

FRAUNHOFER-GESELLSCHAFT

# **CERTIFICATION HANDBOOK AND EXAMINATION REGULATION**

Personnel Certification  
Lightweight Materials

## Revision 2

Valid from September 2020

Fraunhofer Personnel Certification Authority  
Schloss Birlinghoven  
53757 Sankt Augustin  
Germany

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# 1

## Foreword

The certification services of the Fraunhofer Personnel Certification Authority in the field of »Lightweight Materials« are available for all interested persons. The Fraunhofer Certification Authority guarantees the impartial treatment of all applicants.

Following the guidelines set out in the EN ISO 17024 standard »General Criteria for Personnel Certification Bodies«, this document outlines the personnel certification process in the »Lightweight Materials« field, thus defining a uniform certification system.

At the same time this certification handbook serves as examination regulations for the certification examinations for all certification profiles in the »Lightweight Materials« field.

## 2 SCOPE

This certification handbook covers personnel certification by the Fraunhofer Personnel Certification Authority in the »Lightweight Materials« field and also serves as examination regulations for all certification profiles in the »Lightweight Materials« field.

Personnel certification in the »Lightweight Materials« field is based on the certification profiles

- »Lightweight Professional Basic Level«
- »Lightweight Professional Advanced Level«
- »Lightweight Professional Expert Level«

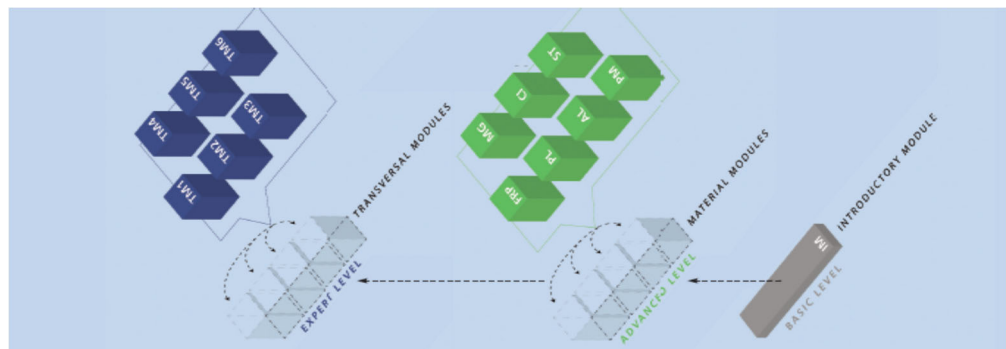


Figure 1: Relationships between certification profiles and corresponding learning content in the field of »Lightweight Materials«

Figure 1 shows how the topics of the learning targets of each certification profile fit in the certification system that includes a basic, advanced and expert level.

Applicants who want to obtain the certificate

- »Lightweight Professionals Basic Level« have to prove all the competences (learning targets) mentioned in annex A.
- »Lightweight Professionals Advanced Level« have to prove the competences (learning targets) of at least four out of six topic areas described in annex B.
- »Lightweight Professionals Expert Level« have to prove the competences (learning targets) of at least four out of six topic areas described in annex C (to be developed).

The specifications of the certification profiles, as detailed in the annexes, are constituent parts of the respective personnel certification. As of September 2020, certifications are carried out only for the basic level and the advanced level profile.

**Fraunhofer Personnel Certification Authority**

Body in the Fraunhofer-Gesellschaft that certifies that an applicant's actual knowledge and skills (qualification) satisfy normative requirements.

**Board of examiners**

Body of examiners who administer and grade the examination on which a certification is based

**Examiner**

Experts who test applicants on behalf of the Fraunhofer Personnel Certification Authority. They perform this function guided only by their professional expertise. They are familiar with the full scope of subjects taught and tested.

**Secretaries**

Persons who, on behalf of the Fraunhofer Personnel Certification Authority, take minutes at examinations in accordance with the regulations of this certification handbook. They are subordinate to the examiners.

**Expert Committee (EC)**

Committee of experts that is appointed by the Fraunhofer Personnel Certification Authority. The tasks of the committee are the following: verification and validation of examination content, creation of examination questions, responsible authority for professional requests and consulting for the Fraunhofer Personnel Certification Authority in terms of the professional quality of the examiners. Full particulars in terms of the tasks and competences can be found in the »internal rules of procedure of the expert committee«. An expert committee will be formed for each certification profile.

**Certification program**

Certification Program denotes the total of certification profiles in a given field. The present certification handbook describes the certification programs in the »Lightweight Materials« field. Certification programs consist of several certification profiles. They are detailed in annexes.

**Certification profile**

Certification Profile denotes a specific level of qualification that can be certified in the »Lightweight Materials« certification program. The certification profiles of the »Lightweight Materials« certification program are: »Lightweight Professional Basic Level«, »Lightweight Professional Advanced Level«, »Lightweight Professional Expert Level«.

**Term »know«**

Corresponds to the first and second level of Bloom's six-level taxonomy of educational objectives (Bloom, B.S.: Taxonomy of Educational Objectives, 1974). It is characterized by repetition from memory triggered by keywords. Relevant skills are to know, to recognize and to emulate.

In examinations in the »Lightweight Materials« field, the objective »to know« refers to different subjects in the different certification profiles. These different subjects are listed in the annexes to this document

**Term »apply«**

Is a synonym for the Reorganization level of educational goals. Corresponds to the third and fourth level of Bloom's taxonomy of educational objectives. It is characterized by the individual processing and reorganizing of a subject. Relevant cognitive skills are to understand, to react and to practice.

In examinations in the »Lightweight Materials« field, the objective »to apply« refers to different subjects in the different certification profiles. These different subjects are listed in the annexes to this document.

**Term »evaluate«**

Is a synonym for the Transfer and Problem Solving level of educational goals. Corresponds to the fifth and sixth level of Bloom's taxonomy of educational objectives. It is characterized by the transfer of basic principles to new, similar tasks or activities unfamiliar to the learner. Relevant cognitive skills are to apply, to judge, to coordinate or solve problems, to automate.

In examinations in the »Lightweight Materials« field, the objective »to evaluate« refers to different subjects in the different certification profiles. These different subjects are listed in the annexes to this document.



## 4 ORGANIZATION OF THE CERTIFICATION PROCESS

This section describes in detail the organization of the certification process.

### 4.1 Goal

Certifications examine if criteria of the actual qualifications of an applicant satisfy well-defined profiles of required qualifications, and document the results in a certificate of competence.

### 4.2 Language

The official languages to communicate with the Fraunhofer Personnel Certification Authority are German or English. All official documents within the certification process are English (application form, certificates, etc.).

The examinations are held in the following languages (depending on the date and place of the examination): English. All documents needed during the examinations will be provided in the corresponding language.

### 4.3 Application

Certificates will be granted to applicants who pass an examination on the subject of »Lightweight Materials«, organized by the Fraunhofer Personnel Certification Authority, and who satisfy the admission requirements defined in the annexes to this certification handbook.

Applicants who want to take a (re-) certification must apply in writing to the Fraunhofer Personnel Certification Authority.

The application must provide the following information about the applicant

- Name, date of birth, private address.
- Relevant certification profile
- Indication whether the applicant seeks a first-time certification, re-certification or re-examination.

Eligible for certification are all persons that have successfully passed an examination of the Fraunhofer Personnel Certification Authority in the field of »Lightweight Materials« and that meet the defined admission requirements according to the annexes of this certification handbook.

### 4.4 Admission to the examination

Applicants that have submitted a complete application and proof of fulfilling all admission requirements are admitted to the examination. The specific admission requirements for each certification profile are detailed in the respective annexes to this document.

Qualifications deemed equivalent to these admission requirements may be accepted by the Fraunhofer Personnel Certification Authority if the applicant submits sufficient proof.

## 4.5 Date and location of the examination

Examination dates are set by the Fraunhofer Personnel Certification Authority. As a rule, examinations will be administered immediately following a course covering the respective certification profile, held by an organization approved by the Fraunhofer Personnel Certification Authority.

Examinations will either be held in locations admitted by the Fraunhofer Personnel Certification Authority - normally in the facilities of a course provider approved by the Fraunhofer Personnel Certification Authority - or online.

## 4.6 Examination procedure

This chapter describes the organization of the examination.

### 4.6.1 Provision of the documents for the examination and assignment of examiners

The Fraunhofer Personnel Certification Authority provides the examiners with the questions and task descriptions for the certification examination, selected from a set of questions and task descriptions for the certification profile validated by the responsible expert committee.

The Fraunhofer Personnel Certification Authority will provide the exam questions in time for the board of examiners to administer the examination at the date set. Questions and task descriptions will be communicated safe from unauthorized access.

The head of the Fraunhofer Personnel Certification Authority commissions the board of examiners to administer the examination.

### 4.6.2 Board of examiners

The members of the board of examiners are mandated by the Fraunhofer Personnel Certification Authority to administer the examinations. The chairperson and members of the board of examiners must not have acted as instructors/teachers of the examinee.

In written examinations (Basic Level, Advanced Level and Expert Level), the board of examiners consists of

- One examiner who satisfies the requirements described in the document »Competence Profile Examiner Written Examinations Lightweight Materials« and is responsible for administering and grading the written examination. (Only in case of examinations which take place in presence)
- One examiner who satisfies the requirements described in the document »Competence Profile Examiner Written Examinations Lightweight Materials« who evaluates the results.

In oral examinations (Expert Level) the board of examiners consists of

- A chairperson or deputy chairperson who both satisfy the requirements described in the document »Competence Profile Examiner Oral Final Examination Lightweight Materials« (responsible for administering and grading the oral examination)

- An examiner who satisfies the requirements described in the document »Competence Profile Examiner Oral Final Examination Lightweight Materials« (responsible for administration and grading of the oral examination)
- Besides the board of examiners, the Fraunhofer Personnel Certification Authority appoints a secretary (see competence profile »Secretary«) who keeps records of the examination. The secretary is not a member of the board of examiners and thus has no say concerning the examination and its results.

Concerning all certification profiles, the board of examiners is tasked with:

- Administering and grading the written, oral and practical examinations,
- Evaluating the examination results,
- Keeping records of the examination and its results.

#### 4.6.3 Administration of the written examinations

Written examinations are executed in all certification profiles within the scope of »Lightweight Professional«.

Applicants who want to obtain the certificate

- »Lightweight Professional Basic Level« will have *one* written examination covering all competences (learning targets) mentioned in annex A.
- »Lightweight Professional Advanced Level« will have *four* written examinations; one examination in each of the four topic areas which have to be chosen in order to obtain the certification (four electives). The examinations cover the competences (learning targets) of the electives described in annex B in each case (to be developed).
- »Lightweight Professionals Expert Level« will have *four* written examinations; one examination in each of the four topic areas which have to be chosen in order to obtain the certification (four electives). The examinations cover the competences (learning targets) of the electives described in annex B in each case (to be developed).

Written examinations will be held in locations approved by the Fraunhofer Personnel Certification Authority or online.

The written examinations (one for each elective) test (by multiple-choice questionnaire) the candidate's knowledge of the respective elective of the »Lightweight Materials« profile. The examination questions are chosen from a pool of questions that cover all the topics that must be tested in the elective. The examination questions are defined by the expert committee and made available to the examiners by the Fraunhofer Personnel Certification Authority.

In case of a presence examination the questions have to be answered by hand. In case of online examinations, the questions have to be answered via the computer. It will be ensured that there is enough time available to answer the examination questions. For this, the expert committee will evaluate how much time is required to answer the questions when preparing the examination.

The written examinations will last 2 hours.

Aids are not admitted.

For candidates who, due to a handicap, cannot take the examination in its normal form, individual exceptions may be agreed. Permission to use for example alternative

means to answer examination questions shall be decided on a case-by-case basis by the Fraunhofer Personnel Certification Authority.

#### **4.6.4 Administration of the oral examination (final examination)**

Oral examinations are administered within the certification profile »Lightweight Professional Expert Level«.

To be admitted to the oral examination, the applicant has to submit the examination results of all electives.

The oral examinations will cover all the competences (learning goals) of the electives of the respective certification profile (Advanced Level or Expert Level).

Oral examinations (final examinations) are administered for groups of candidates (two candidates). In the case of an odd number of candidates for an examination, a candidate may choose to be examined individually or in a group of three candidates. A group size greater than three candidates is not allowed.

The oral examination will last no less than 30 minutes and no more than 35 minutes for each candidate.

At the start of the examination the questions are chosen at random by the candidates from a pool of questions for the oral examination. This pool of examination questions contains questions covering all chosen subjects of the respective levels. The questions are defined by the Expert Committee »Lightweight Materials« or its working groups, and provided to the examiners by the Fraunhofer Personnel Certification Authority.

The questions and the candidate's answers are documented in abbreviated form in the minutes of the examination by the secretary, and verified by the signature of the chairperson of the board of examiners.

Aids are not admitted.

For candidates who, due to a handicap, cannot take the examination in its normal form, individual exceptions may be agreed.

### **4.7 Examination questions and tasks**

The catalogue of examination questions is different for each certification profile. The same number of questions shall be asked for different subject areas and electives.

The questions are clearly assigned to the different certification profiles and subject areas. Questions may only be asked to participants with the corresponding qualification profile.

## 4.8 Grading and evaluation of the examination

The participants have to achieve a minimum degree of performance of 67 % in each of the examination (written exams and/or oral exams). If this is not the case, no certificate will be issued.

### **Written examinations:**

The examiners will be provided with the right answers of the questions. The answers are defined by the expert committee.

### **Oral examinations:**

For each question and task the examiners will be provided with sample solutions which will be used as guideline for the evaluation of the question at hand. Additionally, the expert committee fixes the achievable scores for each question or task.

The examination results are decided by the board of examiners and communicated to the Fraunhofer Personnel Certification Authority.

### **Report card**

The examination results are documented in a report card issued to the candidates by the Fraunhofer Personnel Certification Authority. The report card is issued only in combination with a certificate.

## 4.9 Re-examination

Failed examinations may be repeated twice. Re-examination covers only the parts graded 'fail'.

The first re-examination must be taken within 18 months after the failed (part of an) examination. The second re-examination must be taken within 6 months after the first re-examination. If the candidate fails to take the re-examination within these periods, a new certification process must be applied for.

If a candidate fails three times, a new certification process must be applied for.

## 4.10 Certification

After having passed all necessary examinations for the respective certification profile and submitted proof of fulfilling the admission requirements, the applicant will be awarded the certification for her/his certification profile by the Fraunhofer Personnel Certification Authority.

Applicants may submit proof of professional experience or graduation within one year after passing the certification examination. The certificate will be awarded as soon as all certification requirements are fulfilled. The certificate must be awarded not later than one year after the candidate passed the last part of the examination.

The validity of the certificate starts on the date of the decision by the head of the Fraunhofer Personnel Certification Authority to award the certificate and ends three years minus one day after the last examination.

To extend the validity of a certificate, a re-certification is required. The conditions for re-certification are detailed in the Re-certification section.

The form of proof is part of the quality management system of the Fraunhofer Personnel Certification Authority.

## 4.11 Monitoring

Certifications in the »Lightweight Materials« field are not monitored during the validity of the certificate.

## 4.12 Re-certification

The certificates of all certification profiles need to be renewed before they expire three years minus one day after the last part of the certification examination – re-certification.

The goal of re-certification is:

Proof that the certified person has kept up-to-date her/his professional knowledge and skills.

Re-certification therefore requires proof of relevant work experience during the last three years before re-certification and proof of participation in professional further education.

Within 2 years and 2.5 years after the last examination (one year to six months before the certificate expires), the certified person must file an application for re-certification with the Fraunhofer Personnel Certification Authority. Furthermore, the formal proof of work experience and professional further education must be filed within this period.

In exceptional cases (e.g. illness of the certificate holder) additional time may be granted for re-certification. The decision to grant an extension rests with the head of the Fraunhofer Personnel Certification Authority.

Proof of work experience can, for example, be a formal letter from an employer.

Proof of participation in further professional training can be done by a certificate of attendance filled in by the provider of the professional education. Events of professional further education are eligible if the provider is approved by the Fraunhofer Personal Certification Authority, the event has a duration of at least one day and it consists of at least three modules that are relevant for lightweight material subjects.

If the requirements for re-certification are satisfied, the validity of the certificate is extended by three years minus one day.

If the requirements for re-certification are not satisfied, the validity of the certificate expires. The (former) certified person needs to go through a new certification process (see initial certification).

## 5 RIGHTS AND OBLIGATIONS

(As of October 2018)

The issuance of the Certificate is associated with rights and obligations, which we would like to point out in advance. If you do not agree with the application of the following regulations, participation is not advisable. You will later be handed a copy of these regulations along with the Certificate.

### 5.1 Disclosure

It is possible to obtain information concerning the entitlement of a person that has passed the certification successfully, if the number of the certificate is given (e.g. from potential employer of the mentioned person). To identify the mentioned person, it is necessary to ask for the name, birthday and place of birth. We will compare this information with the Personal Data stored concerning this person (name, birthday, place of birth). Afterwards we confirm the lawfulness positively or negatively, without passing any Personal Data.

The comparison is based on Art. 6 I 1 f GDPR. It is used to prevent the misuse of our certificates, so it is necessary to protect our legitimate interest according to the aforementioned provision.

### 5.2 Rights

Within the scope of his/her occupation in the field of „Lightweight Materials«, the Certificate Holder is entitled to

- refer to his/her certification and the certifying authority on letterheads, on the internet and other printed documents in the following way: certified „NAME OF THE CERTIFICATE“, approved by the Fraunhofer Personnel Certification Authority” or certified „NAME OF THE CERTIFICATE“ (e.g. certified Lightweight Professional Basic Level). By using Alternative 1, he/she shall check that the designation of „approved by the Fraunhofer Personnel Certification Authority“ does not appear bigger than the name of the certified person.
- use the certificate as a whole referring to the certification
- view the document „Certification Handbook and Rules of Procedure – Personal Certification Lightweight Materials“, which explains the certification system of the Fraunhofer Personnel Certification Authority at Fraunhofer FIT.

Further details: see Section 5.3

### 5.3 Obligations

The certificate holder shall comply with following principles:

#### 5.3.1 Diligence

The Certificate Holder shall exercise his/her occupation in accordance with the »State of the Art« in the field of »Lightweight Materials«. The quality of a product is the foremost principle of all action.

### **5.3.2 Independence**

The Certificate Holder shall act without regard to official relations within the company and/or its employees or their desired results (personal independence).

### **5.3.3 Personal performance**

The Certificate Holder shall perform all required services with regard to preparation, execution and evaluation of usability projects in person. He/she shall not use the deed of the certification falsely or in any misleading way.

### **5.3.4 Permitted use of certificates**

The following regulations shall also apply for the use of certificates:

- The certificate shall be granted to the certificate holder. The actual certificate/document shall remain the property of the Fraunhofer Personnel Certification Authority.
- Only valid certificates shall be used.
- The certificate shall not be used inappropriately.
- The certificate shall be returned to the certification board
  - after expiration of the certificate,
  - after the Certification holder has been informed by the Fraunhofer Personnel Certification Authority about withdrawal
- In case of suspension, withdrawal or lapse of the certification the Certification holder shall immediately cease the use of the certificate. References of the Certification holder to the certification and/or the Fraunhofer Personnel Certification Authority shall be removed immediately. In this event letterhead or other printed material shall be destroyed immediately or in case of suspension shall not be used during suspension.
- The use of the certificate and references to it are only permitted if the observer explicitly recognizes who has been examined and certified.
- By using the certification or making references to it he/she shall not give the impression that the certified person is an employee of Fraunhofer-Gesellschaft or that he/she acts on behalf of Fraunhofer-Gesellschaft.
- The Certificate holder is responsible for the correct use of the Certificate. Possible doubts shall be the responsibility of the Certificate holder.

### **5.3.5 The use of Fraunhofer logo**

The certificate of the Fraunhofer Personnel Certification Authority contains the Fraunhofer-Logo. The Logo shall exclusively be used as a part of the certificate in that way that the certificate as a whole may be copied or made available in the internet as proof of the issuing certification board for e.g. clients or employers. Any further use beyond this of the Fraunhofer-Logo or the use of the name Fraunhofer as trade mark is expressly prohibited.

In case of violation Fraunhofer-Gesellschaft is entitled to apply for injunctive relief or damage claims.

### **5.3.6 Duty to give notice**

The certificate holder shall notify the Fraunhofer Personnel Certification Authority without delay of:



- any changes of name (e.g. in case of marriage),
- any change of place of residence,
- the loss of the certificate.

### **5.3.7 Duty to disclose**

Upon request of the Fraunhofer Personnel Certification Authority at Fraunhofer FIT, the Certificate Holder shall disclose and furnish all necessary particulars and documents regarding the monitoring of activities and compliance with the aforementioned duties within a set deadline and without compensation.

He/she may refuse to provide self-incriminating information or such information that may incriminate his/her relatives.

### **5.3.8 Violation to duties as certificate holder**

Depending on the gravity of the violation of a duty stated in this document may be suspended or revoked. The former Certificate Holder is then no longer entitled to refer to his/her certification.

## **Annex A: »CERTIFIED LIGHTWEIGHT PROFESSIONAL BASIC LEVEL«**

### **A 1 Reference to other norms and documents**

EN ISO 17024

### **A 2 Profile of qualification**

#### **A 2.1 Determination**

The qualification profile of a »Certified Lightweight Professional Basic Level« results from the characteristics and description of his or her field of work.

The responsibility of a »Certified Lightweight Professional Basic Level« is to identify and differentiate the steps involved in developing lightweight products, and to use (design, construct and set up processes with) specific lightweight materials in the correct way to fully utilize the lightweight potential

A »Certified Lightweight Professional Basic Level«:

identifies and differentiates the different steps in the process to develop a product in order to critically assess the advantages and disadvantages of lightweight design for specific cases and different materials.

identifies company key figures and components to develop products using a lightweight approach (designers, buyers and quality personnel).

#### **A 2.2 Admission requirements**

##### **A 2.2.1 Previous education**

All applicants must have sufficient competence in the language of the examination in order to be able to understand and answer the questions.

A certified »Lightweight Professional Basic Level« must prove:

Participation in a professional training of at least 40 hours of face to face trainings or at least 20 hours of online training which are approved by the Fraunhofer Personnel Certification Authority and includes all learning targets mentioned below (see chapter »Required competences (learning targets) «).

##### **Note:**

In special cases the applicant has the possibility to prove missing admission requirements within one year after taking the examination.

After examination of the submitted documents, the Fraunhofer Personnel Certification Authority will decide on the requirements. If entry requirements are not fulfilled, the Fraunhofer Personnel Certification Authority will directly communicate the decision to the applicant.

In principle, the Fraunhofer Personnel Certification Authority may in well-founded and justifiable exceptions accept varying evidence. These evidence, documents and decisions of the Fraunhofer Personnel Certification Authority have to be documented.

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Annex A: »CERTIFIED  
LIGHTWEIGHT PROFESSIONAL  
BASIC LEVEL«

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### **A 2.2.2 Additional education, entitlement and practical experience**

A »Certified Lightweight Professional Basic Level« does not have to prove any additional education, entitlement or practical experiences.

### **A 2.2.3 Personal requirements**

None.

### A 2.3 Required competences (learning goals)

A »Certified Lightweight Professional Basic Level« has to be able to prove the following competences:

Topic	Requested competences (learning targets)  The Lightweight Professional Basic Level has to be able to.....			
		know	apply	evaluate
<b>Introduction into lightweight design</b>				
Lightweight design in the contradictory context between ecological, economical and cost related requirements	Explain why development of lightweight products usually requires compromise regarding mass, function, and cost.		x	
<b>Introduction to the Lifecycle Assessment (LCA) method and standards</b>				
Background of life cycle assessment considering Lightweight Design	Describe what a lifecycle of a product is.	x		
	Explain why the identification of the main environmental hot-spots is key to decrease overall environmental impacts.	x		
Introduction to the LCA method and standards	Explain what environmental impact assessment is and which environmental impacts can be addressed.	x		
	Name the phases of a LCA.	x		
<b>The Lifecycle Assessment (LCA) framework</b>				
Lifecycle Assessment Framework	Explain the four phases in which a life cycle assessment is developed.		x	
	Describe the benefits and boundaries of LCA.		x	
	Explain what a sensitivity analysis is.		x	
<b>Life Cycle Costing (LCC)</b>				
Life cycle assessment of lightweight materials and products	Explain which cost categories have to be considered in LCC.	x		
	Describe why the identification of the main cost drivers is key to decrease overall costs.	x		

Topic	Requested competences (learning targets)  The Lightweight Professional Basic Level has to be able to.....			
		know	apply	evaluate
<b>Lightweight Design Strategies</b>				
lightweight design by -using materials of low density - optimizing component shapes - optimizing the overall design concept - careful definition of requirements	Explain the main strategies for lightweight design.		x	
	Name typical architectures found in lightweight structures.	x		
Multifunctional design	Explain the goal(s) of multifunctional design.		x	
Interactions between material, manufacturing, and design.	Name examples for typical interactions between design, material, manufacturing processes, and cost.	x		
<b>General view on development processes in the context of lightweight design</b>				
Aspects related to lightweight design which need to be considered during product development	Explain the basic idea behind structuring the development process.		x	
	Name the basic phases of the product development process.	x		
	Name the most important results for each phase of the product development process.	x		
<b>Product development process (PDP) according to VDI Guideline 2221</b>				
Schematic overview of PDP according to VDI 2221	Explain the different phases of the product development process and their respective results.		x	
Process phases	Explain the different phases of the product development process and their respective results.		x	

Topic	Requested competences (learning targets)  The Lightweight Professional Basic Level has to be able to.....			
		know	apply	evaluate
<b>Introduction to materials for lightweight design</b>				
Most important metallic materials for lightweight design	Name the important classes of metallic materials for Lightweight Design.	x		
	Explain the most important properties for the following materials: steel, aluminum, magnesium, powder materials and Cast iron (as compared to the other materials; i.e. „material class A tends to be relatively brittle compared to other materials“ etc.) (level: „use“).		x	
Most important non-metallic materials for lightweight design	Name the important classes of non-metallic materials for Lightweight Design.	x		
	Explain the most important properties for the following materials: Polymers, fiber reinforced plastics (as compared to the other materials; i.e. „material class A tends to be relatively brittle compared to other materials“ etc.).		x	
<b>Introduction to manufacturing and assembly processes typically used for lightweight components</b>				
Specific to class of materials (metallic and non metallic)	Name important part manufacturing processes for each type of materials.	x		
	Name assembly procedures typically used in lightweight structures.	x		
	Explain at least one important part manufacturing process for each type of materials.		x	
	Explain at least three assembly procedures typically used in lightweight structures.		x	
<b>Qualification of workforce typically necessary for lightweight components</b>				
By category of part/material/pro cess:	Name typical safety issues with respect to production of lightweight structures.	x		

Topic	Requested competences (learning targets)			
	The Lightweight Professional Basic Level has to be able to.....	know	apply	evaluate
-Special skills (craftsmanship, simulation, electronics, chemistry, ...) -Health and safety -Regulatory requirements on formal qualification	Name typical workforce qualification issues with respect to development/production of lightweight structures.	x		
<b>Supply chain: Factors affecting material selection</b>				
Factors affecting material selection	Name typical factors affecting material selection (e. g. technical (e.g. lightweight- indices), logistics (availability), regulatory (e.g. certification), economical (price of material; investment associated with suitable manufacturing processes), socio-economical (e.g. health & safety. environmental), marketing, Sources of information, suggested order of consideration for above mentioned factors affecting material selection).	x		
	Name typical issues to consider with respect to the supply chain for the production of lightweight structures (e. g. technical (e.g. lightweight-indices), logistics (availability), regulatory (e.g. certification), economical (price of material; investment associated with suitable manufacturing processes), socio-economical (e.g. health & safety. environmental), marketing, Sources of information, suggested order of consideration for above mentioned factors affecting material selection.	x		

## ANNEK B: »CERTIFIED LIGHTWEIGHT PROFESSIONAL ADVANCED LEVEL«

### B 1 Reference to other norms and documents

EN ISO 17024

### B 2 Profile of qualification

#### B 2.1 Determination

The qualification profile of a »Certified Lightweight Professional Advanced Level« results from the characteristics and description of his or her field of work.

The responsibility of a »Certified Lightweight Professional Advanced Level« is to identify and differentiate the steps involved in developing lightweight products, and to use (design, construct and set up processes with) specific lightweight materials in the correct way to fully utilize the lightweight potential

A »Certified Lightweight Professional Advanced Level«:

- has successfully completed the Basic Level Certification which provides an overview of key aspects of Lightweight design and strategies.
- has specialized competences in at least four of the following topics: Fiber-reinforced Plastics (FRP), Powder Metallurgy (PM), Additive Manufacturing (AM), Steel (ST), Magnesium (MG), Advanced Cast Irons (CI), Polymers (PL) and Aluminium Light Alloys (AL).

#### B 2.2 Admission requirements

##### B 2.2.1 Previous education

All applicants must have sufficient competence in the language of the examination in order to be able to understand and answer the questions.

A certified »Lightweight Professional Advanced Level« must prove:

Participation at least in four Professional trainings of at least 40 hours of face to face trainings or at least 20 hours of online training which contain the topics Fiber-reinforced Plastics (FRP), Powder Metallurgy (PM), Additive Manufacturing (AM), Steel (ST), Magnesium (MG), Advanced Cast Irons (CI), Polymers (PL) and Aluminium Light Alloys (AL) as well as a successful examination which is approved by the Fraunhofer Personnel Certification Authority and includes all learning targets mentioned below (see chapter »Required competences (learning targets) «).

#### **Note:**

In special cases the applicant has the possibility to prove missing admission requirements within one year after taking the examination.



After examination of the submitted documents, the Fraunhofer Personnel Certification Authority will decide on the requirements. If entry requirements are not fulfilled, the Fraunhofer Personnel Certification Authority will directly communicate the decision to the applicant.

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In principle, the Fraunhofer Personnel Certification Authority may in well-founded and justifiable exceptions accept varying evidence. These evidence, documents and decisions of the Fraunhofer Personnel Certification Authority have to be documented.

### **B 2.2.2 Additional education, entitlement and practical experience**

A »Certified Lightweight Professional Advanced Level« does not have to prove any additional education, entitlement or practical experiences.

### **B 2.2.3 Personal requirements**

None.

## B 2.3 Required competences (learning goals)

A »Certified Lightweight Professional Advanced Level« has to be able to prove competences in at least four of the following fields:

1. **Fiber Reinforced Plastics (FRP)**
2. **Powder Metallurgy (PM)**
3. **Polymers (PL)**
4. **Steel (ST)**
5. **Magnesium (MG)**
6. **Cast Irons (CI)**
7. **Aluminium Light Alloys (AL)**

### B 2.3.1 Fiber Reinforced Plastics

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Introduction</b>				
Definition of composite and definition of FRP  Known/typical examples and applications  General advantages and disadvantages	Name the limitations and benefits of fiber reinforced plastics  Explain the functions of the fibers and matrix in a fiber reinforced plastic	x		
<b>Constituent materials</b>				
FRP components and their functions  Fibres  Plastic matrix  Compatibility between fibres and matrix	Name and describe the components of a fiber reinforced plastic and their influence on the material's key properties.	x		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Manufacturing Methods</b>				
	Name and differentiate manufacturing methods such as....		x	
	Name the parameters and criterion for the manufacturing process selection.	x		
<b>Health and Safety</b>				
Health and Safety in the manipulation of Raw Materials	Define what a hazardous substance is.	x		
	Recognize hazard symbols and explain their meaning.	x		
	Explain R-statements and S-statements.		x	
	Explain H-statements and P-statements.		x	
	Name sources of information about health & safety at work.	x		
	Name and use personal protection equipment.	x		
	Explain how matrix materials and hazardous substances must be disposed.		x	
<b>Environment, Recycling, LCA</b>				
See IM-revision/follow-up	Name points to be heeded in recycling FRP.	x		
	Name the different parameters and steps to take into account in a LCA.	x		
<b>Designing with composites</b>				
Construction methods with FRP	Name possible parameters influencing on FRP properties.	x		
	Name the requirements on reinforcement materials and describe these.	x		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
Predicting mechanical behavior	Name FRP construction methods in lightweight design.	x		
	Name base design rules of laminate structures.	x		
	Name the limitations and benefits of working with the classic laminate theory.	x		
	Name and describe the different mechanisms of intralaminar and interlaminar failure of FRPs.	x		
	Name simulation methods, advantages and limitations.	x		
<b>Post-Processing</b>				
Machining  Joining techniques	Name different machining processes and their advantages and limitations.	x		
	Explain what points must be heeded in machining and processing FRP.		x	
	Name different joining techniques and evaluate them according to the construction method, material, reinforcement etc.	x		
<b>Repairing</b>				
Damage mechanisms / patterns / causes	Name and describe the different mechanisms of intralaminar and interlaminar failure of FRPs.	x		
Repairing methods	Name and describe the different FRP repairing methods.	x		
Non-destructive testing techniques for damage detection	Name and describe the different FRP NDT techniques for damage detection.	x		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Quality Control and Evaluation</b>				
Destructive and non-destructive tests	Explain the sense and necessity of the identification and determination of specific values		x	
	Name and differentiate methods to characterize materials	x		
	Name and differentiate destructive and non-destructive methods of testing	x		
<b>Environmental Influences and Ageing</b>				
Moisture, UV, Lightning, Temperature, From processing (residual stresses), In- service, Others	Describe and explain the specific influence of impact damage and ageing procedures on material properties of FRP		x	

### B 2.3.2 Powder Metallurgy

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Introduction to Powder Metals</b>				
Overview of course; basics of metal powders	Describe how powders may be characterized, what properties are relevant for different manufacturing techniques and the techniques that can be used to measure such characteristics.	x		
	Critically assess the suitability of a powder for a process or vice-versa.	x		
<b>Powder Production</b>				
Overview of powder production methods	Describe the main routes by which metal powders can be converted in to solid, dense components.	x		
Most relevant production methods for current industry	Relate manufacturing techniques to the types of powder that are optimal for each process.	x		
	Describe the main techniques used to produce metal powders.	x	x	
<b>Powder Characterization</b>				
Introduction to powder characterization	Describe how powders may be characterized, what properties are relevant for different manufacturing techniques and the techniques that can be used to measure such characteristics.	x	x	
<b>Powder Handling</b>				
Power Handling	Describe how powders may be characterized, what properties are relevant for different manufacturing techniques and the techniques that can be used to measure such characteristics.		x	

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
	Describe the main routes by which metal powders can be converted in to solid, dense components.		X	
<b>Powder Health and Safety</b>				
Health and Safety	Identify sources of risk to safety and/or health caused by the use of metal powders and propose strategies for mitigating or eliminating such risks.		X	
<b>Additive Manufacturing</b>				
Introduction to Additive Manufacturing techniques	Explain how components made from metal powders and/or by additive manufacturing can be used to reduce mass, compared to cast and machined components		X	
	Describe the main routes by which metal powders can be converted in to solid, dense components.	X		
	Critically assess the suitability of a manufacturing process for a component.		X	
<b>Other Powder Manufacturing processes</b>				
Other Powder Manufacturing processes	Describe the main routes by which metal powders can be converted in to solid, dense components.	X		

### B 2.3.3 Polymers

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Introduction</b>				
First impression about the typical material properties in comparison to other materials	Know about the typical material properties of plastics in comparison to other materials.	x		
First overview about the important sub-categories of the material class and relevant manufacturing and joining methods	Know about the important sub-categories of this material class and the relevant manufacturing and joining methods for plastics.	x		
Final application examples	Name typical applications for plastics.	x		
<b>Economic issues</b>				
Being conveyed where plastics are used and why? Following attributes of plastics are considered: Strength versus stiffness, ribs necessary, and so on.	Assess which polymer is used in which application considering its properties of strength, stiffness, chemical resistance, and so on.	x		
	Know about design features of plastics parts (e.g. ribs).			
History of plastics, applications and branches where plastics are used	Name the important plastics and its historical development.	x		
	Name typical branches and applications.	x		



Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
Advantages and disadvantages of plastics considering strength, costs, density, recycling etc.	Estimate the advantages and disadvantages of typical polymers considering strength, costs, density, recycling and so on.	x		
<b>Basics of Plastics</b>				
Different types of plastics: thermoplastics, thermosets and elastomers	Name the different types of plastics thermoplastics, thermosets and elastomers.	x		
	Know about the differences between the different types.	x		
Material-specific properties, material-specific applications and material specific processing	Know from these plastic types about the material-specific properties, the material-specific applications, the material specific processing.	x		
Advantages and disadvantages of these three types of polymers	Name the advantages and disadvantages of these three types of polymers.	x		
<b>Morphology basics of plastics</b>				
Chemical structures of the represented polymers	Name the chemical structures of the represented polymers.	x		
Different processing methods of plastics (polymerization).	Distinguish different processing methods of plastics (polymerization).	x		
<b>Additivation</b>				
Additivation of plastics: Properties of these materials	Decide which additive is used to change the material properties specifically.	x		

Topic	Requested competences (learning targets)			
	The Lightweight Professional Advanced Level has to be able to.....	know	apply	evaluate
Fillers (fibers, balls, etc.), UV resistance, flame protection, color pigments, thermal and electrical conductivity, plasticizers	Name the following additives: Fillers (fibers, balls, etc.), UV resistance, flame protection, color pigments, thermal and electrical conductivity, plasticizers.	x		
<b>Rheology 1</b>				
Rheological basics viscosity, plasticity and elasticity and visco-elastically behavior of plastic melt	Know about the rheological phenomena of plastics.	x		
	Know about the rheological basic viscosity, plasticity and elasticity and that plastic melt has a visco-elastically behavior.	x		
Influence of visco-elastically behavior of plastics on their material behavior and the manufacturing of polymers (structural viscosity)	Know about visco-elastically behavior of plastics influencing their material behavior and the manufacturing of polymers (structural viscosity)	x		
<b>Rheology 2</b>				
Rheological characteristics of visco-elastically materials: rheological equation of state, flow behavior and determination of rheological material data	Name the rheological characteristics of visco-elastically materials and the rheological equation of state.	x		
	Know about flow behavior of visco-elastically materials.	x		
	Describe with which methods rheological material data can be determined.	x		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Manufacturing Techniques 1</b>				
Screw geometries and the extruders for the manufacturing processes injection molding and extrusion.	Explain the screw geometries and the extruders for the manufacturing processes injection molding and extrusion.		X	
How are screws are arranged? Functions of the compositions	Explain how the screws are arranged and what the functions of the compositions are been.		X	
<b>Manufacturing Techniques 2</b>				
Basic knowledge about injection molding process with one and two components	Distinguish the injection molding processes with one material component and with two material components.		X	
Tool technologies considering the topics: hot runner, cold runner, valve gate nozzle, flow channels, tool temperature control and Variotherm tool cooling	Discuss tool technologies considering the topics: hot runner, cold runner, valve gate nozzle, flow channels, tool temperature control and Variotherm tool cooling.		X	
<b>Manufacturing Techniques 3</b>				
Mono-extrusion, co-extrusion and profile extrusion (pipes, window frames, cable ducts, etc.)	Explain the following extrusion processes: Mono-extrusion, co-extrusion and profile extrusion (pipes, window frames, cable ducts, etc.)		X	

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
Design features of the tool and component	Describe the design features of the tool and semi-finished products.	x		
<b>Manufacturing Techniques 4</b>				
Basics of injection molding: Special processes MuCell and gas or water injection technologies	Explain the special processes MuCell and gas or water injection technologies.		x	
Design features on the tool and component	Discuss about the design features on the tool and the injection-molded component.		x	
<b>Manufacturing Techniques 5</b>				
Blow molding (film blow molding and container blow molding), calendaring (rolls, temperature, roll speed, arrangement, stretching) and shrink films (printing).	Explain the special processes blow molding (film blow molding and container blow molding), calendaring (rolls, temperature, roll speed, arrangement, stretching) and shrink films (printing).		x	
<b>Manufacturing Techniques 6</b>				
Hand laminating, casting, thermoforming, deep drawing, diving (o e.g. gloves), joining, welding, top gluing, screws, rivets	Explain the following manufacturing technologies: Hand laminating, casting, thermoforming, deep drawing, diving (o e.g. gloves), joining, welding, top gluing, screws and rivets.		x	

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Rheology 3</b>				
Calculation of flow processes	Calculate simple rheological material data.		x	
<b>Testing and Analysis of Plastics</b>				
Tensile test and specimen geometry, strain rates, creeping, relaxing, fatigue testing, conditioning (ISO 1110), notched bar impact tests, heat deflection temperature, shore hardness test, DSC, - molecular mass determination, IR spectroscopy and MVR / MVI.	Name the different methods for testing and analyzing of plastics, which are: Tensile test and specimen geometry, strain rates, creeping, relaxing, fatigue testing, conditioning (ISO 1110), notched bar impact tests, heat deflection temperature, shore hardness test, DSC, - molecular mass determination, IR spectroscopy and MVR / MVI.	x		
<b>Transferability from the basic principles to industrial application</b>				
Case study 1: Yoghurt pots  Case study 2: Chip bag	Transfer the basic principles to an industrial application. Choose the manufacturing process and the material.		x	
<b>Lightweight Design with Plastics</b>				
Discussion of plastics concerning their lightweight potential	Discuss about the lightweight potential of plastics and in which applications plastics have established already as a lightweight product.		x	
Aspects of sustainability of plastics	Discuss about aspects of sustainability for plastics.		x	

### B 2.3.4 Steel

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to			
		know	apply	evaluate
<b>Introduction: Lightweight with steel</b>				
Lightweight strategies	Name applicable lightweight strategies for steel	x		
Requirements of lightweight	Name requirements of lightweight (Known/typical examples and applications for steel)	x		
General advantages and disadvantages	Name advantages of using steels	x		
<b>Fundamentals of steel</b>				
Fundamentals of steel, metal physical structure	Name crystal structures of steels and its features	x		
Iron-carbon-diagram	Describe components of the iron-carbon -diagram		x	
<b>Fundamentals of steel technology</b>				
Classification of steel grades	Name the classification of steel and its features	x		
	Describe the development tendency of steel according its properties (strength and ductility)		x	
<b>Manufacturing methods</b>				
Production of semi-finished products	Describe the production of flat- and long semi-finished steel products	x		
	Differentiate delivery shapes of semi-finished steel products		x	
Forming manufacturing methods	Name forming manufacturing methods of steel nicht vorhanden	x		
	Describe the manufacturing method: deep drawing and hydroforming		x	
	Describe the manufacturing method: hot stamping (press hardening)		x	
	Describe the manufacturing method: stretch forming		x	

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to			
		know	apply	evaluate
	Describe the manufacturing method: impact extrusion		x	
	Describe the manufacturing method: die forging		x	
<b>LCA</b>				
	Name the different parameters and step to take into account in LCA steel	x		
<b>Health and safety</b>				
Work health and safety attitudes, mindsets and perceptions	Name the work health and safety attitudes	x		
	Name hazard groups in the steel industry	x		
Evaluation of risks and preventive measures	Name and use personal protection equipment	x		
<b>Basics of steel</b>				
Fundamentals of steel	Describe essential properties of Fe and steel		x	
	Describe components of the iron-carbon-diagram		x	
	Explain use of the iron-carbon-diagram		x	
<b>Microstructure of steel</b>				
Microstructure of steel	Name strengthening mechanism	x		
	Explain the procedure of strengthening mechanisms		x	
	Describe the effects of microstructural constituents on properties		x	
	Describe the role of alloying elements		x	
<b>Developments in the production and further processing of steel</b>				
Developments in the production and further processing of steel	Name developments trends in steel production	x		
	Describe steel production of flat products		x	

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to			
		know	apply	evaluate
<b>Design steel for flat products</b>				
Design steel for flat products	Name development targets of steel design for flat products	x		
	Explain metallurgical issues of steel design for flat products		x	
	Describe commercial grades of flat products		x	
<b>Design steel for long products</b>				
Design steel for long products	Name development targets of steel design for long products	x		
	Explain metallurgical issues of steel design for long products		x	
	Describe commercial grades of long products		x	
<b>Post Processing I: manufacturing method – hot stamping (press hardening)</b>				
manufacturing method – hot stamping (press hardening)	Describe methods of press hardening		x	
	Explain differences between various methods of press hardening		x	
	Describe methods of press hardening		x	
	Evaluate pro and contra of methods of press hardening		x	
<b>Post Processing II: manufacturing method – impact extrusion</b>				
manufacturing method – impact extrusion	Name methods of impact extrusion	x		
	Explain differences between various methods of impact extrusion		x	
	Describe methods of impact extrusion		x	
	Describe pro and contra of methods of impact extrusion		x	
<b>Joining methods</b>				
Joining methods	Name joining methods of steel from a lightweight point of view	x		



Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to			
		know	apply	evaluate
	Explain pro and contra of joining methods		x	
	Describe joining methods of steel from a lightweight point of view		x	
<b>Quality control and evaluation: Formability</b>				
Testing and evaluation of formability of steel	Name tests for investigation of formability	x		
	Explain use and interpretation of obtained parameters from tests		x	
	Describe tests for investigation of formability		x	

### B 2.3.5 Magnesium

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Introduction: Lightweight application with Magnesium</b>				
Lightweight strategies	Name applicable lightweight strategies for magnesium.	x		
Requirements of lightweight Known typical examples and applications	Name general requirements of lightweight construction.	x		
General advantages and disadvantages of magnesium	Name advantages and obstacles of using magnesium.	x		
<b>Fundamentals of Magnesium</b>				
Application in daily use, history and statistics, occurrence, extraction, notification	Name historical, present and future applications of magnesium components	x		
	Have knowledge of occurrence in nature, extraction and statistics		x	
	explain essential properties of Mg and Mg alloys		x	
General properties Crystal structure Deformation mechanisms (slip systems, twinning)	Know and describe the crystal structure and deformation mechanisms of magnesium		x	
	Name general properties of manufacturing methods of magnesium	x		
Forming behavior Texture development Forming limits	Describe the forming behavior of magnesium alloys		x	
	Explain the texture development, forming behavior and the forming limits.		x	
	Estimate the crystal structure and deformation mechanisms		x	

Topic	Requested competences (learning targets)			
	The Lightweight Professional Advanced Level has to be able to.....	know	apply	evaluate
	Describe the metal physical structure	X		
	Name general properties of manufacturing methods of magnesium	X		
Microstructure of magnesium	Explain the effect strengthening mechanism		x	
	Explain the roll of alloying elements		x	
<b>Basics of magnesium</b>				
	Name several alloying elements and their properties	x		
	Describe general properties of manufacturing methods of magnesium		x	
	Name several alloying elements and their properties	x		
	Name advantages and obstacles of magnesium use	x		
	Name several alloying elements and their properties	x		
	Explain metallurgical issues of Magnesium flat products		x	
<b>Magnesium of flat products</b>				
	Name and describe for manufacturing methods of flat products	x		
	Explain metallurgical issues of Magnesium flat products		X	
	Name development targets of Magnesium design for flat products	x		
	Name strengthening mechanisms of metals	x		
	Name and describe for manufacturing methods of long products	x		
	Name development targets of magnesium for long products	x		
	Explain metallurgical issues of magnesium long products		X	

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Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Safety requirements and burnability</b>				
	Name and describe properties of magnesium which are of particular importance for health and safety issues	x		
	Name and describe the physical boundaries for metal burnability	X		
	Name and describe safety measures to prevent and extinguish metal fires	x		
<b>Health and Safety</b>				
	Know the physical boundaries for metal burnability	X		
	Know safety measures to prevent and extinguish metal fires	x		
	Name Health and Safety requirements	x		
	Recognize hazard symbols and explain		x	
<b>Corrosion and joining</b>				
	Name methods of corrosion protection	X		
	Explain different methods for Magnesium corrosion protection	X		
	Explain the effect of protection		x	
	Name joining methods	x		
	Explain advantages and disadvantages of joining methods		x	
	Evaluate joining methods for Magnesium		x	

### B 2.3.6 Cast Irons

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Introduction</b>				
Key properties of Cast Irons for engineering applications	Identify the most relevant application fields.	x		
Cast Iron as a material for lightweight design	Describe Cast Irons lightweight attractiveness.		x	
Overview of application fields and relevant examples of applications	Describe some common applications.	x		
General advantages and disadvantages	Name the limitations and benefits of Cast Irons.	x		
<b>Constituent materials</b>				
Overview of the main families of Cast Irons; Classification of Cast Irons according to EN standards	Name and describe the most common Cast Iron families, according to EN standards.	x		
Cast Irons: review of main alloying elements	Define effects and role of most relevant alloying elements, particularly in view of lightweight design.		x	
<b>Review of foundry processes for Cast Irons</b>				
Fundamentals of foundry processes	Name and differentiate processes adopted in foundry.		x	
Key stages in sand casting	Individuate main features of sand casting process.		x	
<b>Production of Grey and Ductile Iron</b>				
Foundry process solutions for Grey Iron and Ductile Iron	Name and differentiate foundry process solutions for Grey and Ductile Irons.	x		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Production of CGI and high-Si Cast Iron</b>				
Role of alloying elements  Foundry process solutions for CGI  Foundry process solutions for high-Si Cast Iron	Name and differentiate foundry process solutions for CGI and high-Si Cast Irons.		X	
<b>Heat treatment of Cast Iron and production of Austempered Ductile Iron (ADI)</b>				
Heat treatment solutions for Cast Irons  Fundamentals of Austempering treatment	Describe the stages and the targets of Austempering treatments.	X		
<b>Comparison among different types of Cast Iron Comparison with steels</b>				
Properties review of different families of Cast Irons  Key-issues in the competition between Cast Irons and steels	Describe relevant properties of Cast Irons and steels.	X		
<b>Guidelines for Cast Irons selection</b>				
Technological and economic advantages of Cast Irons with respect to steel in view of lightweight design	Describe the approach to select Cast Irons for relevant applications.		X	
	Make a critical comparison among Cast Irons and steels.		X	
<b>Environment, recycling, LCA</b>				
Lifecycle of Cast Irons	Define the main stages in Cast Iron lifecycle.	X		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
Environmental impact of cast iron components production LCA applied to Cast Iron components	Evaluate eco-sustainability of Cast Irons.		x	
<b>Process and properties modelling for Cast Irons</b>				
Process simulation techniques applied to Cast Irons technologies	Describe the approach to be followed and the results achievable by simulating welding processes.		x	
Prediction of microstructure and properties of Cast Iron components  Defects prediction in Cast Iron products	Describe the main correlations among process parameters, microstructural evolution and mechanical behavior of Cast Irons.		x	
<b>Designing with Cast Irons (1)</b>				
Design rules and criteria for Cast iron components	Describe approaches and tools to be adopted in (lightweight) design of Cast Irons alloys components.	x		
Static design  Impact behavior: Effect of higher strain rates  Role of defects on component behavior and related design considerations  Lightweight design with Cast Irons and related examples	Summarize the design chain applied for a typical Cast Iron component, to achieve lightweightness.	x		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Fatigue design of Cast Iron components</b>				
Fatigue behavior of Cast Irons –  Estimation fatigue behavior of Cast Irons –  Notch sensitivity and effect of cast skin	Define the fatigue behavior of Cast irons.	x		
Role of microstructure and defects –  Mean stress effect –  Low cycles fatigue	Explain the microstructural challenges in fatigue of Cast Irons.		x	
<b>Innovation in post-casting treatments</b>				
Potential of welding and joining processes applied to Cast Irons	Describe challenges and feasibility of welding and joining processes applied to Cast Irons.		x	
<b>Surface treatments of Cast Irons</b>				
Review of main surface treatments: nitriding, shot peening, etc.	Name and describe the main surface treatments for Cast Irons.	x		
Final properties of surface treated Cast Irons	Describe application characteristics achievable by surface treatments of Cast Irons.	x		



Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Quality control and evaluation</b>				
Review of destructive (metallography, microstructure, tensile, fatigue) and non-destructive (X-rays inspection, Computer tomography, visual inspection, penetrants liquids) tests	Name and describe the most relevant quality investigation techniques (both destructive and non-destructive) applied to Cast Iron components.	x		
Cast Irons tested in Lab	Become familiar with the use of most common quality investigation techniques.		x	
<b>Development of Cast Iron components for lightweight: case study #1 (Ductile Iron)</b>				
Process simulation Design Validation	Describe and explain how lightweightness can be achieved by using Ductile Iron components.		x	
<b>Development of Cast Iron components for lightweight: case study #2 (ADI)</b>				
Process simulation Design Validation	Describe and explain how lightweightness can be achieved by using ADI components.		x	

### B 2.3.7 Aluminium Light Alloys

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Introduction</b>				
Key properties of Aluminium alloys for engineering applications	Name the limitations and benefits of Aluminium alloys.	x		
	Identify the most relevant application fields.	x		
	Describe Aluminium lightweight attractiveness.		x	
	Describe some common applications.	x		
<b>Basics of Aluminium and its alloys</b>				
Aluminium alloys: review of main alloying elements  Classification of alloys according to EN standards  Overview of wrought and casting alloys	Name and describe the most common Aluminium alloys, according to EN standards.	x		
	Define effects and role of most relevant alloying elements, particularly in view of lightweight design.		x	
<b>Production of Aluminium and its alloys</b>				
Production of primary Aluminium	Individuate pros and cons of primary and recycled Aluminium alloys.		x	
Production of and recycled Aluminium	Name and differentiate methods for the production of primary and recycled Aluminium alloys.			
Production of billets, rolling plates and ingots			x	

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Manufacturing Methods (1)</b>				
Plastic deformations processes  Overview of rolling processes  Overview of extrusion processes	Name and differentiate manufacturing methods based of plastic deformation of Aluminium alloys.		x	
<b>Manufacturing Methods (2)</b>				
Foundry production of Aluminium alloys components  Gravity casting processes (sand and permanent mould)  Low and High Pressure Die casting processes  Innovative foundry processes	Name and differentiate foundry processes suitable for Aluminium alloys.		x	
<b>Manufacturing Methods (3)</b>				
Heat treatment of Aluminium alloys	Describe the most relevant heat treatment processes for Aluminium alloys.	x		
Solutioning, Quenching and Age Hardening: principles and processing issues	Describe the principle of precipitation hardening.	x		
<b>Comparison among alloys and processes</b>				
Technological flexibility of Aluminium alloys	Individuate the most suitable process technologies for each family of alloys.	x		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
Comparison among technological properties achievable by Aluminium alloys manufactured by different processes	Estimate the properties achievable by alloys according to the process adopted.		X	
<b>Guidelines for Alloys and Process selection</b>				
Rules for Aluminium alloys selection	Describe the rules followed for selecting alloys and processes in view of mobility applications.	X		
Alloys and processes selection: examples in the mobility field	Describe the lightweight potential of Aluminium alloys.	X		
<b>Environment, Recycling, LCA</b>				
Lifecycle of Aluminium alloys	Define the main stages in Aluminium lifecycle.	X		
Environmental impact of primary and recycled alloys  LCA applied to Aluminium components	Describe differences in eco-sustainability of primary and recycled Aluminium alloys.	X		
<b>Process and properties modelling for Aluminium alloys</b>				
Process simulation techniques applied to	Describe the most common simulation techniques used in process modelling of Aluminium alloys.	X		

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
Aluminium technologies  Prediction of microstructure and properties of Aluminium alloys components  Defects prediction in Aluminium alloys castings	Describe the main correlations among process parameters, microstructural evolution and mechanical behavior of Aluminium alloys.		X	
<b>Designing with Aluminium alloys</b>				
Design rules and criteria for Aluminium alloys components  Role of defects on component behavior and related design considerations	Describe approaches and tools to be adopted in (lightweight) design of Aluminium alloys components.	X		
Lightweight design with Aluminium and its alloys Examples of design with Aluminium alloys	Summarize the design chain applied for a typical Aluminium alloys component, to achieve lightness.	X		
<b>Welding and Joining (1)</b>				
Review of welding and joining processes	Name different welding & joining processes and their advantages and limitations.	X		
Typical microstructure and defects  Estimation of properties after welding	Explain the microstructural and mechanical challenges in welding of Aluminium alloys.		X	

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Welding and Joining (2)</b>				
Simulation of welding processes and prediction of properties of welded joints	Describe the approach to be followed and the results achievable by simulating welding processes.		X	
<b>Surface finishing</b>				
Review of main surface finishing treatments: anodizing, painting  Selection of alloys in view of surface finishing treatments	Name and describe the main surface finishing treatments for Aluminium alloys.	X		
Surface properties of treated alloys	Describe application characteristics achievable by surface finishing of Aluminium alloys.	X		
<b>Quality control and Evaluation</b>				
Review of destructive (metallography, microstructure, tensile, fatigue) and non-destructive (X-rays inspection, Computer tomography, visual inspection, penetrants liquids) tests	Name and describe the most relevant quality investigation techniques (both destructive and non-destructive) applied to Aluminium alloys components.	X		
Aluminium alloys tested in Lab	Become familiar with the use of most common quality investigation techniques.		X	

Topic	Requested competences (learning targets)  The Lightweight Professional Advanced Level has to be able to.....			
		know	apply	evaluate
<b>Development of Aluminium components for lightweight: case study #1 (rolled and/or extruded component)</b>				
Selection of alloys and process solutions	Describe and explain how lightweightness can be achieved by using rolled and/or extruded Aluminium alloys components.			
Process simulation			X	
Design				
Validation				
<b>Development of Aluminium components for lightweight: case study #2 (cast component)</b>				
Selection of alloys and process solutions	Describe and explain how lightweightness can be achieved by using cast Aluminium alloys components.			
Process simulation			X	
Design				
Validation				

## **ANNEX C: »CERTIFIED LIGHTWEIGHT PROFESSIONAL EXPERT LEVEL«**

This certification profile is to be developed within 2019/2020.