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Creating knowLedge and skilLs in AddItive Manufacturing

CLLAIM

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Work Package WP06

Work Package Leader TWI

Deliverable 6.2

Title: Pilots of the European matrix of LOs for the European AM Qualifications

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1. Introduction

This document presents the results from the CU pilots that were carried out during this project. The aim of the pilots was to implement and evaluate the usefulness and applicability of the Qualifications guidelines for the international AM qualification system produced during this project. All the pilots were organised to cover the different profiles and to test different CU's of each profiles. Partners selected which CU's they will offer depending on their AM speciality.

Initially CU pilots were arranged to be delivered in person/classroom sessions, in this way the consortium ensured that during the pilots the candidates had access to facilities, AM equipment and practical sessions. However, in 2020, due to the Covid restrictions in different countries, the consortium agreed and obtained authorisation to carry out some pilots via online platforms with the practical part limited if required. Despite the restrictions and online training, all partners completed the contact hours recommended for each CU in accordance with the AM qualification guideline.

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2. National Pilots

During October 2019 and October 2020, seven CLLAIM partners coordinated and delivered the pilots in Spain, Germany and the UK. In total 232 candidates attended the CU pilots, in Spain Idonial delivered three CU's to pilot the designer profile. Cesol delivered three CU's for the designer profile. For Germany Fraunhofer delivered three CU's for the operator profile and two CU's for the Supervisor profile. LZH delivered three CU's for the supervisor profile and DVS delivered 10 CU's for the Operator profile. In the UK, TWI and Lloyd's Register delivered seven CU's for the Inspector profile. The schedule for the CU's pilots that each partner delivered is detailed in Table 1.

Table 1 - CU pilots schedule details

Partner	Profile	CU Pilots / Participants		Date
FRAUNHOFER	Operator	CU00, CU15, CU17	10 participants	22 – 23 Oct 2019
	Supervisor	CU47, CU48	5 participants	01 – 09 Sep 2020
DVS	Operator	CU00, CU15, CU16, CU17, CU18, CU19, CU20, CU21, CU48, CU49	6 participants	07 – 11 Sep 2020
LZH	Supervisor	CU00	12 participants	25 Feb 2020
		CU08	10 participants	25 Jun 2020 & 02 Jul 2020
		CU47	8 participants	12 – 13 Oct 2020
IDONIAL	Designer	CU00	10 participants	15 Sep 2020
		CU15	10 participants	16 – 18 Sep 2020
		CU59	10 participants	21 – 24 Sep 2020
CESOL	Designer	CU00	15 participants	09 Jan 2020
		CU60	7 participants	21 – 25 Sep 2020
		CU61	7 participants	28 Sep – 02 Oct 2020
TWI/LR	Inspector	CU00 – Online	16 participants	May - July 2020
		CU01	22 participants	11 Jun 2020
		CU08	20 participants	18 Jun 2020
		CU15	17 participants	01 Jul 2020
		CU22	11 participants	02 Jul 2020
		CU63	20 participants	08 – 09 Jul 2020
		CU64	16 participants	15 – 16 Jul 2020

For all the pilots, evidence of training and attendance was recorded and the procedure for exams was encouraged in accordance with 'Procedure for pilot activities CU's and RPL' (Annex 1). Partners compiled evidence of pilots as follows:

- For CU pilots: Lesson plan, attendance list, evidence of assessments and photographic evidence of training.

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Table 2 - Checklist to gather evidence for CU pilots

	Document title	Documents required
☐	Lesson plan	1 per CU pilot
☐	Attendance list	1 per CU pilot
☐	Evidence of assessments, candidate's answer sheet	1 per candidate
☐	Evidence of practical tasks, (**if applicable)**	1 per candidate
☐	Photographic evidence of pilot	1 per CU pilot
☐	Feedback from CU pilot	1 per candidate 1 per tutor

Where the pilots were delivered online, the attendance list and photographic evidence was recorded using screenshots.

All participants that attended the CU pilots were required to provide insightful feedback. Evidence of CU's pilots was compiled in a report for each partner.

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3. Pilots general evaluation results

In this section, a summary of the feedback received from CU pilots is presented. During the pilots, an evaluation of the event was required from candidates and tutors.

3.1. CU Pilots evaluation results from Participants

For the CU pilots 232 candidates participated in the training. Figure 1 shows that 5.5% of candidates attended pilots for the supervisor profile delivered by Fraunhofer and LZH; 53% attended the Inspector profile delivered by TWI and Lloyds register; 25.5% participated in the designer profile delivered by Idonial and Cesol and 16% attended the operator profile pilot delivered by DVS.

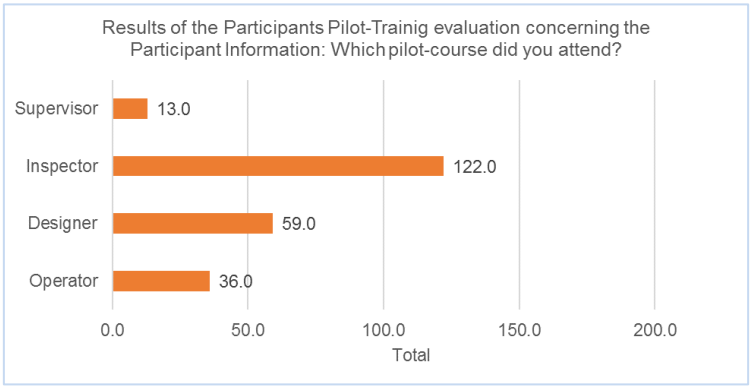

Figure 1 - CU pilots evaluation results from participants concerning 'attendance'

Figure 2 illustrates that majority of candidates belong to 'other' industry sector which demonstrates the scope of AM applications.

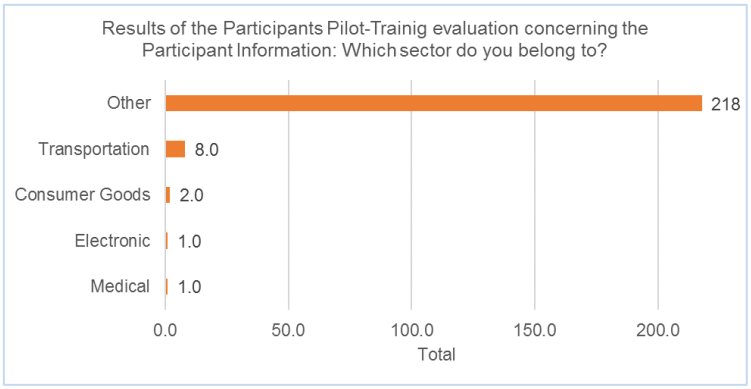

Figure 2 - CU pilots evaluation results from participants concerning 'sector'

Regarding the industrial AM experience from trainees, Figure 3 shows a good distribution of experience among candidates that attended the CU pilots; 47% of candidates declared to have medium to high AM industrial experience and 53% declared little to no experience. The distribution of AM experience as shown in Figure 3 was valuable to demonstrate the usability of the learning outcomes with candidates from different levels of expertise.

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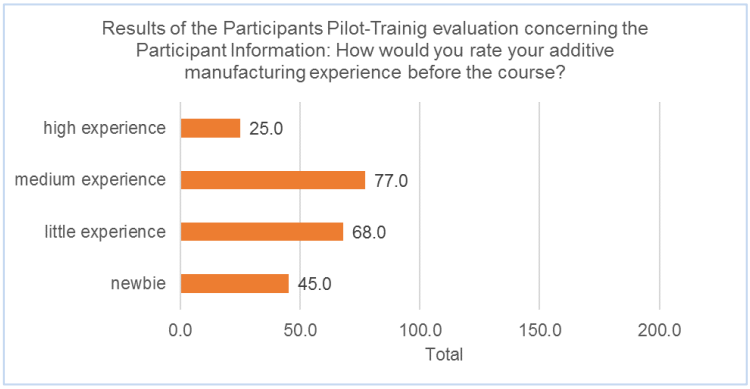

Figure 3 - CU pilots evaluation results from participants concerning 'industrial experience'

The overall quality of the training, support provided and infrastructure of the training institution were highly scored by candidates all above 3.5 out of 4 as Figure 4 illustrates. These results demonstrate that despite some limitations for teaching online, the CU's delivered by partners were of high quality.

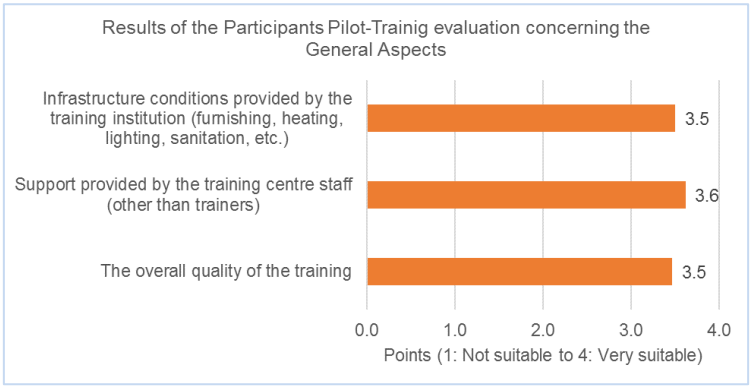

Figure 4 - CU pilots evaluation results from participants concerning 'General aspects of training'

Regarding the training programme, the results in general were highly scored obtaining scores above 3 out of 4 as shown in Figure 5. The only factor that was scored less than 3 points was the theoretical and practical workload, this evaluation was affected by the limitations of accessing AM facilities due to the Covid situation in some of the delivered pilots.

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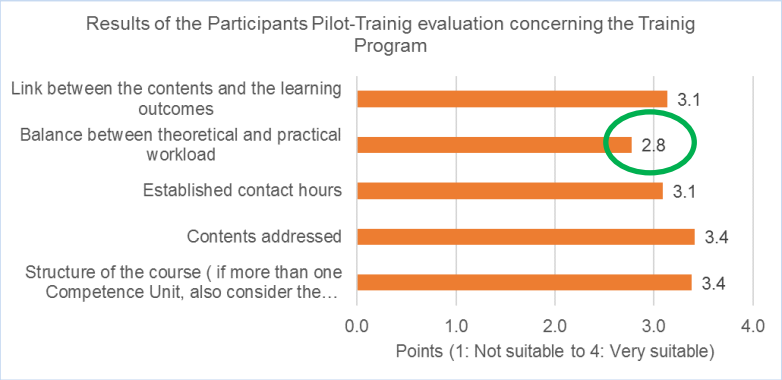

Figure 5 - CU pilots evaluation results from participants concerning 'training programme'

Figure 6 illustrates the scores received for the training sessions. Most factors were highly scored above 3 (out of 4) which demonstrates the ability and expertise of partners in delivering the CU's learning outcomes. The two scores that received less than 3 points were related with the practical part and access to AM equipment, which was a limitation due to covid restrictions for some of the pilots delivered. All candidates were aware of the practical part limitation and tutors made an effort to compensate with other resources such as videos, animations and discussions during the online sessions.

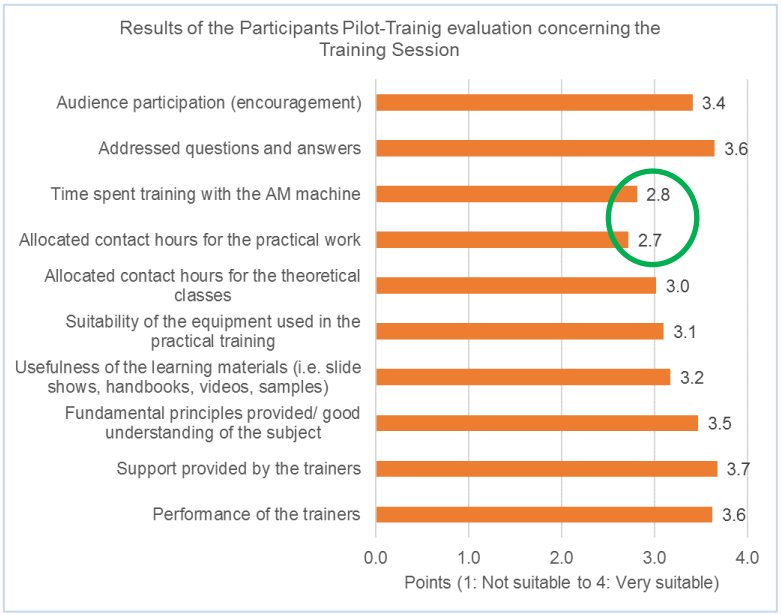

Figure 6 - CU pilots evaluation results from participants concerning 'training session'

Figure 7 shows the scores received regarding the training objectives, applicability of learning outcomes, examination methods and skills/knowledge acquired during the training. All factors were highly scored above 3 out of 4 points. These results demonstrate that candidates found the training very useful, which is a result of the quality of sessions and guidelines and materials developed by CLLAIM partners during this project.

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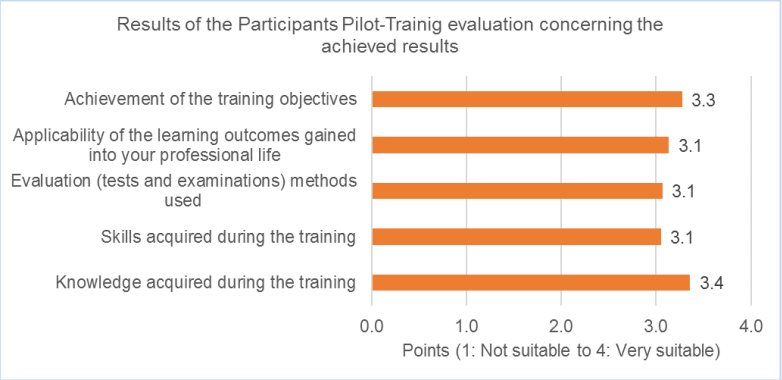

Figure 7 - CU pilots evaluation results from participants concerning 'achieved results'

From the evaluation received, it can be concluded that trainees from different backgrounds and wide range of AM industrial experience agree in the quality of the materials delivered and the applicability of the learning outcomes in their industry. The evaluations received from 230 candidates during CU pilots validated the usability of the AM guideline and highlighted the impact that an international AM qualification system would have for future implementation.

3.2. CU Pilots evaluation results from Trainers

Trainers that supported the delivery of CU sessions provided valuable feedback based on their experience in teaching the learning outcomes and producing the material for the different profiles. Figure 8 shows the distribution of trainers experts that participated in the CU pilots.

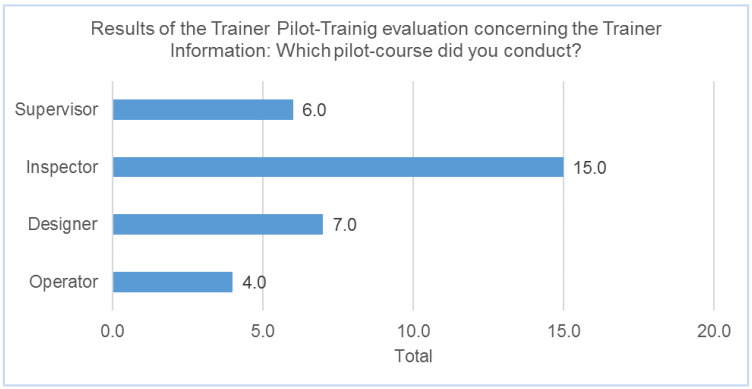

Figure 8 - CU pilots evaluation results from trainers concerning 'profile delivered'

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Majority of trainers were highly experienced in delivering training as shown in Figure 9, 78% declared to have medium to high experience while 22% declared to have little to no experience. The teaching support was highly scored by candidates regardless of teacher background. Having a structured profile with the learning outcomes and contact hours helped trainers to coordinate and succeed delivering the CU pilots.

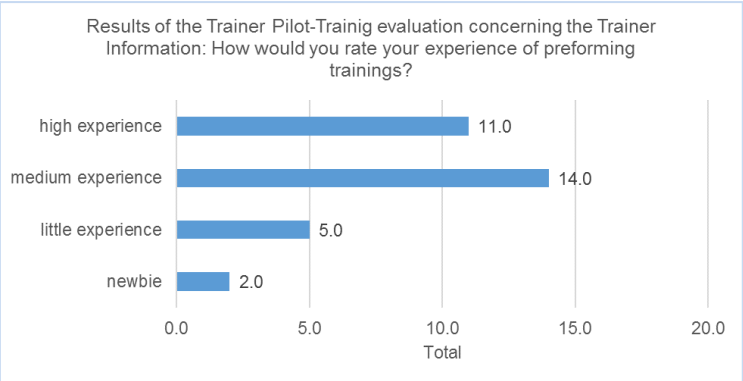

Figure 9 - CU pilots evaluation results from trainers concerning 'experience performing training'

Tutors evaluated the overall quality of the training as very high, the results from Figure 10 illustrate that in general the pilots were well organise and good communication among coordinators and trainers was achieved.

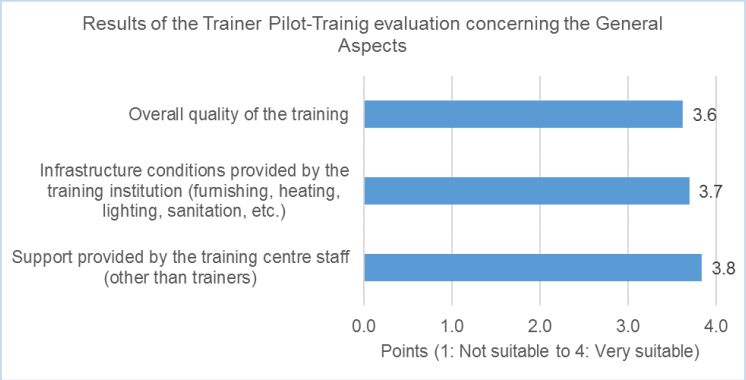

Figure 10 - CU pilots evaluation results from trainers concerning 'general aspects of training'

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Figure 11 summarises the CU evaluation from trainers regarding learning outcomes, content and structure of the course received high scored from trainers all above 3 out of 4 points. Similarly, the contact hours and balanced between theory and practical received high evaluation, some trainers commented on the challenges of delivering the training online especially for CU's that covered full day contact hours. Some pilots were limited in the practical part due to the Covid restrictions, covering theory and replacing the practical part with more presentations was challenging for trainers and participants however the information provided was well received and long breaks between presentations were suggested when covering long hours of online teaching.

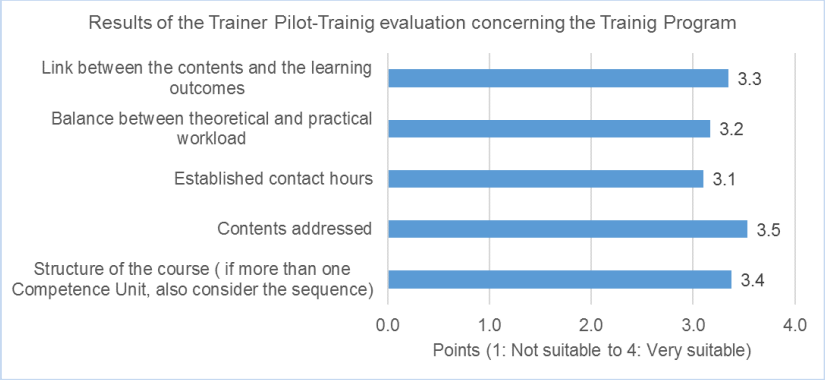

Figure 11 - CU pilots evaluation results from trainers concerning 'training program'

Trainers that participated in the CU pilots were able to provide insightful feedback on the overall training session as shown on Figure 12. Learning materials, equipment used and the balance between contact hours and teaching session for theory and practical. In general, all factors were highly evaluated by trainers, an improvement to balance the contact hours against the practical and theory classes could be implemented by having full access to the facilities, which was a limitation for some pilots. Most candidates mentioned that they prefer the sessions in person, which in non-covid circumstances would have been the first option.

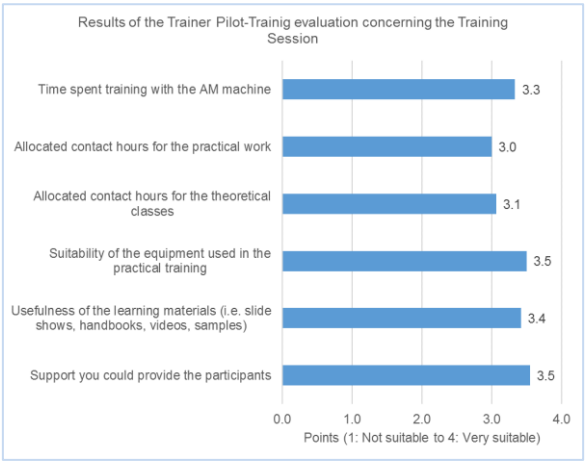

Figure 12 - CU pilots evaluation results from trainers concerning 'training session'

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Regarding the achieve results during CU pilots training sessions tutors evaluated the knowledge and skills transferred to candidates as very satisfied as shown in Figure 13. Regarding the examination process, the evaluation was highly scored by trainers. Some trainers mentioned that the quality of exam questions should be reviewed to ensure that questions are clear and the translation into other languages is correct. Some partners implemented a second revision of exam questions used for the pilots, which improved the evaluation received, by trainers and participants.

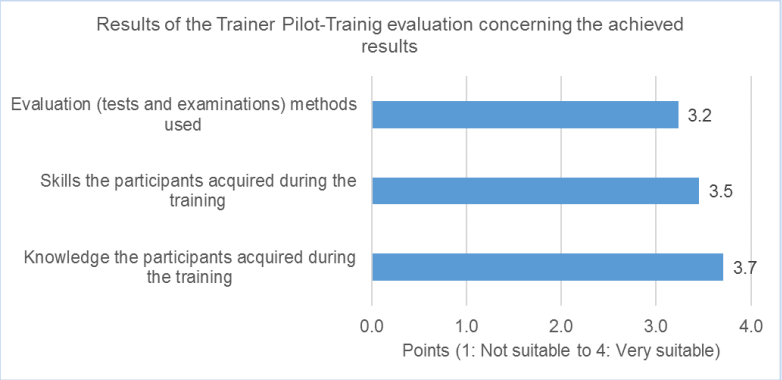

Figure 13 - CU pilots evaluation results from trainers concerning 'achieved results'

From the feedback received from trainers that delivered CU training sessions it can be concluded that the quality of the sessions and knowledge transferred was very satisfied and challenges regarding online teaching were overcome. These results are from AM experts with advanced experience on teaching; their feedback validates the usability of the qualification system and structured AM guideline developed during this project.

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4. Conclusion

The main objective of the CU pilots was to demonstrate the use and applicability of the AM guidelines developed during this project. From the feedback collected by the participants (trainees and trainers), it can be concluded that the CU pilots were successful and well accepted in industry and for future AM users, in particular:

- The usability for industry of the AM guidelines and tools that were implemented during the pilots was successfully validated and evaluated in different countries for all the developed AM profiles;
- The outcomes from pilots have confirmed the usability and industrial demand for the international AM qualification system, which was developed during this project;
- The success of the pilots performed during this project will benefit the future implementation and acceptance of the international AM qualification system.

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5. Annexes

Annex 1

Procedure for pilot activities CUs and RPL

1. Introduction

This document is a guidance for the collection of evidence and evaluation (feedback) that needs to be gathered during the **CU's and RPL pilots**. The evidence collected during pilots is critical to assess the quality and usability of the training, methodology and tools.

For piloting CU's and RPL this procedure shall be followed using the documents that can be found in **WP06**, folder: '***D6.2 D6.3 Guidance to gather evidence and evaluation of CU'S & RPL pilots***' and to collect feedback all evaluation forms are available on **WP09**, folders: 08 & 09. These work packages and folders contain the required documentation and templates used as reference in this procedure.

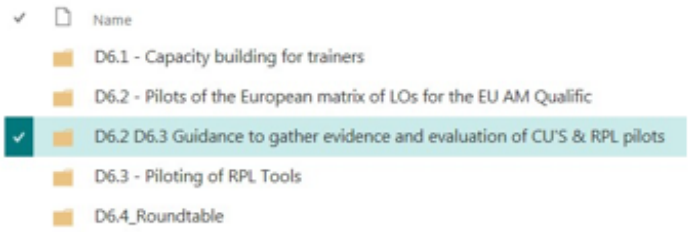

Figure 1 – WP06, Minimum requerements for evidence and evaluation for pilots

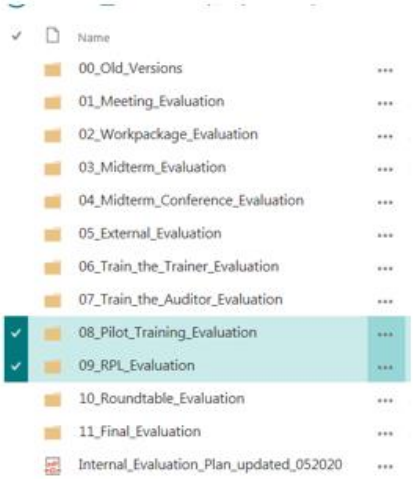

Figure 2 - WP09, Evaluation of LO's and RPL

2. Scope and targets

This procedure which covers the minimum requirements for collecting evidence of training and evaluating CU and RPL pilots, is aimed at CLLAIM project partners (VET Providers) who will be supplying training as ATB's (Authorised Training Bodies) and examination of candidates.

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3. Use of tools for recording evidence and evaluation of pilots

This guide aims to assist the instructors in collecting documents required from all **delivered training** and **implementation of RPL** during pilots.

3.1. Evidence required for CU's pilots

At the beginning of the sessions, the tutor is responsible of informing participants that evidence of their training is required, it is also responsibility of the tutor to collect all the evidence before the end of each training.

During each training, a '**training file**' shall be produced, per candidate, with all the documents collected. This **training file** will be used as evidence of the training provided and feedback received. The following steps shall be followed to collect the required documentation:

3.1.1. Prepare the checklist

As a tool to gather all the required documents, it is recommended to have a checklist available before and during the training. An example of this document can be found in Annex 1.

3.1.2. Produce a Lesson Plan

A lesson plan that can be adapted to different AM Profiles and CU's shall be produced for each training. The lesson plan shall contain a detailed description of the activities, scheduled during training, the resources required for each activity and the contact hours covered during the day. A template for lesson plan is presented with the minimum information required, an example can be found in Annex 2.

3.1.3. Attendance list

It is **mandatory to produce an attendance list** during the training. All participants will be required to sign every day as a proof of their participation. If pilots were deliver online, include **screenshots** showing participants attendance.

Attendance list should include specific information regarding the training, competence unit, start date of the training, contact hours, training venue, and name and signature of the instructor in charge. A template is presented with the minimum information required, an example of this document can be found in Annex 3.

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3.1.4. Evidence of assessments, candidate's answer sheet

Any results achieved by participants during the theory sessions, shall be collected as evidence of assessments. It is responsibility of the partner delivering the pilot to collect and keep the results or answer sheets of any assessment completed by the candidates. If pilots were deliver online, google forms, survey monkey or similar are acceptable to collect exam results.

At least one answer sheet or assessment results shall be provided as proof of final theory assessment. A template for evidence of assessments is presented with the minimum information required, an example of this document can be found in Annex 4.

3.1.5. Evidence of practical tasks

If applicable, a list of practical tasks should be produced by the candidate as a proof of training for practical exercises. This list of practical task should include sufficient details and be included in the **training file** for each participant. If practical assessment was not possible, include a brief justification.

An example of this document can be found in Annex 5.

3.1.6. Photographic evidence of training (optional)

It is **recommended** to gather photo-evidence during the training sessions to demonstrate: candidate's participation in training activities both practical (as appropriate) and theory sessions either classroom-based or online. If pilots were deliver online, include **screenshots** showing participants attendance.

An example of this document can be found in Annex 6.

3.1.7. Evaluation (feedback) from pilots - Participant and Tutors

It is **mandatory** to obtain feedback from participants and to keep evidence from their training. In the case of CU pilots, it is mandatory to obtain feedback from each competence unit and encourage participants to include their comments for each CU. If pilots were deliver online, google forms, survey monkey or similar are acceptable to collect evaluations.

Tutors/Trainers are required to provide feedback and evaluate each CU delivered.

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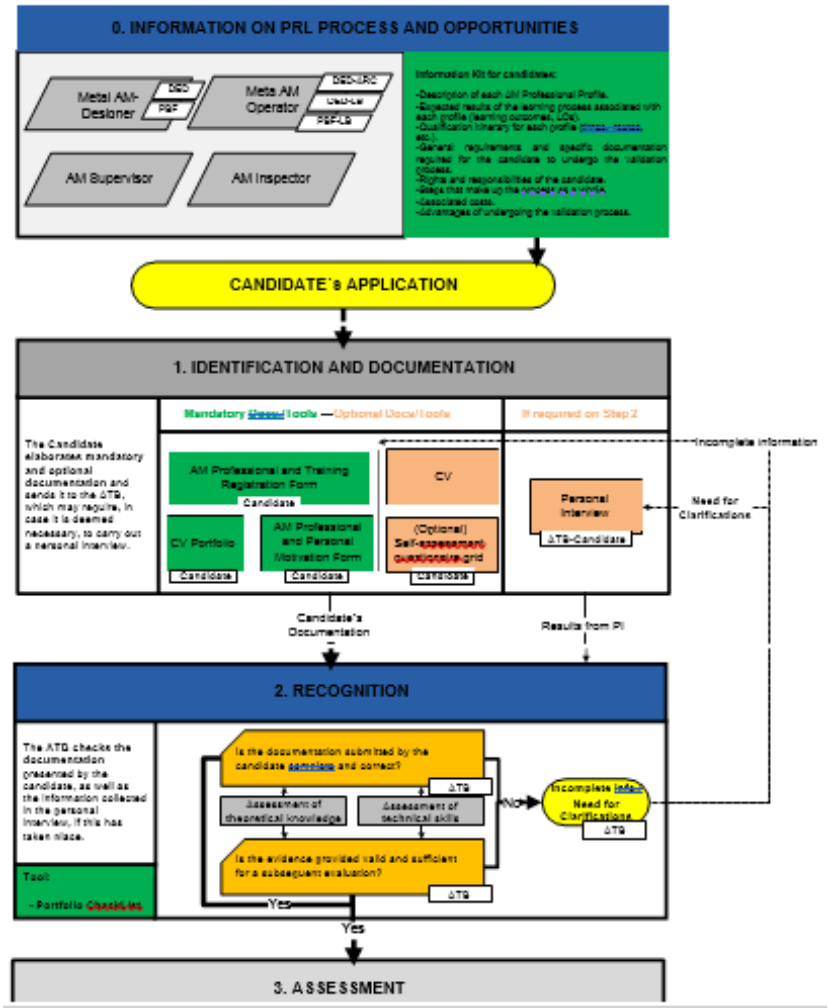
3.2. Tools for RPL pilots

Regarding RPL pilots, the examiners and partners performing RPL pilots are responsible for gathering documents from candidates participating in the RPL pilots. These documents will built the **candidate's portfolio**. It is responsibility of examiners to:

- Verify all documents and experience presented from candidates.
- Provide feedback of the available tools for RPL pilots.
- Collect feedback from participants of the RPL pilots.

3.2.1. RPL Process

Refer to the RPL process from the latest version of the 'Guideline for RPL in the AM sector' on WP05.



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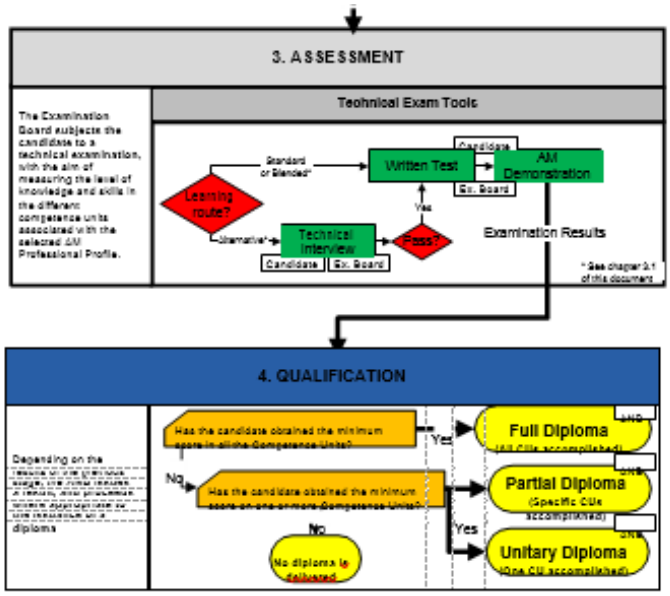

Figure 3 - RPL process proposed in the 'Guideline for RPL in the AM Sector

3.2.2. Checklist for examiners - RPL pilots

It is a highly recommended to use this tool to verify documents required during the RPL pilots. A template of this document is available on **WP06** and presented in Annex 7:Checklist for RPL examiners.

3.2.3. Evaluation from examiners and participants - RPL pilots

It is **mandatory** to obtain feedback from candidates and to record evidence of participation. Examiners are responsible to collect feedback and encourage participants to comment on their final observations. If pilots were deliver online, google forms, survey monkey or similar are acceptable to collect evaluations.

Examiners taking part in the RPL pilots are required to provide feedback. It is required to complete an evaluation at the end of each pilot activity.

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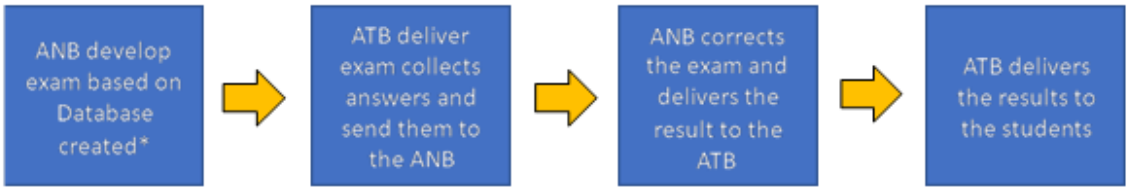
4. Procedure for CU & RPL exams

All partners performing CU's or RPL pilots are responsible to follow the procedure for exams as follows:



1. Each ANB (DVS, CESOL, and TWI) will be responsible to produce the exams required for the CU'S & RPL pilot activities. Database of all exam questions is available through EWF.
2. ATB's (All Partners) are responsible for asking the ANB for the exam with at least one week before the examination date.
3. The ANB will then make available the exam to the ATB at least two days before the examination date.
4. ATB conducts the exam and sends it the ANB.
5. The ANB has one week to correct (mark) the exam and send the results to the ATB.
6. ATB provides exam results to candidates.

5. Summary

- All templates required, annexes and examples presented in this document and the annexes are available in WP06 folder **D6.2_D6.3 Guidance to gather evidence and evaluation of CU'S & RPL pilots**
- All **evidence of pilots** collected from participants shall be uploaded on SharePoint as follows:
  - ✓ **CU Pilots: Upload evidence on WP06, folder D6.2**
  - ✓ **RPL Pilots: Upload evidence on WP06, folder D6.3**
- All **evaluation (feedback)** collected from participants and tutors during the CU's and RPL pilots shall be scanned and uploaded on SharePoint WP09, using folder 08 for CU Pilots, folder 09 for RPL pilots.
- Once pilot activities are completed, update the status on the pilots schedule excel file WP06.

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6. Annexes

Annex 1: Check list – CU Pilots

	Document title	Documents required	Notes
☑	Lesson plan	1 per training	
☑	Attendance list If pilots were deliver online, include **screenshots** showing participants	1 per training	
☑	Evidence of assessments, candidate's answer sheet If pilots were deliver online, **google forms, survey monkey or similar** are acceptable to collect exam results.	1 per candidate	
☑	Evidence of practical tasks, **(if applicable)** If practical assessment was not possible, include a brief justification in this form	1 per candidate	
☑	Photographic evidence of training If pilots were deliver online, include **screenshots** showing participants	1 per training	
☑	Feedback from training Evaluation form available on WP09.	1 per candidate	

Figure 4 - Example of checklist

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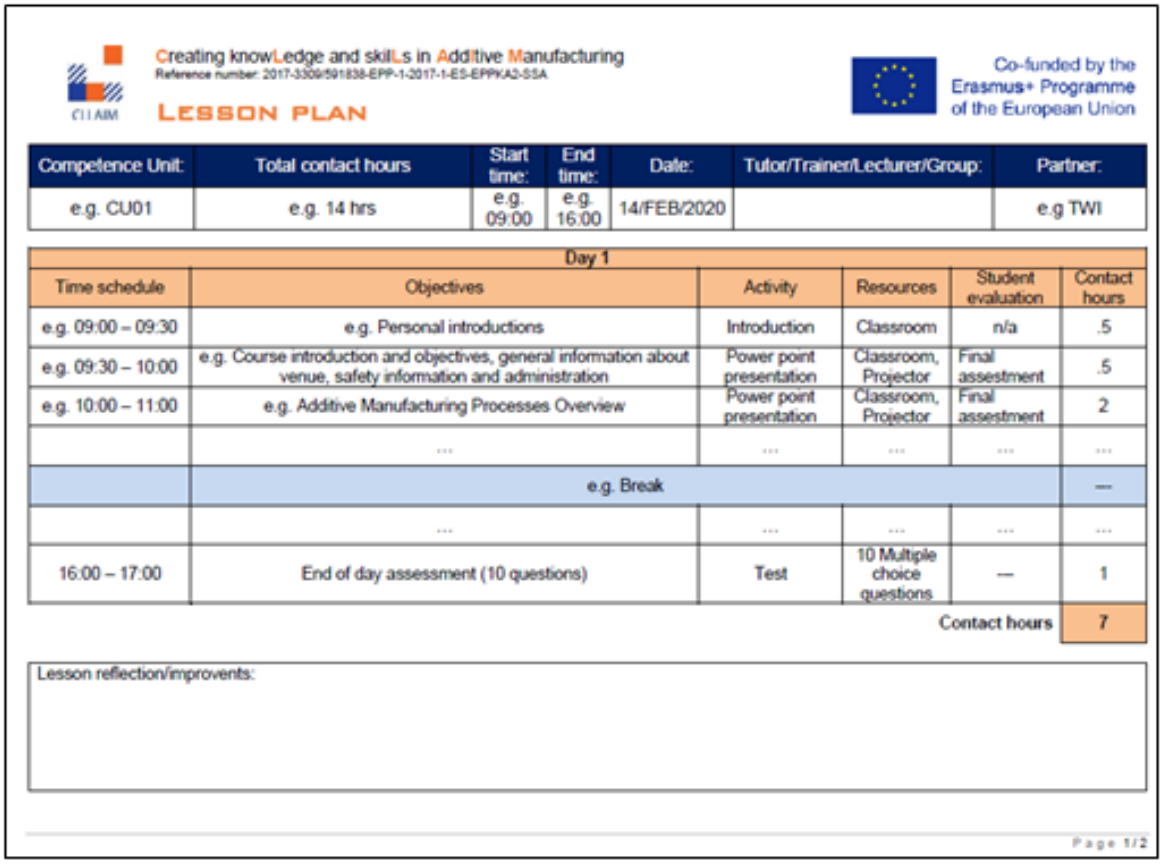
Annex 2: Lesson Plan – CU pilots



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

LESSON PLAN

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

Competence Unit:	Total contact hours	Start time:	End time:	Date:	Tutor/Trainer/Lecturer/Group:	Partner:
e.g. CU01	e.g. 14 hrs	e.g. 09:00	e.g. 16:00	14/FEB/2020		e.g TWI

Day 1					
Time schedule	Objectives	Activity	Resources	Student evaluation	Contact hours
e.g. 09:00 – 09:30	e.g. Personal introductions	Introduction	Classroom	n/a	.5
e.g. 09:30 – 10:00	e.g. Course introduction and objectives, general information about venue, safety information and administration	Power point presentation	Classroom, Projector	Final assestment	.5
e.g. 10:00 – 11:00	e.g. Additive Manufacturing Processes Overview	Power point presentation	Classroom, Projector	Final assestment	2
	...	...	...	...	...
	e.g. Break				—
	...	...	...	...	...
16:00 – 17:00	End of day assessment (10 questions)	Test	10 Multiple choice questions	—	1
				Contact hours	7

Lesson reflection/improvents:

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Figure 5 - Example of Lesson Plan, part I

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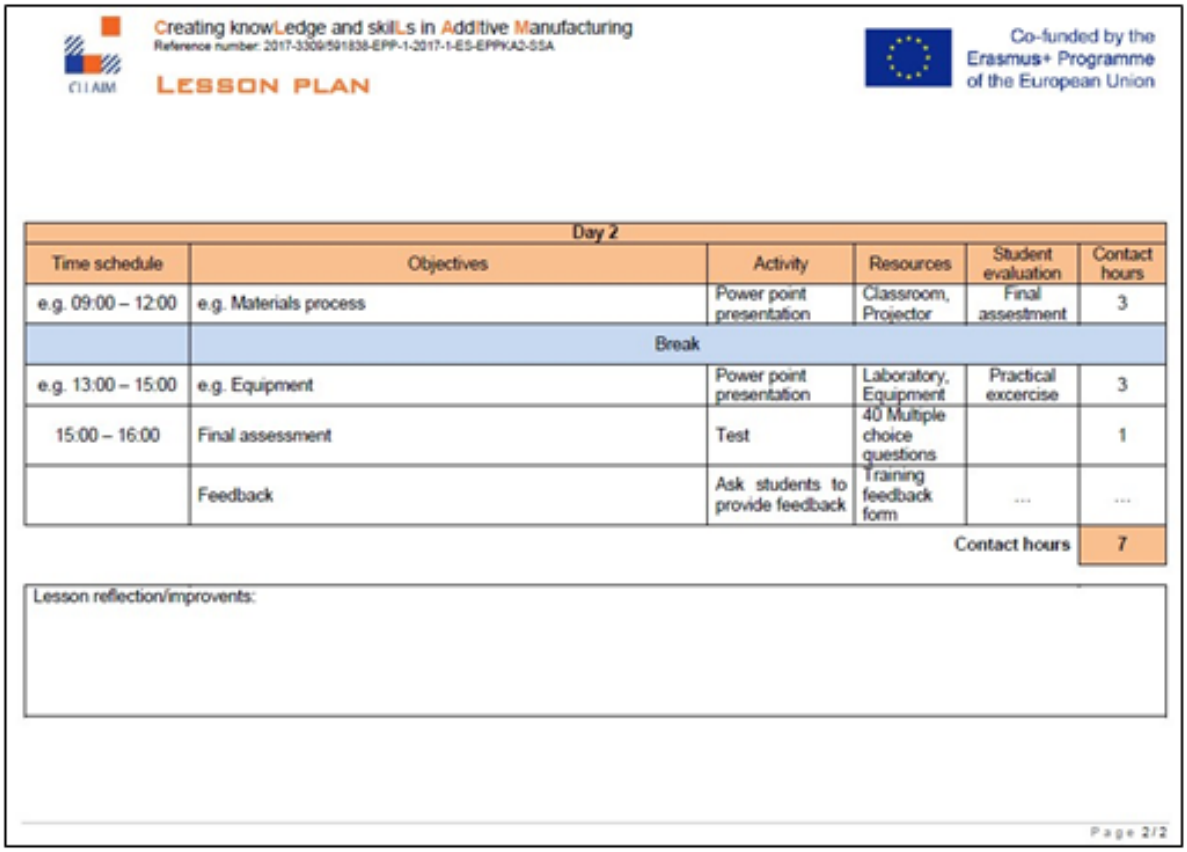

Creating knowLedge and skilLs in Additive Manufacturing
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LESSON PLAN

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Day 2					
Time schedule	Objectives	Activity	Resources	Student evaluation	Contact hours
e.g. 09:00 – 12:00	e.g. Materials process	Power point presentation	Classroom, Projector	Final assestment	3
	Break				
e.g. 13:00 – 15:00	e.g. Equipment	Power point presentation	Laboratory, Equipment	Practical excercise	3
15:00 – 16:00	Final assessment	Test	40 Multiple choice questions		1
	Feedback	Ask students to provide feedback	Training feedback form	...	...
				Contact hours	7

Lesson reflection/improvents:

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Figure 6 – Example of Lesson Plan, part II

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Annex 3: Attendance list – CU pilots

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ATTENDANCE LIST - TRAINING

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Competence Unit:	Start day:	Contact hours:	Training venue:	Instructor's name and signature
e.g. CU01	e.g. 14/FEB/2020	14 hrs	e.g. TWI, Cambridge UK	

#	Candidate's name	Employer	Day 1 e.g. 14/FEB/2020	Day 2 e.g. 15/FEB/2020	Day 3	Day 4	Day 5
1	e.g. Yo yo	e.g. TWI	e.g. Signature	e.g. Signature	e.g. N/A	e.g. N/A	e.g. N/A
2							
3							
4							
5							
6							
7							
8							
9							
10							

Figure 7 - Example of attendance list

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Annex 4: Evidence of assestments (for theory)

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EVIDENCE OF ASSESSMENT

Candidate's answer sheet

Competence Unit:	Start day:	Training venue:
e.g. CU01	e.g. 14/FEB/2020	e.g. TWI, Cambridge UK

Question	Candidate's answer	Question	Candidate's answer	Question	Candidate's answer	Question	Candidate's answer
1.	e.g. A	11.	e.g. A	21.		31.	
2.	e.g. B	12.	e.g. B	22.		32.	
3.	e.g. C	13.	e.g. C	23.		33.	
4.	e.g. A	14.	e.g. A	24.		34.	
5.	e.g. B	15.	e.g. B	25.		35.	
6.	e.g. C	16.	e.g. C	26.		36.	
7.	e.g. A	17.	e.g. A	27.		37.	
8.	e.g. B	18.	e.g. B	28.		38.	
9.	e.g. C	19.	e.g. C	29.		39.	
10.	e.g. A	20.	e.g. A	30.		40.	

Type of assessment	Score
e.g. Final test	e.g. 10/20 = 50%

Comments
E.g. due to low score, candidate was offered extra support to ensure understanding of the content.

Candidate's name:	
Signature:	
Date:	

Instructor's name:	
Signature:	
Date:	

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Figure 8 - Example evidence of assestment

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Annex 5: Evidence of tasks (for practical excercises)

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EVIDENCE OF TASKS

Competence Unit:	Start day:	Training venue:
e.g. CU01	e.g. 14/FEB/2020	e.g. TWI, Cambridge UK

Date:	Description of task completed during training
e.g. 14/FEB/2020	e.g. calibrate equipment

Candidate's name:	
Signature:	
Date:	

Instructor's name:	
Signature:	
Date:	

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Figure 9 - Example evidence of tasks

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Annex 6: Photographic evidence of training

Figure 10 - Example photo-evidence of training

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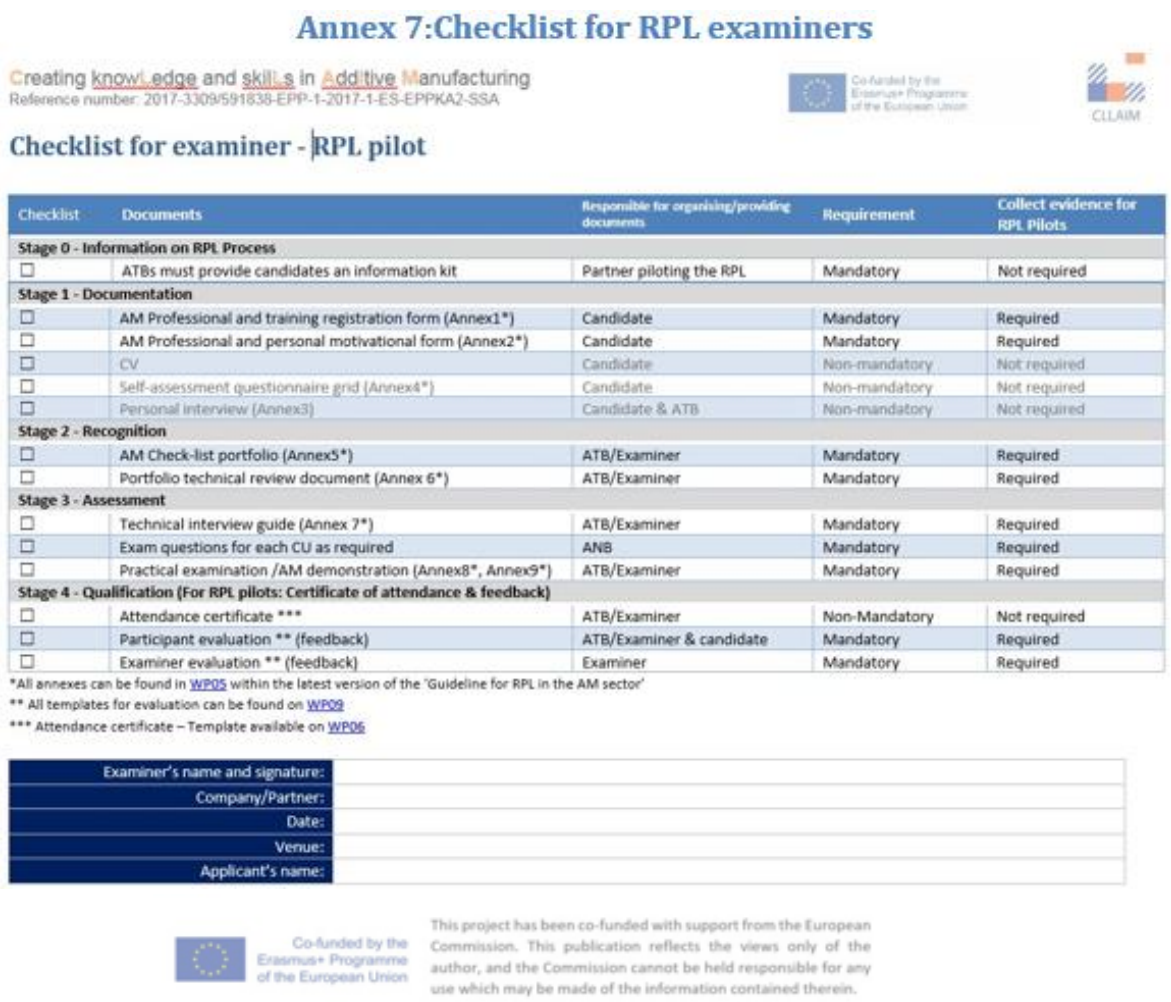

Annex 7:Checklist for RPL examiners

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CLLAIM

Checklist for examiner - RPL pilot

Checklist	Documents	Responsible for organising/providing documents	Requirement	Collect evidence for RPL Pilots
Stage 0 - Information on RPL Process				
☐	ATBs must provide candidates an information kit	Partner piloting the RPL	Mandatory	Not required
Stage 1 - Documentation				
☐	AM Professional and training registration form (Annex1*)	Candidate	Mandatory	Required
☐	AM Professional and personal motivational form (Annex2*)	Candidate	Mandatory	Required
☐	CV	Candidate	Non-mandatory	Not required
☐	Self-assessment questionnaire grid (Annex4*)	Candidate	Non-mandatory	Not required
☐	Personal interview (Annex3)	Candidate & ATB	Non-mandatory	Not required
Stage 2 - Recognition				
☐	AM Check-list portfolio (Annex5*)	ATB/Examiner	Mandatory	Required
☐	Portfolio technical review document (Annex 6*)	ATB/Examiner	Mandatory	Required
Stage 3 - Assessment				
☐	Technical interview guide (Annex 7*)	ATB/Examiner	Mandatory	Required
☐	Exam questions for each CU as required	ANB	Mandatory	Required
☐	Practical examination /AM demonstration (Annex8*, Annex9*)	ATB/Examiner	Mandatory	Required
Stage 4 - Qualification (For RPL pilots: Certificate of attendance & feedback)				
☐	Attendance certificate ***	ATB/Examiner	Non-Mandatory	Not required
☐	Participant evaluation ** (feedback)	ATB/Examiner & candidate	Mandatory	Required
☐	Examiner evaluation ** (feedback)	Examiner	Mandatory	Required

*All annexes can be found in WP05 within the latest version of the 'Guideline for RPL in the AM sector'
** All templates for evaluation can be found on WP09
*** Attendance certificate – Template available on WP06

Examiner's name and signature:	
Company/Partner:	
Date:	
Venue:	
Applicant's name:	

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Figure 11 – Checklist for examiner – RPL pilots