



Educational Objectives European Lighting Expert Indoor / Outdoor Lighting

Olten, 11 February 2020





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Preface

With the European Lighting Expert (ELE), a cooperation project has been created in Europe which is ground-breaking for future cooperation and the resulting joint activities of the national lighting companies of Germany (LiTG), Austria (LTG), the Netherlands (NSVV) and Switzerland (SLG), and recently also Romania (A.R.I.). The European Lighting Expert stands for the responsible use of light and defines a transnational educational standard, the content of which is described in the following taxonomy. The national lighting companies, which are committed to the implementation of an examination and registration and are organised in the European Lighting Expert Association (ELEA), commit themselves mutually to the implementation of the following taxonomy and vouch for its quality.

The national lighting societies are convinced that the European Lighting Expert meets a great need in the standardisation of the level of requirements for indoor and outdoor lighting. The level of knowledge, which is described in the taxonomy, is high and the topics are comprehensive and interdisciplinary. Passing the examination and registration as a European Lighting Expert is proof of the ability to apply the comprehensive lighting technology knowledge in a practical and hands-on manner. It enables the classification of lighting experts and provides orientation about their qualifications and the level of performance of the companies that employ registered Lighting Experts.

LiTG, LTG, NSVV and SLG as founding members of ELEA and A.R.I. as a new member stand with their position and name for a positive reputation of the European Lighting Expert and thus guarantee credibility, reliability, trustworthiness and responsibility of the registered Lighting Experts. The national lighting societies do their utmost to make this standard known in their countries and to establish it successfully.

Acknowledgements

A first thanks goes to all the experts who have unselfishly and with great personal effort contributed to the creation of this taxonomy. They have made it possible to lay a compelling basis for the joint project. We also like to thank the national lighting societies of Germany, Austria, the Netherlands and Switzerland, who have unreservedly and with great pleasure supported this joint project. The ELE concept is currently being implemented in Romania. This is an expression of a new form of international cooperation, whose first result is the European Lighting Expert.

Invitation

LiTG, LTG, NSVV, SLG and A.R.I. encourage all other European lighting societies to contribute to this common project. In this way, the European Lighting Expert will be developing into the foundation of a high level European light culture.



Objective of this document

The aim of this document is to define the learning objectives for the qualification of the European Lighting Expert in indoor and outdoor lighting. The people who are examined according to these learning objectives are qualified to work independently in the areas of inventory, analysis, planning, consulting, construction as well as operation and maintenance of lighting systems (interior lighting or exterior lighting).

The target groups are people who want to qualify as experts in the field of lighting technology and lighting planning for interior or exterior lighting.

In particular these are

- Employees and persons responsible for all corporate divisions (e.g. technology, planning, construction, facility management, sales, operations, fault service, etc.) who are already working in the lighting industry and would like to expand their knowledge,
- People who want to enter the lighting industry for the first time or who have the intention to have the ability to work in the lighting industry with relevant training or relevant professional experience (e.g. electrical engineer, electrical wholesaler, energy consultant)
- persons involved in lighting technology and lighting design (e.g. architects, engineers, planners, technical offices, electrical wholesalers, institutional or public building owners or testing and monitoring bodies).

Proof of qualification

Professionals seeking registration must have theoretical knowledge of the relationships between physiological perception, light, the effect of light and the associated electrical engineering and be able to apply this knowledge in a practical manner, taking into account the relevant laws and regulations, ecology and economy. They must know the current equipment and its controls and be able to use them optimally, taking into account economic factors. They must have knowledge of the relevant interfaces to neighbouring specialist areas, in particular to the fields of architecture, ecology, ergonomics and electrical engineering.

In the course of the qualification of persons, it is important not only to check the knowledge just listed but also to determine their technical ability, such as recognising the connections between the specialist areas relevant to lighting technology and lighting design (e.g.: electrical engineering, lighting technology, ergonomics, ecology, economics).

In particular, the person must have the ability to think in a networked, interdisciplinary and unifying way, to make decisions and act practically in the field of lighting technology and its related disciplines (e.g. electrical engineering, ergonomics, operating resources, legal and standard requirements, energy and environmental requirements etc.).



Taxonomy

To pass an examination to become a European Lighting Expert Interior Lighting or Outdoor Lighting, knowledge learned by heart is not enough. The learning objectives must be worked out with individual mental effort to achieve the required competence.

The learning objectives are therefore classified according to the level of competence to be achieved. The following three levels of difficulty are used for the examination:

C1: Knowledge	Reproduction of knowledge learned by heart or acquired through practice: e.g. enumerating, naming, describing, pointing out, distinguishing, defining, representing, knowledge about connections, regularities and applications.
C2: Comprehension	What has been learned is understood and can be explained, also if it occurs in an unknown context: Processing of facts and problems, if possible from practical experience with calculations, graphic representations and explanatory descriptions.
C3: Application	What has been learned must be applied in a new, previously unknown situation; a transfer of knowledge takes place in a new application situation: Working on multi-layered problems, such as those that can arise in everyday working life, finding the optimal solution from various possible solutions.

The difficulty increases from C1 to C3. The level to achieve in a specific subject is marked at the adequate position.

Legal reservation

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Olten, 11 February 2020

1. Basic Knowledge

1.1 Lighting Technology		Indoor	Outdoor
1.1.1 Scientific Base			
	<i>Electromagnetic Waves</i>	C1	C1
	<i>Types of Light Sources</i>	C1	C1
1.1.2 Quantities and Units			
	<i>Spectral Sensitivity</i>	C2	C2
	<i>Luminous Flux Φ</i>	C3	C3
	<i>Solid Angle Ω</i>	C3	C3
	<i>Luminous Intensity I</i>	C3	C3
	<i>Illuminance E</i>	C3	C3
	<i>Inverse Square Law</i>	C2	C2
	<i>Luminance L</i>	C3	C3
	<i>Luminous Efficacy η</i>	C3	C3
	<i>Luminous Intensity Distribution LVK</i>	C3	C3
	<i>Contast and Contrast Types</i>	C3	C3
	<i>Contrast Rendering Factor</i>	C3	C3
1.1.3 Light and Colour			
	<i>Colour and Spectrum</i>	C1	C1
	<i>Colour Temperature T_F</i>	C2	C2
	<i>CIE Colour Rendering Index R_a / CIE CRI</i>	C2	C2
	<i>Additive and subtractive Colour Mixing</i>	C2	C1
	<i>Colour Systems</i> <i>- Hue, Saturation and Brightness</i>	C2	C1
1.1.4 Optic Characteristics of Materials			
	<i>Absorption</i>	C2	C2
	<i>Transmission</i>	C2	C2
	<i>Reflection</i>	C2	C2
	<i>Relationships</i>	C2	C2
	<i>Lambertian Radiator, Diffuse Reflection</i>	C2	C2
1.1.5 Vision and Perception			
	<i>The Human Eye</i> <i>- Adaptation</i> <i>- Visual Acuity</i> <i>- Accommodation</i> <i>- Field of View</i>	C2	C2
	<i>Perception</i>	C1	C1
	<i>Colour Perception</i>	C1	C1

1.1.6 Effect on Humans			
	<i>Health aspects, psychologic effects, photobiological effects, Perception, Equality, emotional effect</i>	C2	C2
	<i>Light as a timer</i>	C1	C1
	<i>Light and working conditions</i>	C1	C1
	<i>Dynamic lighting</i>	C1	C1
	<i>Dynamic lighting in the work environment</i>	C1	-
	<i>Light therapy</i>	C1	-
1.1.7 Visual Disturbances			
	<i>Glare and gloss</i>	C2	C3
	<i>Disturbances from light sources</i> - Stroboscopic effect, - Flicker, electrode flicker	C2	C2
1.1.8 Standards			
	<i>EN 12665</i>	C1	C1

1.2 Electrical Engineering		Indoor	Outdoor
1.2.1 Fundamentals			
	<i>Standards</i> <i>National and European standards</i>	C1	C2
	<i>Fundamentals of electricity</i> - Touch voltage - Error voltage	C1	C2
	<i>Electric safety, types of systems</i> - Safety precautions - Grounding, lightning protection - Safety categories	C1	C2
	<i>Electrical, apparent, and reactive power</i> - Compensation - Power factor	C1	C2
1.2.2 Technical Requirements			
	<i>General connect requirements</i>	C1	C2
	<i>Cable diameter dimensioning</i>	C1	C2
	<i>Cable conduction</i>	C1	C2
1.2.3 Documentation			
	<i>Electrical design documents and their content</i>	C1	C2
	<i>Installation manager</i>	C1	C1
	<i>Installation book</i>	C1	C2

1.3 Light Sources		Indoor	Outdoor
1.3.1 List of light sources			
	<i>Description of electric lamps</i>	C1	C1
	<i>Lamp fittings</i>	C1	C1
	<i>Typical indices light sources</i>	C1	C1
	<i>Definitions lifetime of light sources (failure, luminous reflux)</i>	C1	C1
1.3.2 Temperature radiator			
	<i>lamps</i>	C1	C1
	<i>Halogen lamps</i> <i>- Principle of operation, IRC lamps, operation</i>	C1	C1
1.3.3 Low pressure discharge lamps			
	<i>Fluorescent lamps, cold cathode lamps</i> <i>- Development and functionality</i> <i>- Spectrum</i> <i>- Correlated Colour Temperature and colour rendering</i> <i>- Lifetime (luminous reflux and failure)</i> <i>- Temperature sensitivity</i> <i>- Replacements</i> <i>- Switching circuit</i> <i>- Usage</i>	C2	C2
	<i>Energy saving lamps (CFL, compact PL)</i>	C1	C1
	<i>Sodium vapour low-pressure lamp</i>	C1	C1
	<i>Induction lamp</i>	C1	C1
1.3.4 High pressure discharge lamps			
	<i>Sodium vapour high-pressure lamp</i> <i>- Development and functionality</i> <i>- Spectrum</i> <i>- Correlated Colour Temperature and colour rendering</i> <i>- Lifetime (luminous reflux and failure)</i> <i>- Temperature sensitivity</i> <i>- Replacements</i> <i>- Switching circuit</i> <i>- Usage</i>	C2	C2
	<i>Mercury vapour high-pressure lamp</i>	C2	C2
	<i>Halogen metal vapour high-pressure lamp</i>	C2	C2
1.3.5 Solid state light sources – "electronic" lamps			
	<i>LED</i> <i>- White and monochromatic light</i> <i>- Development and functionality</i> <i>- Spectrum</i> <i>- Light colour and colour rendering</i> <i>- Lifetime</i> <i>- Temperature behaviour</i> <i>- Light source replacement</i> <i>- Switching circuits</i> <i>- Application</i> <i>- Binning, Mc Adams ellipse</i> <i>- System/ module, luminaire, indices</i>	C1	C1
	<i>OLED</i>	C1	C1



1.3.6 Ballasts and Drivers for light sources			
	<i>Types, function and applications</i> - Magnetic, electronic ballasts - Starter - Steering device	C2	C2
	<i>Security requirements</i> - Types of protection - Spark suppression - Over voltage protection	C1	C1
	<i>Incandescent and halogen lamp</i>	C1	-
	<i>Fluorescent and compact fluorescent lamps</i>	C1	C1
	<i>Sodium vapour low-pressure lamp</i>	-	C1
	<i>High-pressure discharge lamp</i> - Sodium vapour lamp - Mercury vapour lamp - Halogen Metal vapour lamp	C1	C1
	<i>Induction lamp</i>	-	C1
	<i>LED</i>	C2	C2
1.3.7 Energy labelling and certificates			
	<i>EU and national Directives and Policies</i>	C1	C1
	<i>Economical comparison of different types of light sources</i>	C2	C2
1.3.8 Recycling of lamps			
	<i>Recycling concepts</i>	C1	C1
	<i>Gray energy, sustainability, resource</i>	C1	C1

1.4 Luminaires		Indoor	Outdoor
1.4.1 General			
	<i>Photometric influence of the mounting position</i> - Shade - Shape: technical/decorative - Reflector shapes	C2	C2
	<i>Long term characteristics</i> - Enclosure material/compensation (corrosion properties) - closeness/ sealing systems - Shade (impact resistance. UV permanence) - Vibration behaviour (including fixation / support system etc.) - Temperature behaviour (LED thermal management)	C2	C2

1.4.2 Luminaire types			
	<i>Interior lighting</i> - Trough luminaires - Reflector luminaires - Grid luminaires - direct/indirect luminaires - Radiator	C1	-
	<i>Exterior lighting</i> - Street lighting luminaires - Spot lights - Direct-/indirect luminaires - Bollard - Recessed ground luminaires	-	C1
1.4.3 Luminaire specifications			
	<i>Photometric properties</i> - Luminous flux distribution, - Luminaire efficiency - Classification	C2	C2
	<i>Performance data</i> - Luminaire efficiency - System performance	C1	C1
	<i>Unified Glare Rating (UGR)</i>	C1	C1
	<i>Brightness class</i>	C1	C1
	<i>Glare index class</i>	C1	C1
	<i>Safety requirements</i> - Safety classes (IPxx), safety features, over voltage protection, spark suppression, fire safety, explosion protection, ball sports protection, vandalism, ball impact protection	C1	C1
	<i>Required description on luminaire</i>	C1	C1
	<i>Test Mark (ENEC, national Test Marks, ...)</i>	C1	C1
1.4.4 Standards			
	<i>Overview of EN 60598</i>	C1	C1

2. Lighting Design – Interior

2.1 Lighting Design for Interior Spaces		Indoor	Outdoor
2.1.1 Fundamentals for Lighting Design			
	<i>Human needs</i> - Ergonomics - Comfort - Wellbeing - Light needs - Work atmosphere - Productivity	C2	-
	<i>Standards and guidelines</i> - EN 12464-1 - Further national standardization, regulations (e.g. ASR A3.4) and recommendations	C2	-
	<i>Energy efficiency requirements</i>	C3	-



2.1.2 Planning issues			
	<i>Planning steps</i> - Check guide values - Lamp choice - Choice of lights - Calculations - Determine the type of lighting - Economics - Safety requirements	C3	-
	<i>Problems before planning begins</i> - Delayed process start - Missing or incorrect detail descriptions - Failure to observe special spatial conditions - Electric network conditions	C2	-
	<i>Problems during planning</i> - Reflection grading - Luminaires pattern - Classification of luminaires - Maintenance factor - Fixing height - Special luminaires	C3	-
2.1.3 Lighting design considerations			
	<i>Fundamentals of Design</i> - Illuminance - Grouping/steps illuminance - Uniformity of illuminances - Reflection factors - Luminance distribution - Maintenance illuminance	C3	-
	<i>Glare limitation</i> - UGR method	C3	-
	<i>Optical impression</i> - Direction of light - Shadow, modelling - Correlated Colour Temperature - Colour rendering	C3	-
	<i>Maintenance plan</i> - Maintenance factor (LLMF, LMF, LSF, RSMF) - Necessity replacement light source - Module replacement for LED - Luminaires (single and multiple replacements) - Period of usage - Switching circuits	C3	-
2.1.4 Lighting Calculations			
	<i>Dimensioning of lighting</i> - Environmental data - Maintenance values - Light sources data - Arrangement	C3	-
	<i>UGR method</i>	C3	-
	<i>Computer design</i> - Basic knowledge functionality - Applicable tools - Design possibilities	C3	-

2.1.5 Selection of luminaire concept			
	<i>Lighting concept</i> - Direct lighting - Indirect lighting - Direct/indirect lighting - Additional lighting	C3	-
	<i>Daylight</i> - Daylighting - Alternate lighting for daylight - Daylight control systems	C2	-
	<i>Electric lighting</i> - General lighting - Workplace oriented general lighting - Workplace lighting	C3	-
2.1.6 Economic considerations			
	<i>Cost Types</i> - Purchase costs - Planning costs - Installation costs - Operating costs - Conservation costs - Maintenance costs - Test costs - Energy costs - Cost development	C3	-
	<i>Energy needs, national assumptions, Requirements</i>	C2	-
2.1.7 Daylight systems			
	<i>Daylight systems and their control</i>	C1	-
2.1.8 Light management			
	<i>Open- & closed loop control concepts (DALI, DMX, 1-10 V, KNX, ...)</i> - Daylight dependent control - Precision detector	C2	-
2.1.9 Documentation			
	<i>Planning documents</i> - Economic considerations - Lighting calculations - Service plan	C2	-
	<i>Luminaire documentation</i> - Lighting data - Electrical characteristics	C3	-
	<i>Test results</i>	C3	-

2.1.10 Emergency Lighting				
	<i>Type of emergency lighting</i> - Replacement lighting - Safety lighting - Safety lighting for evacuation routes - Anti-panic lighting - Safety lighting for higher-risk workplaces	C2	-	
	<i>Power supply</i> - Single battery - Group battery (LPS) - Central battery (CPS)	C1	-	
	<i>Security and rescue symbols</i>	C1	-	
	<i>Photometric projection and legal principles, etc.</i>	C3	-	
	<i>Overview standards</i> - EN 1838 - EN 50171 - EN 50172 - EN 62034 - EN 60598-2-22 - Further national standards and recommendations	C1	-	

2.2 Execution and operation of interior lighting			Indoor	Outdoor
2.2.1 Execution support				
	<i>Plan review, changes</i> - Space impression - Activities in the space - Photometric qualitative properties - Building perspectives - Types of luminaires - Transition point to other installations	C3	-	
2.2.2 Service & Maintenance				
	<i>Maintenance and repair information</i> - Maintenance plan with information about lamp replacement, lamp cleaning, measures for later work	C2	-	
2.2.3 Test and Inspection				
	<i>Electrical test</i>	C2	-	
	<i>Photometric test</i>	C2	-	
	<i>Object test / inspection (stateless parts etc.)</i>	C2	-	
	<i>Test documentation</i>	C2	-	
2.2.4 Work places				
	<i>Requirements</i> - EN 12464-1 - Further actual standards and recommendations	C3	-	
2.2.5 Sports halls / multi-purpose halls				
	<i>Special requirements</i> - EN 12464-1 - EN 12193 - Further actual standards and recommendations	C3	-	

2.3 Renovation of interior lighting		Indoor	Outdoor
2.3.1 Renovation Aspects			
	<i>Inventory</i> - existing lighting systems - Ergonomics - Energy saving potential	C3	-
	<i>Design procedure</i> - Visual tasks - Lighting concept - Type of lighting, daylight lighting - Alternative solutions - Savings potential - Investment costs, operating cost - Economics - Technical requirements - Tender, award - Award control	C3	-
2.3.2 Electrical engineering – special issues during renovation			
	<i>What is a substantial expansion?</i>	C1	-
	<i>Safety precautions</i>	C1	-
	<i>Test, analysis, documentation of file</i>	C1	-
	<i>Electrical dangers in outdated installations</i>	C1	-

3. Lighting Design – Exterior

3.1 Lighting Design for Exterior Spaces		Indoor	Outdoor
3.1.1 Fundamentals for Lighting Design			
	<i>Aspects of urban design</i> - Architecture - Urban furniture - Feelings of security / criminality	-	C2
	<i>Legal basis</i> - Road safety commitments - Obligations road owners - Lighting obligations - Compensation for damages - Responsibility questions - Tolerance commitment	-	C2
	<i>Street lighting standard EN 13201</i> - Traffic definitions - Zoning / ranges - Traffic flows - Velocity - Risks - Quality determination - Lighting classes - Glare limitation - Physiological glare (TI-factor) - Psychological glare	-	C3

	<p><i>Conflict zones / meeting areas</i></p> <ul style="list-style-type: none"> - Pedestrian zones - Parking places - Pedestrian crossings - Roundabouts - Traffic lane distribution - Other conflict zones 	-	C3
	<i>Further national provisions / standards</i>	-	C2
	<i>Energy efficiency requirements</i>	-	C3
	<i>Electrical engineering including lightning protection</i>	-	C2
3.1.2 Lighting design considerations			
	<p><i>Determination of lighting concepts</i></p> <ul style="list-style-type: none"> - Choice of lighting situation - Choice of lighting classification - Determination of Correlated Colour Temperature - Determination of lighting geometry 	-	C3
	<p><i>Design basics</i></p> <ul style="list-style-type: none"> - Maintenance values and new values - Luminance - Longitudinal and overall uniformity of the luminance u. Illuminance - Luminance distribution - Illuminance (vertical, horizontal, cylindrical, semi-cylindrical) 	-	C3
	<p><i>Developing maintenance plan</i></p> <ul style="list-style-type: none"> - Maintenance factor / Required lamp replacements - Switching circuits 	-	C3
	<p><i>Problem before planning starts</i></p> <ul style="list-style-type: none"> - Delayed process start - Insufficient or incorrect detail/analysis - Missing / incorrect traffic data - Insufficient knowledge of street situations, material, and environmental aspects - Electrical network conditions 	-	C3
	<p><i>Problems during planning</i></p> <ul style="list-style-type: none"> - Traffic parameters - Road surface properties - Danger zones - Luminaire arrangement - Classification of luminaires - Maintenance factor - Practical implementation d. Lighting geometry - Special luminaires 	-	C3
3.1.3 Light management			
	<i>Regulation and control concepts (use of switching, control and regulating devices)</i>	-	C2
	<i>Dimming on demand</i>	-	C2
	<i>Further possibilities</i>	-	C2

3.1.4 Choice of support system			
	<i>Support System</i> - Type - Construction - Fixation possibilities - Fundaments - Static and dynamic calculations - Material properties	-	C2
3.1.5 Lighting calculations			
	<i>Dimensioning of Lighting</i> --Street data (subterranean, areas) - Traffic data - Maintenance value - Light sources data - Luminaires data - Application = lighting geometry - TI- Glare analysis/ Limit - Illuminance classes - Glare indices	-	C3
	<i>Computer designs</i> - Basic functionality< - Common tools - Possible designs	-	C3
3.1.6 Economic aspects			
	<i>Cost Types</i> - Purchase costs - Design costs - Installation costs - Operating costs - Conservation costs - Maintenance costs - Test costs - Storage costs - Energy costs	-	C2
	<i>Lifecycle cost calculations</i>	-	C2
	<i>Payback time, ROI (Return of Investment)</i>	-	C2
	<i>Types of financing</i> - Contracting	-	C2
	<i>Energy needs</i>	-	C2
	<i>National challenges/requirements</i>	-	C2
3.1.7 Documentation			
	<i>Planning documents</i> - Economic considerations - Lighting calculations - Conservation and maintenance plans	-	C3
	<i>Luminaire documentation</i> - Photometric data - Electrical indices	-	C3
	<i>Test results</i>	-	C3

3.2 Execution and operation of Outdoor lighting systems		Indoor	Outdoor
3.2.1 Execution support			
	<i>Plan review, changes</i> - Special requirements, local condition - Photometric quality characteristics - Building principles - Danger zones - Types of luminaires - Transition point to installation	-	C3
3.2.2 Service & Maintenance			
	<i>Maintenance and repair information</i> - Maintenance plan with information about lamp replacement, lamp cleaning, measures for later work	-	C2
3.2.3 Testing and Inspecting			
	<i>Electrical test (maintenance, inspection)</i>	-	C2
	<i>Photometric test</i>	-	C2
	<i>Static test – support parts (maintenance, inspection)</i>	-	C2
	<i>Object test/inspections (Icicles, stateless parts etc.)</i>	-	C2
	<i>Test documentation</i>	-	C2
3.2.4 Light management			
	<i>Checking and adjusting the light control according to user behaviour</i>	-	C3
3.2.5 Exterior work places			
	<i>Requirements</i> - EN 12464-2 - Deviations from EN 13201 - Further actual standards/recommendations	-	C3
3.2.6 Exterior sport arenas			
	<i>Requirements of EN 12193</i>	-	C3
	<i>Specific requirements (e.g., TV recordings)</i>	-	C3
	<i>Typical luminaires / spot lights</i>	-	C3
	<i>Emergency lighting - EN 1838</i>	-	C3
3.2.7 Illumination of objects			
	<i>Buildings, other structures</i> - Facades - Advertising columns, panels - Effect lighting	-	C2
	<i>Projection requirements</i>	-	C2
	<i>Light imissions</i> - Room lighting and glare (environment, residents)	-	C1
	<i>Deliberate use of light – shadow – colour</i>	-	C1
3.2.8 Tunnel lighting, underpasses, passageways			
	<i>National standards and recommendations</i>	-	C1



3.3 Renovation of Exterior Lighting Installations		Indoor	Outdoor
3.3.1 Renovation aspects			
	<i>inventory</i> - existing lighting systems, analysis requirements, light guide - Lighting technology - Electrical engineering - Structure - Environmental aspects	-	C3
	<i>Planning procedure</i> - Legal Aspects - Lighting concept - Art + requirements - Profitability, amortization - Savings potential operating costs - Type of award - tender - Award control	-	C3
3.3.2 Electrical engineering – special issues during renovation			
	<i>What is a substantial expansion?</i>	-	C1
	<i>Safety precautions</i>	-	C1
	<i>Test, analysis, documentation of file</i>	-	C1
	<i>Electrical dangers in outdated installations</i>	-	C1

4. Photometric Measurements

4.1 Fundamentals		Indoor	Outdoor
	<i>Photoelectric receivers</i>	C1	C1
	<i>Influence of precision on the design</i>	C1	C1
	<i>Measurements instruments for practice</i> - Illuminance measurement instrument (Lux meter) - Luminance measurement instrument/camera - Further measurement instrument (e.g., multi meter, thermometer)	C1	C1
	<i>Standards and guidelines</i>	C1	C1

4.2 Measurements of luminaires		Indoor	Outdoor
	<i>Luminous intensity distribution</i>	C1	C1
	<i>Measurement of luminance</i>	C1	C1
	<i>Measurement of luminous flux</i>	C1	C1
	<i>Determination of light output ratio</i>	C1	C1

4.3 Measurements – Interior Lighting		Indoor	Outdoor
	<i>Execution of measurements</i> - Measurement grid - Luminance measurements - Local illuminance - Average illuminance - Reflections of surrounding areas - Empty spaces - Furnished spaces	C3	-
	<i>Measurement analyses</i> - Measurement protocol - Elaboration models - Accuracy of measurements - Assessment	C3	-

4.4 Measurements – Exterior Lighting		Indoor	Outdoor
	<i>Execution of measurements</i> - Measurement grid - Measurements illuminance & luminance - Physical measurements of luminance - Determination of TI - Assessment subterranean track	-	C3
	<i>Measurement analyses</i> - Measurement protocol - Calculation of not-directly measurable quality indices (uniformity, ...) - Elaboration models - Accuracy of measurements - Assessment (also in comparison with calculations)	-	C3