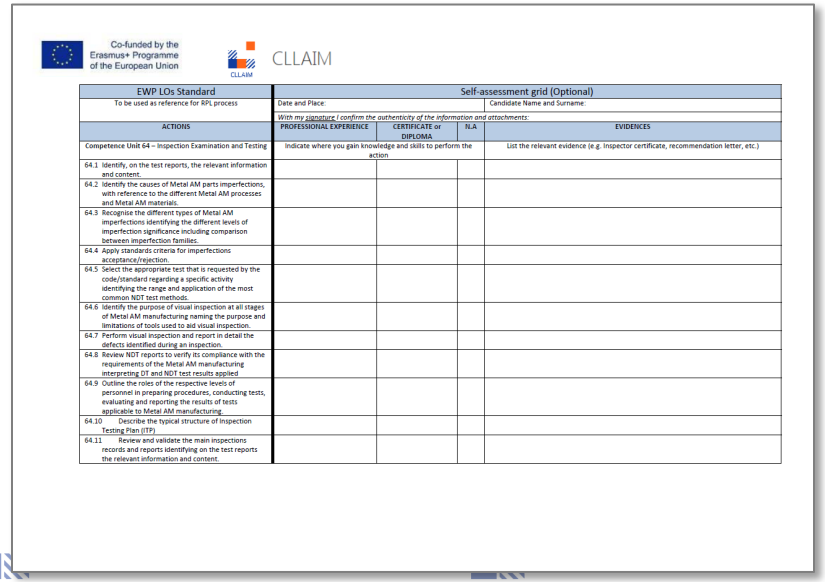
- What reasons led you to enrol in a validation of competences' process?

- What do you expect to achieve with this process?

- From the areas listed below and based on your experience, please indicate areas you have higher & lower preference. The non-ticking of an area means that it is not of your preference:

Additive Manufacturing Areas		Higher preference	Lower preference
AM Designer	AM processes and equipment		
	Materials		
	AM construction strategies and design		
	Fabrication, applications engineering		
	Manufacturing strategies		
	Pieces build-up		
AM Inspection	Quality Assurance/Quality Control		
	Testing of pieces and reporting		
AM Supervision	AM processes and equipment		
	AM designs and strategies		
Manufacturing processes	Laser processing		
	Layer thickness		
	Manufacturing platform level		
	Powder quantity		
	Optimization of working area		

Applicant Self-Assessment Grid (Applicant Portfolio)



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EWP LOs Standard	Self-assessment grid (Optional)			
To be used as reference for RPL process	Date and Place:			Candidate Name and Surname:
	With my signature I confirm the authenticity of the information and attachments:			
ACTIONS	PROFESSIONAL EXPERIENCE	CERTIFICATE or DIPLOMA	N.A	EVIDENCES
Competence Unit 64 – Inspection Examination and Testing	Indicate where you gain knowledge and skills to perform the action			List the relevant evidence (e.g. inspector certificate, recommendation letter, etc.)
64.1 Identify, on the test reports, the relevant information and content.				
64.2 Identify the causes of Metal AM parts imperfections, with reference to the different Metal AM processes and Metal AM materials.				
64.3 Recognise the different types of Metal AM imperfections identifying the different levels of imperfection significance including comparison between imperfection families.				
64.4 Apply standards criteria for imperfections acceptance/rejection.				
64.5 Select the appropriate test that is requested by the code/standard regarding a specific activity identifying the range and application of the most common NDT test methods.				
64.6 Identify the purpose of visual inspection at all stages of Metal AM manufacturing naming the purpose and limitations of tools used to aid visual inspection.				
64.7 Perform visual inspection and report in detail the defects identified during an inspection.				
64.8 Review NDT reports to verify its compliance with the requirements of the Metal AM manufacturing interpreting DT and NDT test results applied				
64.9 Outline the roles of the respective levels of personnel in preparing procedures, conducting tests, evaluating and reporting the results of tests applicable to Metal AM manufacturing.				
64.10 Describe the typical structure of Inspection Testing Plan (ITP).				
64.11 Review and validate the main inspections records and reports identifying on the test reports the relevant information and content.				

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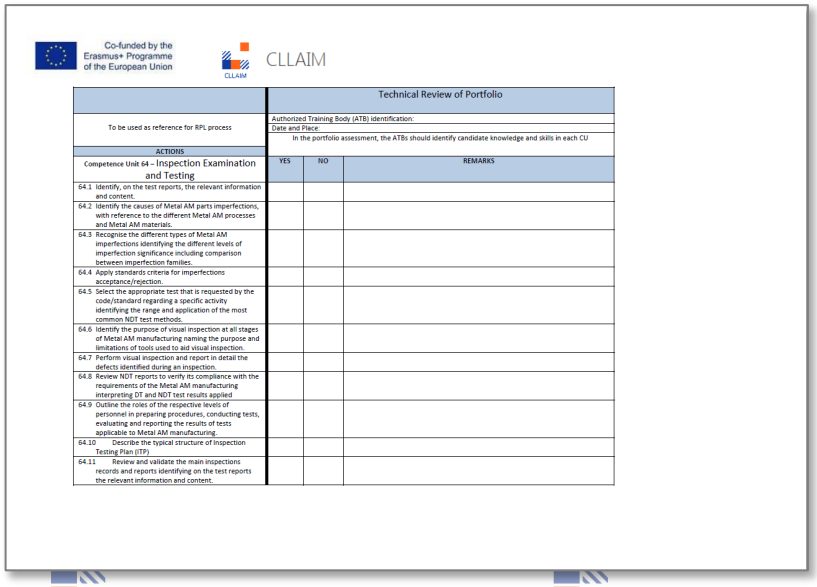
Alternative route – pilot

Recognition of previous learning (RPL):

Assessor Review of Applicant's Portfolio



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	Technical Review of Portfolio		
To be used as reference for RPL process	Authorized Training Body (ATB) identification: Date and Place: In the portfolio assessment, the ATBs should identify candidate knowledge and skills in each CU		
ACTIONS Competence Unit 64 – Inspection Examination and Testing	YES	NO	REMARKS
64.1 Identify, on the test reports, the relevant information and content.			
64.2 Identify the causes of Metal AM parts imperfections, with reference to the different Metal AM processes and Metal AM materials.			
64.3 Recognise the different types of Metal AM imperfections identifying the different levels of imperfection significance including comparison between imperfection families.			
64.4 Apply standards criteria for imperfections acceptance/rejection.			
64.5 Select the appropriate test that is requested by the code/standard regarding a specific activity identifying the range and application of the most common NDT test methods.			
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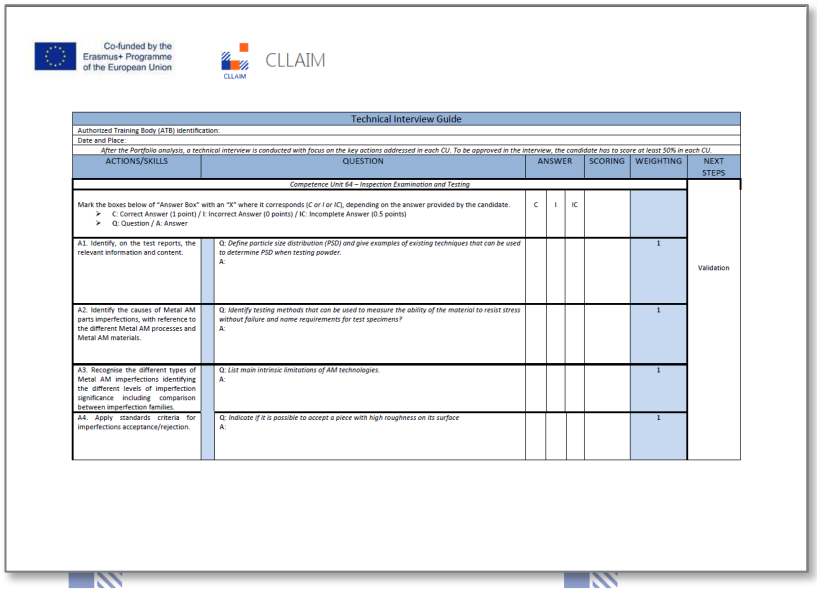
64.10 Describe the typical structure of Inspection Testing Plan (ITP)			
64.11 Review and validate the main inspections records and reports identifying on the test reports the relevant information and content.			

Technical Interview of Candidate by Assessor



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Technical Interview Guide

Authorized Training Body (ATB) identification:

Date and Place:

After the Portfolio analysis, a technical interview is conducted with focus on the key actions addressed in each CU. To be approved in the interview, the candidate has to score at least 50% in each CU.

ACTIONS/SKILLS	QUESTION	ANSWER			SCORING	WEIGHTING	NEXT STEPS
Competence Unit 64 – Inspection Examination and Testing							
Mark the boxes below of "Answer Box" with an "X" where it corresponds (*C or I or IC*), depending on the answer provided by the candidate. ➢ C: Correct Answer (1 point) / I: Incorrect Answer (0 points) / IC: Incomplete Answer (0.5 points) ➢ Q: Question / A: Answer		C	I	IC			
A1. Identify, on the test reports, the relevant information and content.	Q: *Define particle size distribution (PSD) and give examples of existing techniques that can be used to determine PSD when testing powder.* A:					1	Validation
A2. Identify the causes of Metal AM parts imperfections, with reference to the different Metal AM processes and Metal AM materials.	Q: *Identify testing methods that can be used to measure the ability of the material to resist stress without failure and name requirements for test specimens?* A:					1	
A3. Recognise the different types of Metal AM imperfections identifying the different levels of imperfection significance including comparison between imperfection families.	Q: *List main intrinsic limitations of AM technologies.* A:					1	
A4. Apply standards criteria for imperfections acceptance/rejection.	Q: *Indicate if it is possible to accept a piece with high roughness on its surface* A:					1	

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Alternative route – pilot

Recognition of previous learning (RPL):

- If Candidate successfully passes the RPL review and interview, they can then sit the assessment without completing the standard route course
- During the pilot, 4 Candidates completed the RPL assessment (none of the candidates had participated in the standard route pilot but all RPL candidates had experience of AM Inspection)
- Following successful RPL assessment, all Candidates sat the end assessment for each competence unit in the Inspector Profile

Assessor for RPL pilot: Andrew Imrie (LR)

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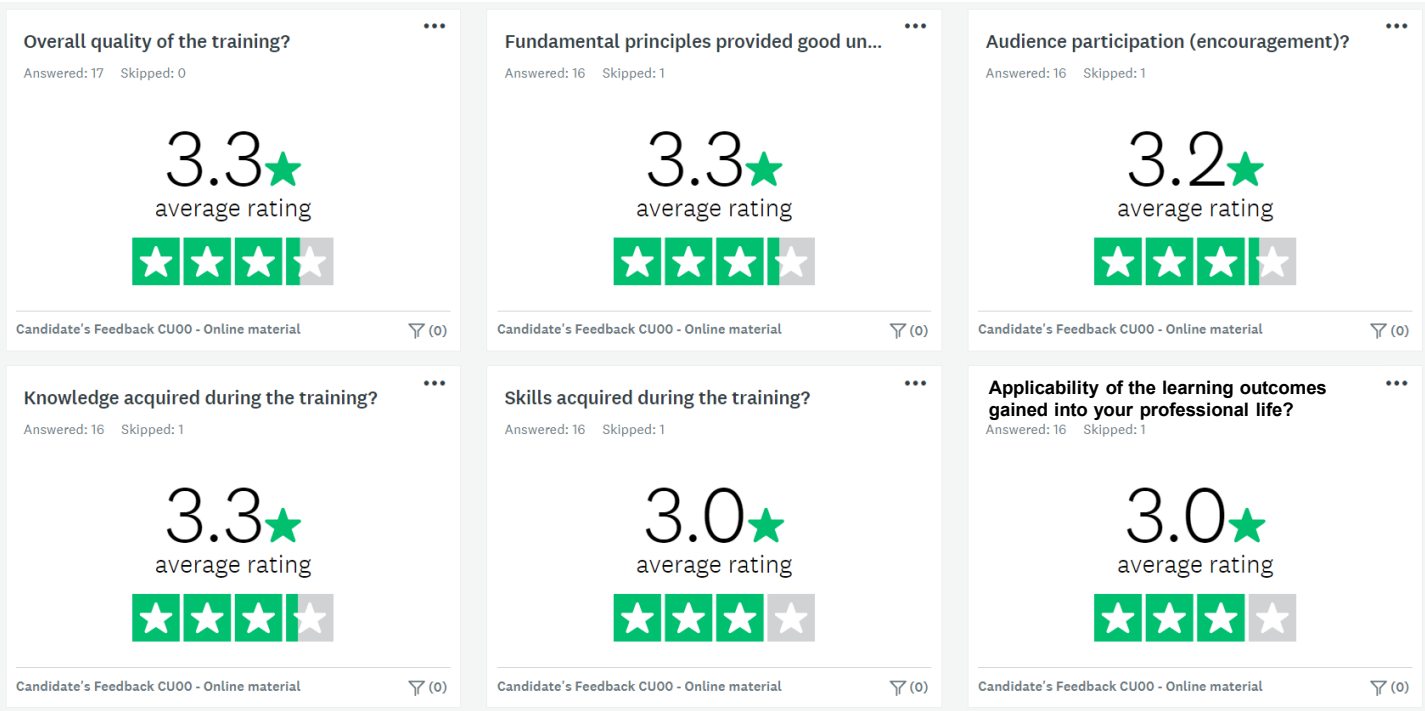
Metal AM inspector profile

CU00 – AM Process overview

- Online material from TWI virtual academy
- In total **16 candidates** completed the material and provided feedback.
- Average score final assessment: **89%**



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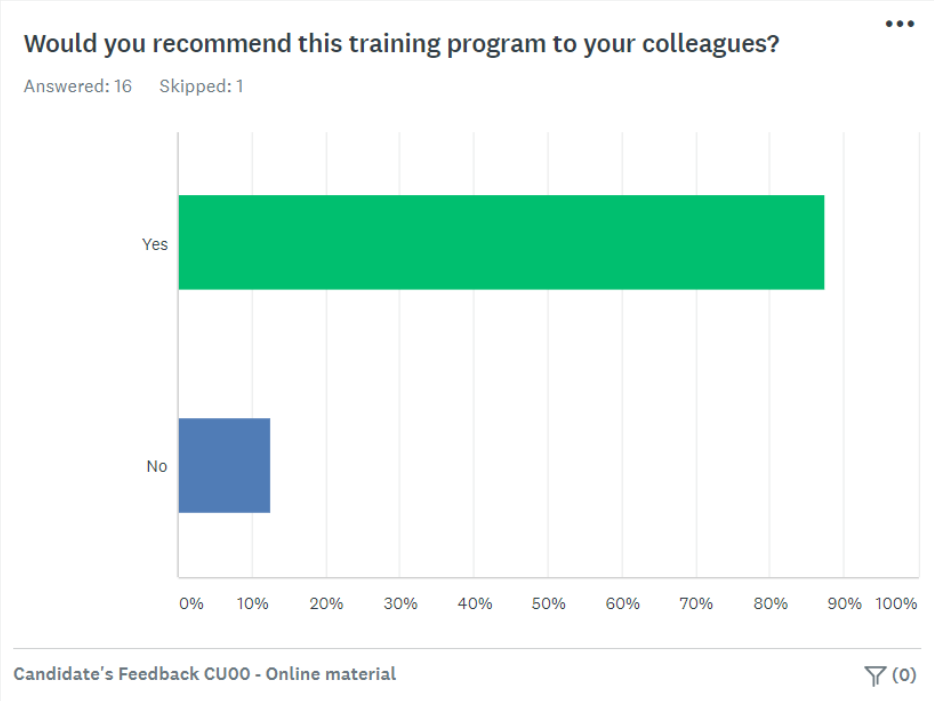
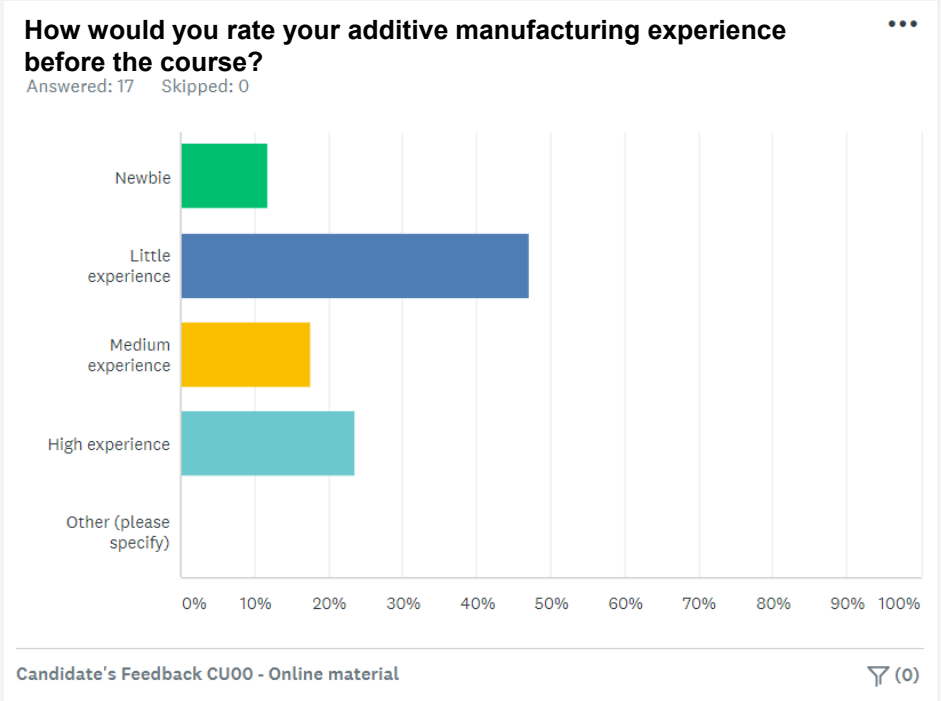
Metal AM inspector profile

CU00 – AM Process overview





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Metal AM inspector profile

CU01: DED-Arc

- In total **22 candidates** completed the material and provided feedback.
- Average score final assessment: **89%**

Feedback received:

‘All trainers very knowledgeable’

‘Well presented’

‘Participation aspect during the course – this kept me engaged.’

‘I really liked the audience participation. This was good in jogging out memories on what had been covered.’

‘The trainers were able to answer all questions and seemed to know their stuff. I liked that they allowed questions to be asked throughout’

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Metal AM inspector profile

CU08: DED-LB

- In total **20 candidates** completed the material and provided feedback.
- Average score final assessment: **83%**

Feedback received:

‘Knowledgeable presenters’

‘Well structured’

‘Interesting and engaging presenters.’

‘Good engagement with participants.’

‘Good coverage of topics.’

‘Professional & Unique to the marketplace’

‘It is very difficult to find process and practical information on DED processes. This is the most comprehensive course that I have come across for this area.’

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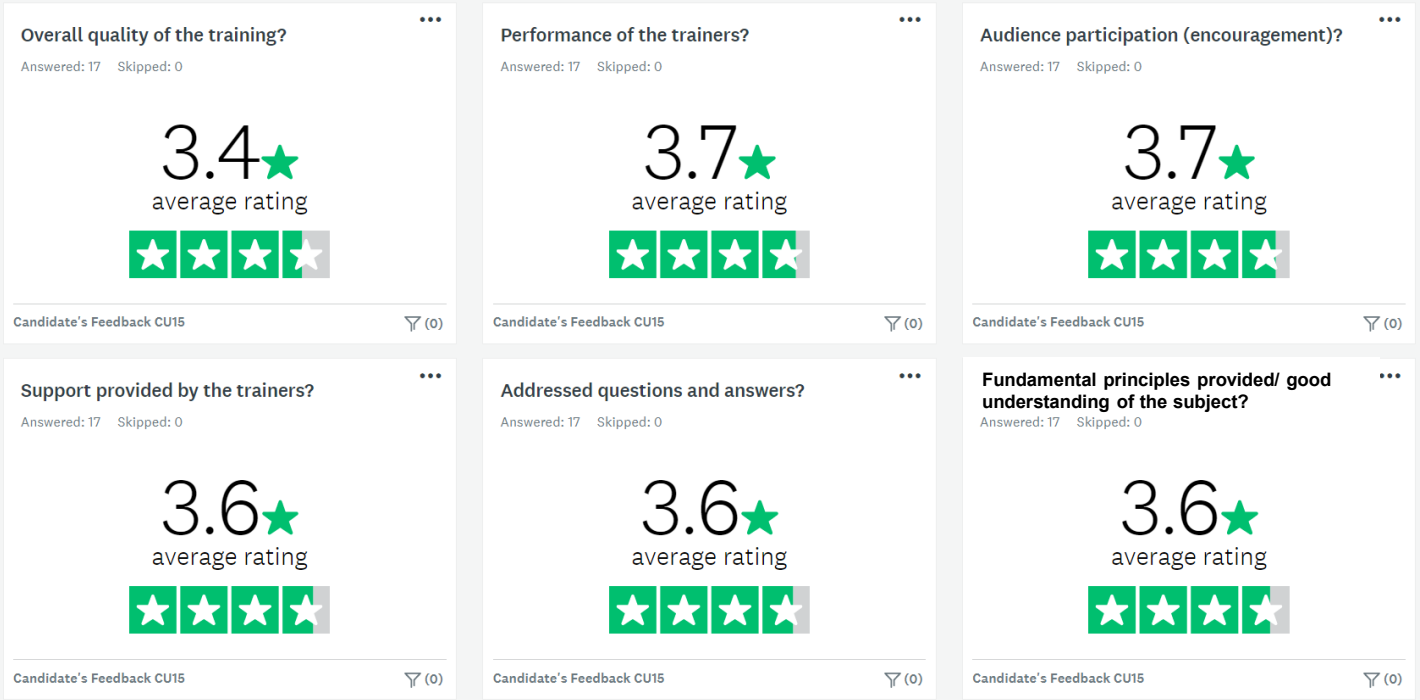
Metal AM inspector profile

CU15: PBF-LB

- In total **17 candidates** completed the material and provided feedback.
- Average score final assessment: **81%**



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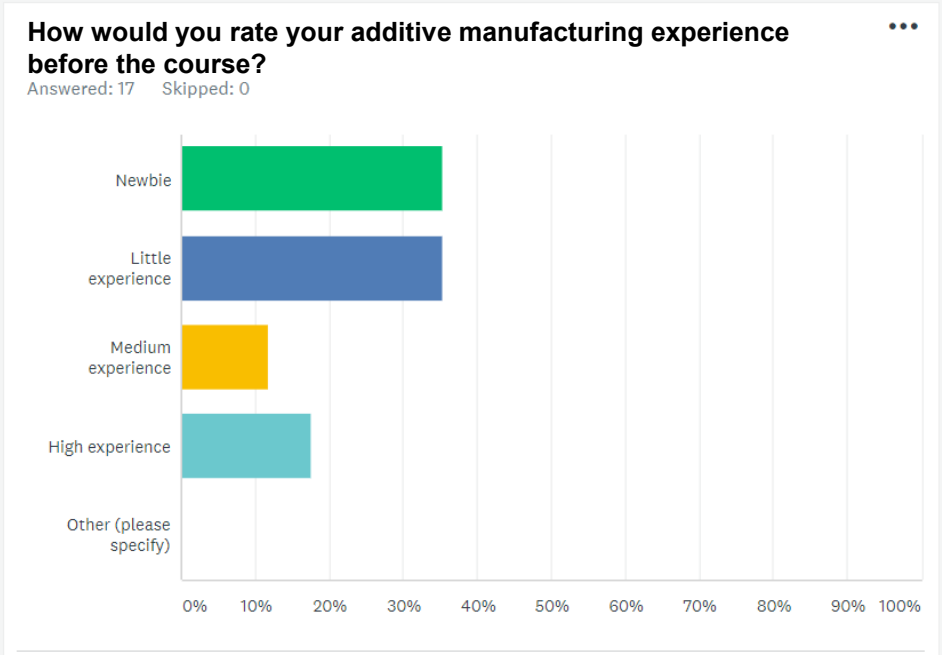
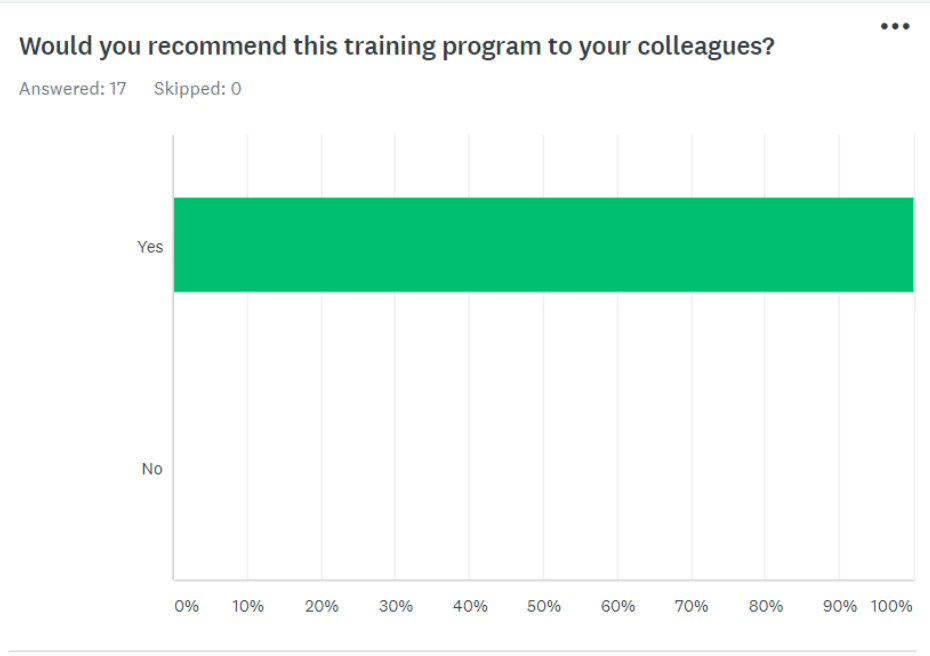
Metal AM inspector profile

CU15: PBF-LB





‘High quality product related to cutting edge technology’

‘Very interesting and expect it to be more popular in the future. I would advise my colleagues to train know, to be able to hit the ground running in the future.’

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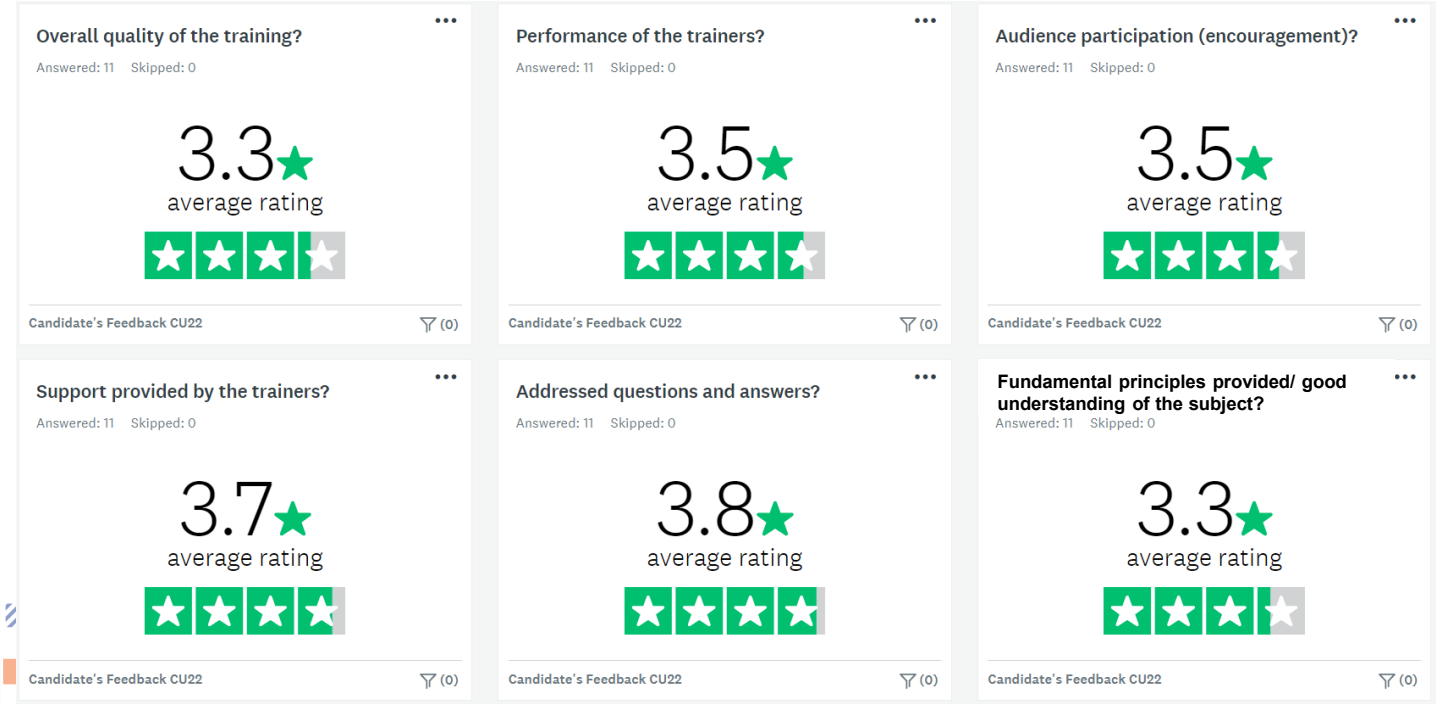
Metal AM inspector profile

CU22: PBF-EB

- In total **11 candidates** completed the material and provided feedback.
- Average score final assessment: **90%**



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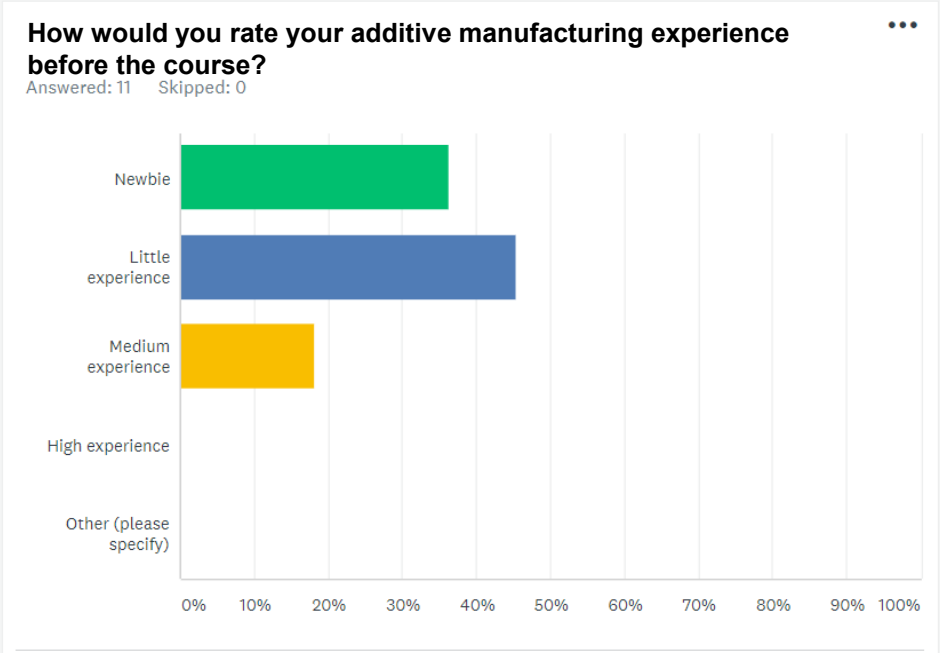
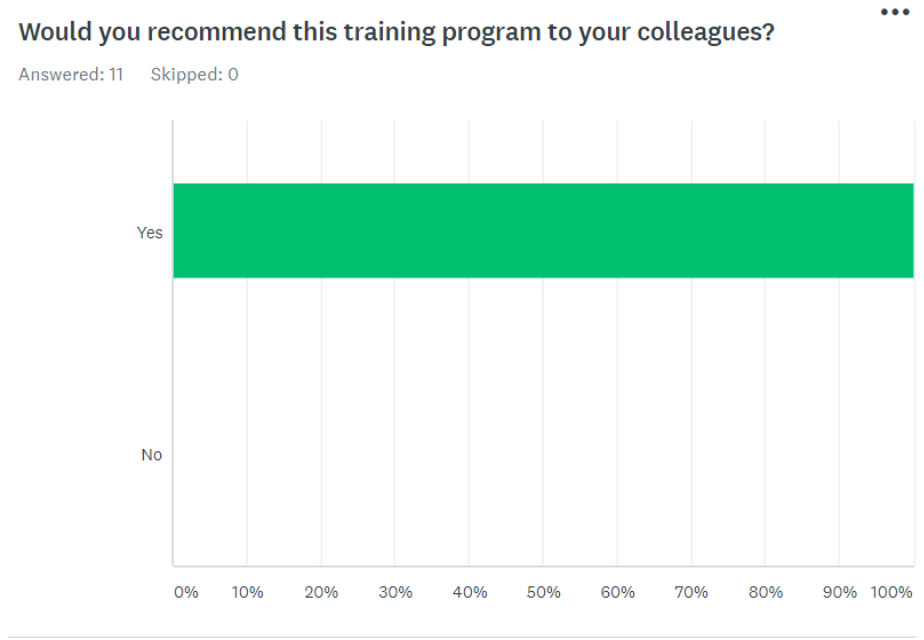
Metal AM inspector profile

CU22: PBF-EB





Feedback received:

‘Ability to show content of standards and specifications on screen.’

‘Comprehensive, well delivered course’

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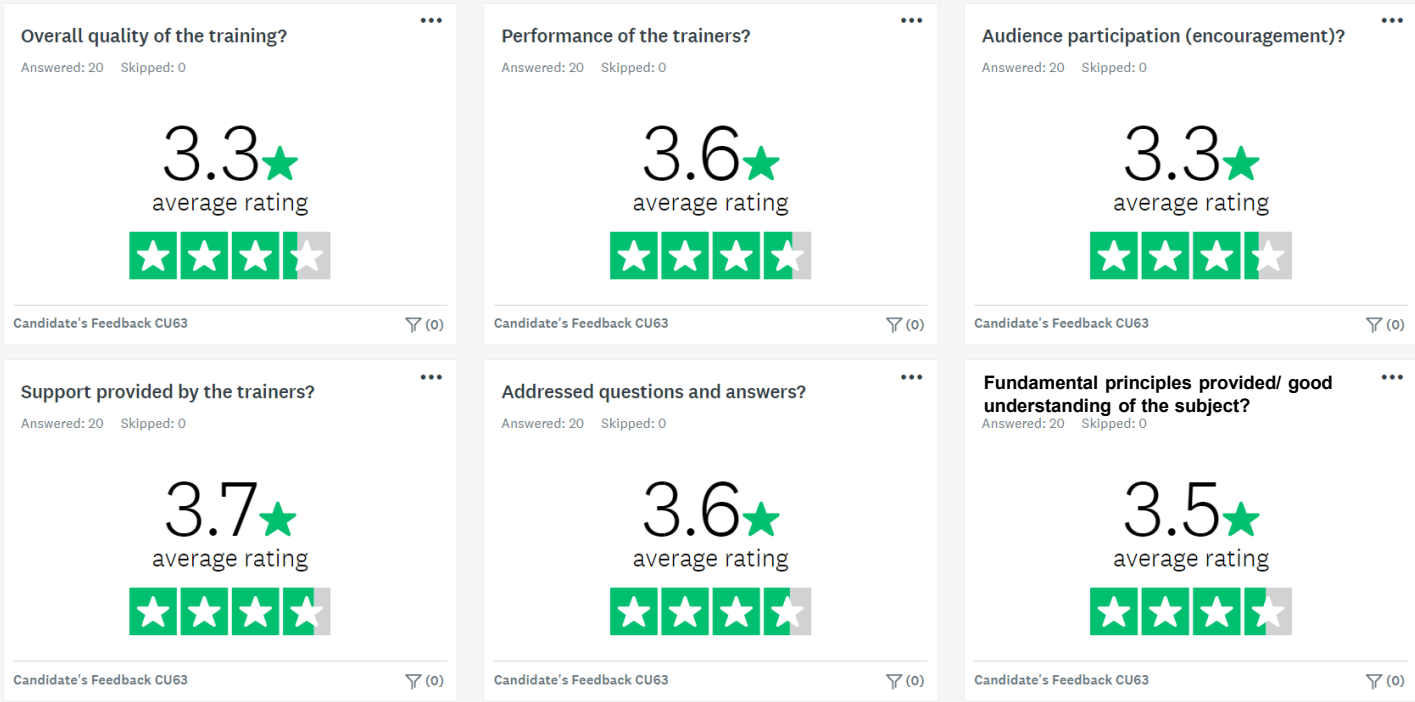
Metal AM inspector profile

CU63: Quality assurance and quality control for inspection

- In total **20 candidates** completed the material and provided feedback.
- Average score final assessment: **85%**



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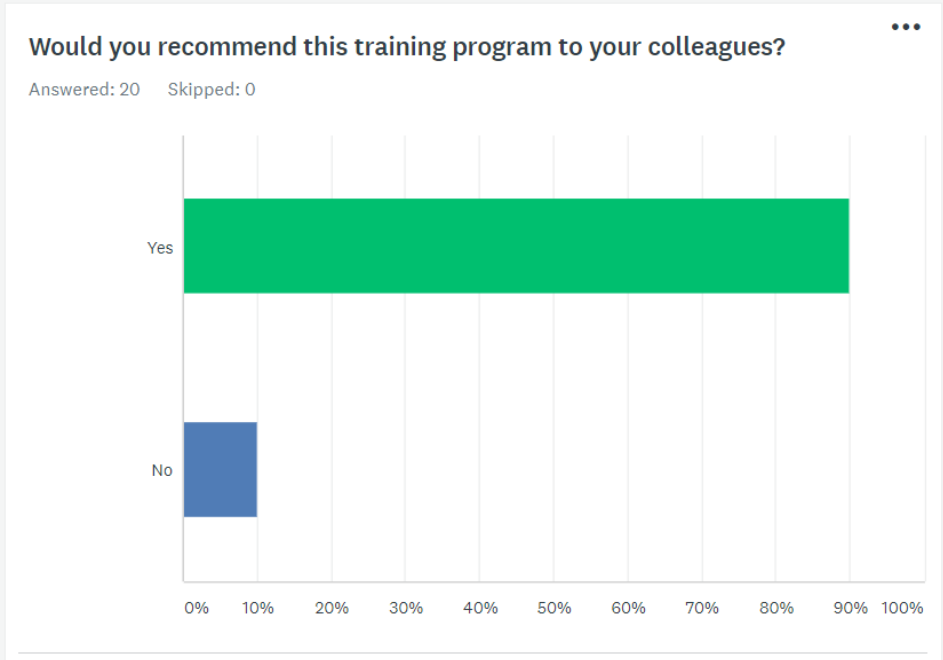
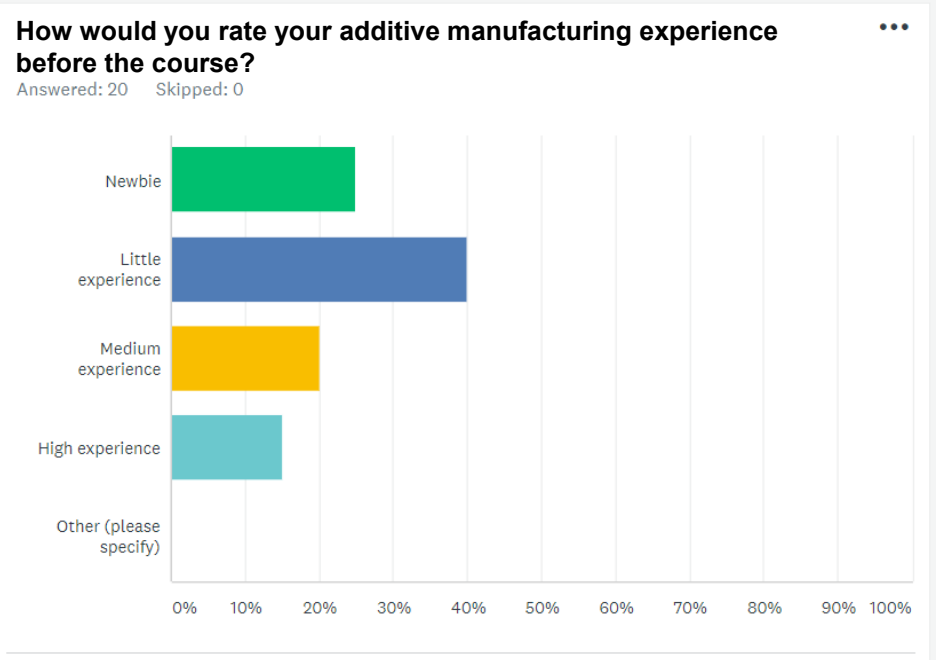
Metal AM inspector profile

CU63: Quality assurance and quality control for inspection





Feedback received:

‘Followed a sequential learning and excellent course delivery. Very high standards’ ‘Comprehensive, well delivered course’

‘Clear guidelines and lesson plan for coverage’

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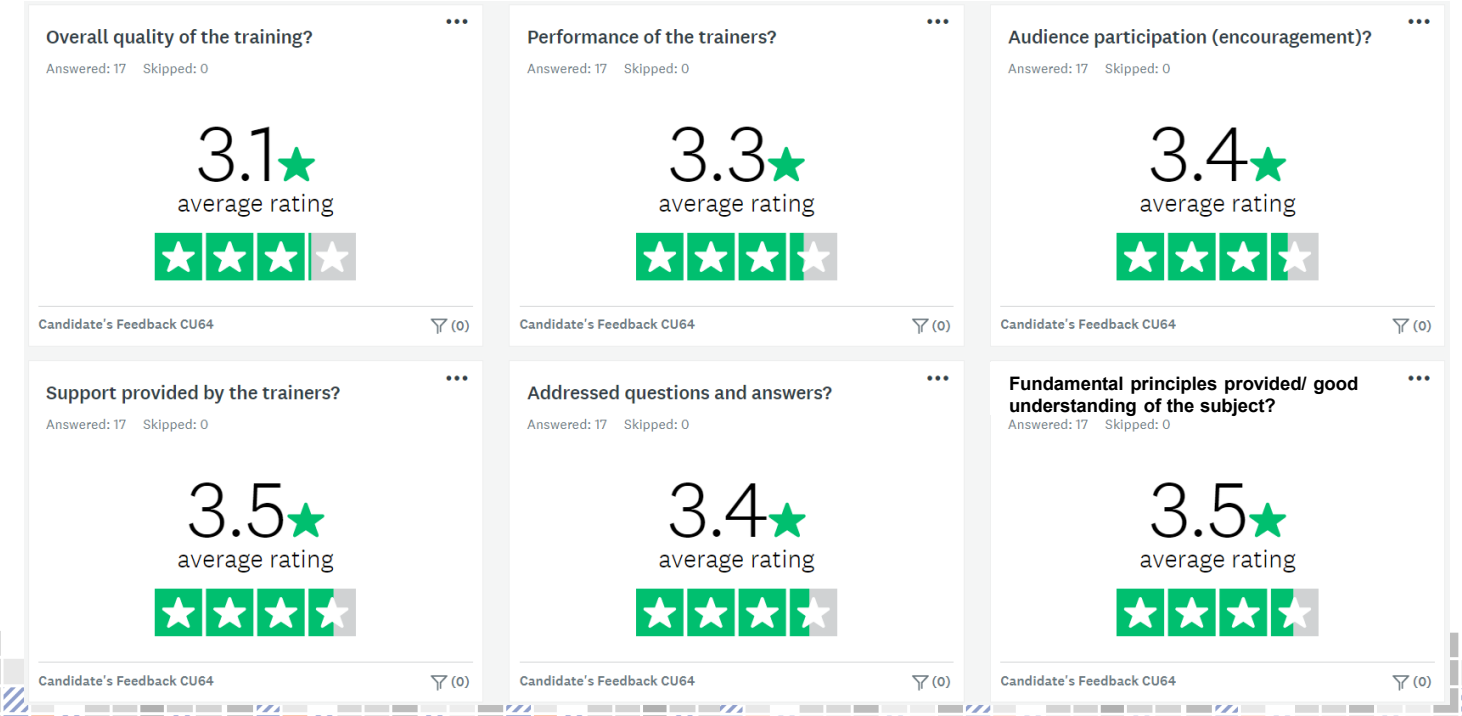
Metal AM inspector profile

CU64: Inspection, examination and testing

- In total **16 candidates** completed the material and provided feedback.
- Average score final assessment: **78%**



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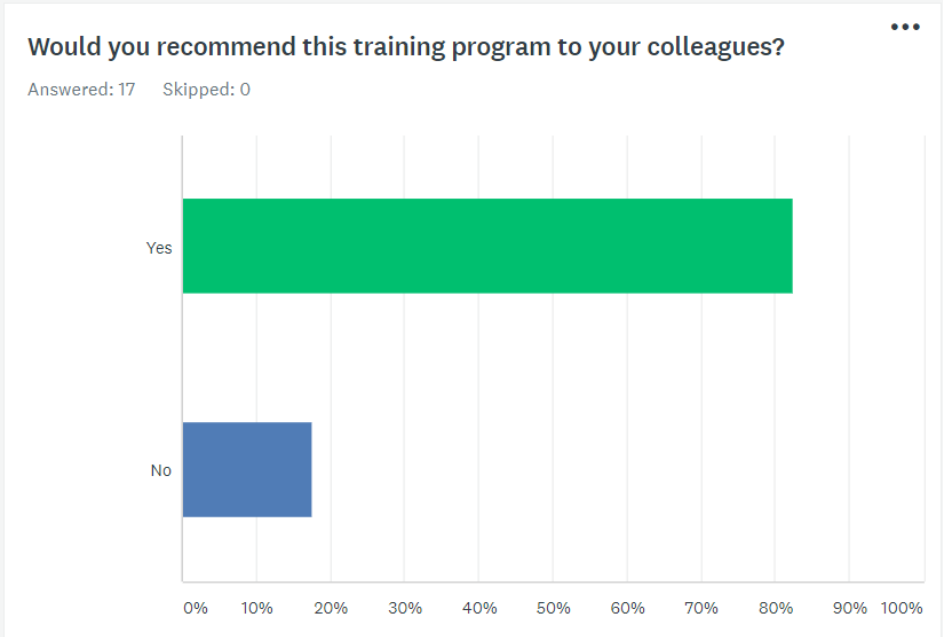
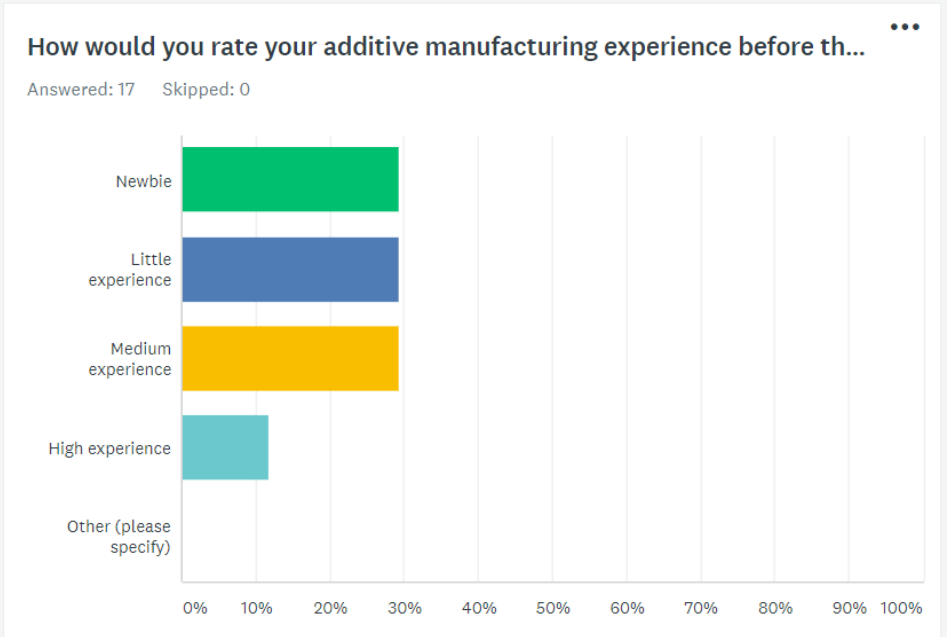
Metal AM inspector profile

CU64: Inspection, examination and testing





Feedback received:

‘Contained all the Key Technologies’

‘Gives you the required knowledge and competency towards additive manufacturing. Excellent insight overall covering processes, parameters, their effects, testing & certification.’

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Metal AM inspector profile

RPL Pilots

- In total **4 candidates** completed the material and provided feedback.
- Average score final assessment:

CU	Set	Exam results (Average score)	Number of respondents
CU00	1	57%	4
CU15	1	86%	1
CU08	2	57%	1
CU01	1	93%	4
CU22	4	86%	1
CU22	3	89%	2
CU08	1	73%	1
CU22	2	79%	1
CU63	2	89%	1
CU01	2	71%	1

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Metal AM inspector profile

RPL Pilots

Pilots evaluation	Average Rating
Guidance provided by the evaluator institution through the RPL process?	3.0
Understanding of the different phases of the RPL process?	3.0
Methodology used?	3.0
Effort to go through the RPL process?	3.0
Duration to go through the RPL process?	3.0
Usefulness of the process?	3.0
Quality of the technical interview?	4.0
Relevance of the technical interview?	3.0
Transparency of the process?	4.0

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Thank you for your attention

David Hardacre (LR)
Alicia Gonzalez (TWI)

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