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**ANNEX A**

Compilation Basis of IALA Guideline Draft

Measurement of Marine Lights Performance

# Summary

This document describes in detail the additions, deletions, and modifications to the draft IALA Marine Lighting Measurement Guidelines as compared to the original Recommendation document E200-3.

# Key Revised content and basis

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| --- | --- | --- | --- |
| Section | Content Comparison | | Justification |
| Original document | The change in guideline draft |
| Full text | 1. Introduction  2. Scope  3. Objective  4. Measurement principles  5. Models and functions  6. Measurement equipment  7. General Laboratory Procedures  8. Photometry methods and requirements.  9. Colorimetry method and requirements.  10. Presentation of Results  11. Definitions  12. Acronyms  13. References  AnnexA Detailed measurement method - zero-length photometry.  AnnexB Detailed Measurement Method - Outdoor Telephotometry  AnnexC Detailed Measurement Method - Tristimulus Colorimetry  AnnexD Detailed Measurement Method - Spectroradiometry  Annex E Example of A Photometry Uncertainty Budget | 1 Introduction  2. Scope  3. Objective  4. Terms and Definitions  5. Measurement principles  6. Measurement equipment  7. General measurement conditions  8. Photometry methods and requirements  9. Colorimetry method and requirements  10. Presentation of Results  11. Measuring in field applications  12. Acronyms  13. References  Annex A Detailed Measurement Method - Zero Length Photometry  Annex B Detailed Measurement Method - Outdoor Telephotometry  Annex C Detailed Measurement Method - Tristimulus Colorimetry  AnnexD Detailed Measurement Method - Spectroradiometry  Annex E Laboratory Measurement Management  Annex F Analysisand reference of error factors in goniophotometry  Annex G Implementation of the Convolution Function to Determine Flash Duration  Annex H Example of A Photometry Uncertainty Budget  ANNEX I Method for Detecting Character of AtoN Light Based on Spectral Analysis  ANNEX J Detection Method of AtoN Light Based on Image Processing Techniques  ANNEX K Practical Methods of Measuring Light Source Degradation | **For the adjustment of the framework structure of the full-text chapters:**  **1. Delete Chapter 5 and Chapter 11,** **and summarize them into the new Chapter 4 Terms and Definitions based on the original Chapter 3 Purpose, Chapter 5 Models and Functions , and Chapter 11 Definition** : This integration not only streamlined the content but also adhered better to the conventional document format of current international standards.  2. **Modify Chapter 7 General Laboratory Procedures as General Measurement Conditions, the contents of the original Chapter 7 (** **7.1-7.4, 7.10-7.17 ) are merged and separated into Annex E:**  Most of the content in the original Chapter 7, which was sourced from ISO documents and established standards, was better suited as informative appendices. This portion of content now exists as AnnexE. Additionally, the revised Chapter 7 has been expanded to include general measurement conditions, serving as a reference for measurement applications.  **3. Add a new Chapter 11 Measuring in field applications**: This chapter integrates the proposal submitted to ENG ENG 13-3.1.1.9 Intelligent Measurement of the Character of Aids to Navigation Lightand ENG 12- 3.1.4 Method of Measuring Light Source Degradation.These proposals serve as important supplementary components for measuring maritime light performance in on-site applications.  **4. New Annex F, G, I, J, K:** From the input proposal documents submitted to IALA ENG, the contents of which are compiled to make the guidelines draft more complete.  Annex F: ENG 16-3.1.1.5.1 Annex on goniophotometry  Annex G : ENG 9-8.5 Implementation of the Convolution Function to Determine Flash Duration  Annex I: ENG 13-3.1.1.9 Intelligent Measurement of the Character of Aids to Navigation Light  Annex K: ENG 12-3.1.4 Method of Measuring Light Source Degradation  **For the content:**  In addition to refining and enhancing the draft content, inappropriate descriptions from the original version have been either deleted or modified to align with current relevance. |
| 2. Scope | "This recommendation applies to the photometric measurement and characterisation of all marine aids-to-navigation signal lights." | Revise to "This guideline applies to the measurement and characterisation of all marine aids-to-navigation signal lights. " | In addition to photometric measurement, it also includes measurement and characterization of other properties such as colorimetric parameters. |
| 2. Scope | "Light sources used in marine aids-to-navigation signal lights are typically incandescent lamps or discharge lamps. Light emitting diodes (LEDs) are increasingly being used, while acetylene open flame or gas-mantle light sources are becoming increasingly rare." | Revise to "The types of light sources used in marine aids-to-navigation signal lights are diverse. Light emitting diodes (LEDs) are gradually replacing tungsten filament lamps or metal halide lamps., while acetylene open flame or gas-mantle light sources has almost ceased to exist." | The original document was released earlier, and the current development status of light sources has been revised according to the actual situation |
| 3. Objective | "Marine aids-to-navigation signal lights encompass projection-type equipment, using various light sources, lenses and mirrors, singly or in combination, and Fresnel-type drum lenses." | Change to "The optical performance covered in this guideline include the luminous intensity, color, character (of a navigation light), effective luminous intensity, and luminous range of the marine AtoN signal lights." | The scope of applicable navigation lights has been mentioned in the scope of Chapter 2.Here, we further explain the coverage of optical performance in the guidelines, providing greater clarity. |
| 4 Terms and Definitions | 3 Objective (The specific items are not listed in detail, see the original text )  5. Models and functions(except 5.3 Talbot-Plateau Law)  11 Definitions | 4 Terms and definitions (the specific items are not listed in detail, see the new draft for details) | 1. Integrate and summarize the content of Chapters 3, 5 and 11 of the original document to form new chapter 4 of terms and definitions: This refinement streamlined the section content and aligns better with the conventional approach of current international standardization documents.  2. Revised the introductory words in Chapter 11 Definitions of the original document and used them as the introductory words in new Chapter 4 : This conforms to the conventional approach of current international standardization documents.  3. Modified imprecise content in the original terminology definitions and introduced new terms: "Tristimulus Values <of a color stimulus>,""Chromaticity coordinates""Goniospectroradiometer""Photometric centre" and "Reference center<of the DUT>." These term definition revisions and additions reference IEC 60050-845@IEC 2020 standard and ongoing technical documents of CIE TC 2-78.  4. Remove "Hue", "Color Saturation", "Chroma", and "CIE Illumiant A": The draft does not involve hue and color saturation, andchroma are not a standard term in IEC 60050-845, so they are deleted. Content from the original Section 5.7 regarding "CIE Illuminant A" was imprecise; relevant explanations are now present in the new Section 6.7 on Calibration Light Sources.  5.Relocated "Spectral Mismatch Error and Correction" to Chapter 5, the section on Measurement Principles: This adjustment enhances readability and facilitates better understanding. |
| 4.1 Photometry | 3.1 Photometry | See the new draft for details | 1. "Measurement of quantities referring to radiation as evaluated according to a given spectral luminous efficiency function, e.g. V(λ) or V′(λ)." replaces the first paragraph in original document. The content of this term comes from the international general terminology standard IEC 60050-845 @IEC 2020 .  2. "The CIE system of physical photometry establishes internationally recognized human visual spectral luminous efficiency functions, which quantitatively assess optical radiation." to further explain the given spectral luminous efficiency,forming a coherent link with the definition in Section 4.2, assisting in comprehension.  3. "Luminance measurement instruments" is used in place of "an instrument called a photometer" as the use of spectroradiometer instruments, which is not a photometer, can also achieve the purpose of luminance measurement, .  4. As this entry pertains to photometry, the final two sentences related to color have been removed. |
| 4.2.Spectral luminous efficiency <for a specified photometric condition> | 5.1. Photopic Luminous Efficiency Function of the Standard Observer V(λ)  5.2. Scotopic Luminous Efficiency Function V’(λ) | Integrate the content in 5.1 and 5.2 of the original document into this term | Sections 5.1 and 5.2 in the original document both constitute specific cases of spectral luminous efficiency under specified photometric conditions. Integrating them together enhances conciseness while also creating a resonance with the "given spectral luminous efficiency" mentioned in Section 4.1, aiding comprehension. The added content in the terminology is based on the internationally accepted terminology standard IEC 60050-845@IEC 2020. |
| 4.3 Spectral distribution | 3.17 Spectral distribution | Add formulas and descriptions , modify and adjust the text.(see the draft for details) | According to IEC 60050-845@IEC 2020 |
| 4.4 Spectral power distribution | 3.18 Spectral Power Distribution | 1. Modify"A spectral power distribution (SPD) curve shows the radiant power emitted by a light source at each wavelength or band of wavelengths over the electromagnetic spectrum." to "The spectral distribution of radiant power. Spectral power distribution (SPD) or relative spectral power distribution is often used in marine AtoN navigation light measurements" .  2. Delete the phrase"orluminous intensity" in original content"they may be weighted by the V(λ) function to obtain a photometric value of luminous flux or luminous intensity"  3. Modify the y-axis lable of the spectral power distributiondiagram of white LED,"Radiance (mW)", to "Radiant Power (mW)" | 1. The transition language makes the connection between 4.4 and 4.3 more natural  2. Luminous intensity is obtained by weighting the V(λ) function and the radiant intensity, not the radiant power.  3. The unit of radiance is W/(sr·m2), and the unit of Radiant power is W. Given the context, in this instance, it refers to Radiant Power rather than Radiance. |
| 4.5 Luminous flux (lumen) | 3.3 Luminous flux (lumen) | Add formulas and descriptions , modify and adjust the text order | According to IEC 60050-845@IEC 2020 |
| 4.6 Solid angle | 3.4 Solid angle | 1. Add formulas and descriptions, modify and adjust the text order  2. Added an illustration depicting the calculation of solid angles.  3. Replaced the original geometric solid angle illustration corresponding to 1 steradian. | 1. The newly added content in the first paragraph is based on the international common terminology standard IEC 60050-845@IEC 2020;   1. The illustration and formulas for calculating solid angles are provided based on the definitions, enhancing a more intuitive understanding of the terms. 2. Replaced the original geometric solid angle illustration corresponding to 1 steradian with images that better align with actual sensory perception. |
| 4.7 Luminous Intensity (candela) | 3.5 Luminous Intensity (candela) | 1. Increase the calculation and derivation formula of luminous intensity, modify the content of term description, and adjust the order of words;  2. Modify the interpretation of the unit candela. | 1. The term content is based on IEC 60050-845@IEC 2020;  2. The description of the candela unit comes from the new SI method based on 7 constants adopted by the 2018 International Conference on Weights and Measures (avaliable at https://www.bipm.org/en/committees/cg/cgpm/26-2018/resolution-1) |
| 4.7.1.Angular luminous intensity distribution | 3.5.1Angular luminous intensity distribution | Delete "For many applications, the intensity is restricted to a plane. The intensity distribution is then a function of one angle only I = I ()." | Added 5.2 Coordinate System and Chapter 8 as well as Chapter 10 have detailed descriptions of luminous intensity distribution, to reduce repetition and redundancy. |
| 4.7.3 Fixed Intensity  Continuous Intensity | 3.5.3 Continuous intensity, 3.5.4 Fixed intensity | Merge the definition of these two into one term.And modify the definition to "The luminous intensity of a light source that emits continuous and stable light while maintaining a consistent color. " | The terms have the same meaning and can be combined |
| 4.7.4 Maximum intensity | 3.5.3 Maximum intensity | "The maximum intensity in any given angular plot."is changed to "The maximum luminous intensity on a specified plane in the angular luminous intensity distribution." | Modify according to actual application and usage practice |
| 4.7.5 Reference intensity Io | / | New item. "The luminous intensity on the reference axis or reference plane." | The reference luminous intensity finds extensive application in cases of asymmetric distribution in practical scenarios. To enhance convenience of use, this term has been newly introduced. Its utilization can be found in various instances, such as in Section 4.10 on beam divergence angles and in Section 10.1 on reporting results,. |
| 4.7.6 Peak intensity Ipeak | 3.5.6 Peak intensity ( I o ) | Modify the symbol I0to Ipeak | Ipeak is more intuitive |
| 4.7 .7 10th percentile intensity I 10% ile | 3.5.7 10th percentile intensity | Add the symbolI10% ile | I 10% ile has been used in Chapter 10 , and it is added directly in the terms and definitions chapter. |
| 4. 7 .8 Time-Integrated Intensity J int | 3.5.8.Integrated Intensity (Iint) | Modify the symbol Iint to Jint | Referring to the symbol J in CIE 229: 2018. And it is not suitable to use the symbol I for the light intensity after integrating process. |
| 4.7.9 Effective intensity *I*eff | 3.5.9 Effective intensity ( Ie ) | 1. Modify the symbol I e to I eff ;  2. "This is the intensity of a continuous light that gives the equivalent perception as that of a flash of light when viewed at the achromatic threshold of visual detection." is changed to "Luminous intensity of a fixed light, of the same relative spectral distribution as the flashing light,which would have the same luminous range (or visual range in aviation terminology) as theflashing light under identical conditions of observation.".  3. Add "The range at which an observer may just see a light flash may be described in terms of a single parameter which is called the 'effective intensity of the flash...... with the lowest effective intensity of the flashes in a character defining the nominal range of that light."  See the draft for details. | 1. Refer to the symbol of effective luminous intensity in CIE 229: 2018 ;  2. According to CIE S 017/E:2011  3. According to IALA G1135 ED3.1 |
| 4.8 Luminance  4.9 Illuminance | 3.6 Luminance  3.7 Luminous flux density or illuminance | 1. Add formulas and modify descriptions (see the draft for details)  2. Add an illustration depicting illuminance. | Formulas and descriptions are based on IEC 60050-845@IEC 2020 |
| 4.10 Beam divergence | 3.8 Beam divergence | 1. Change "Maximum Intensity" to "Reference Intensity"with corresponding modifications in subsequent text.;  2. Add "Due to the possible asymmetry in the actual luminous intensity distribution, the value of the beam divergence is twice the smaller of the two angles formed between the corresponding rays with the reference axis or reference plane, where the intensity drops to 50% (when using FWHM) or 10% (when using FWTM) of the reference intensity (see 10.1.1), i.e., FWHM = 2 x min{ΔH1 , ΔH2}, FWTM = 2 x min{ΔT1 , ΔT2}.”;  3. Add an illustration. | 1. Combined with the content of Chapter 10, the luminous intensity used here should be the luminous intensity at the reference axis or reference plane , which is the newly defined term reference intensity.  2 & 3. The newly added content directly specifies the method of determining values within the definition, enhancing clarity and comprehension. The diagrams and value formulas are derived from the original content in Section 10.1. |
| 4.11 Critical Flicker Frequency OR Fusion Frequency | 3.9.Flicker Fusion Frequency or Critical Flicker Frequency | Add "For a given set of conditions, the frequency of alternation of stimuli above which flicker is not perceptible.. " | The content is based on IEC 60050-845@IEC 2020 |
| 4.1 5 Limiting photometricdistance | 3.13 Minimum photometric distance | 1. Modify "minimum photometric distance" to "limiting photometric distance";  2. Change "The minimum photometric distance is the minimum distance between the beacon and the photoreceptor needed to ensure a certain accuracy for the measurement" to "The minimum distance in a given direction from a light source at which the photometric distance law holds.";  3. "In some cases the crossover distance can be used as the minimum photometric distance (see section A 9.8)." is changed to "For sector projector, the crossover distance can be used as the limiting photometric distance (see section 8.6)" | 1 & 2. The term "Limiting photometric distance" is from the CIE system, with its specific definition based on the ongoing technical document from CIE TC 2-78.  3. According to the content of the crossing distance chapter later, certain instances have been specified to apply to projection sector lights. |
| 4.16 RMS | 3.14 RMS | Added "For a time-depending quantity, positive square root of the mean value of the square of thequantity taken over a given time interval." | According to IEC 60050-103-02-03 |
| 4.17 Goniometer  4.18 Goniophotometer  4.19 Goniospectroradiometer | 3.15 Goniometer, Goniophotometer | 1. "A goniometer is an instrument used for measuring geometric angles." is changed to "Device used for producing or measuring angular rotations."  2. "When such an instrument is combined with a photometer to measure luminous intensity against a geometric angle, the device is called a goniophotometer." is modified to "Photometer for measuring the directional light distribution characteristics of sources, luminaires, media or surfaces.”  3. Added the definition forgoniospectroradiometer "Measuring system that has the capability to measure spectral radiant quantities in different directions from the source." | Relevant content is based on IEC 60050-845@IEC 2020 and CIE TC 2-78 technical documents under development |
| 4.20 Colorimetry | 3.2 Colorimetry | 1. Add "Measurement of colour stimuli based on a set of conventions."  2. Delete "Colorimetry is the science of measuring colours. This could be the colour of a light source or the colour of a surface (e.g. red paint). The colorimetry of surface colours depends upon the illuminating light source, its angle of incidence, the viewing angle, surface texture and other variables. ";  3. Delete "The main focus of surface colorimetry has been the development of methods for predicting visual colour matching based on physical measurements. The colorimetry of surface colours is not covered by this document." | 1. The new added content is based on IEC 60050-845@IEC 2020;  2&3 Since surface color measurement is not involved, so the relevant contentis deleted. |
| 4.21 CIE Standard Colorimetric Observer | 5.4 CIE Standard Colorimetric Observer | Added "Standard colorimetric observer defined by the CIE colour-matching functions.", "The ideal observer whose colour-matching properties correspond to the CIE colour-matching functions adopted by the CIE in 1931 is CIE 1931 standard colorimetric observerr" | The new content is based on IEC 60050-845@IEC 2020 |
| 4.22.Tristimulus values, <of a colour stimulus> | / | New definition:  "Amounts of the reference colour stimuli, in a given trichromatic system, required to match the colour of the stimulus considered.  ...  and k is a normalized constant."  See the draft for details | 1. The definition content of the first paragraph is based on IEC 60050-845@IEC 2020;  2. Added formulas for measuring the light tristimulus values in practical applications of AtoN lights, referencing GB/T 7922-2008 "Method of Measuring the Color of Light Sources." This addition aims to facilitate understanding of the chromaticity measurement section throughout the text. |
| 4.23 Chromaticity coordinates  4.24 Chromaticity | 5.5 Chromaticity | 4.23 Chromaticity coordinates : newly added "Coordinates expressing the quotients of each of a set of three tristimulus values and their sum";  4.24 Chromaticity: Added "Property of a colour stimulus defined by its chromaticity coordinates, or by its dominant or complementary wavelength and purity taken together",".....chromaticity diagram, the plane diagram in which points specified by chromaticity coordinates represent the chromaticities of colour stimuli". | According to IEC 60050-845@IEC 2020 |
| 4.25 color temperature  4.26 Correlated color temperature | 5.6 Color temperature and correlated color temperature | 4.25 Color temperature: new symbol Tc, new definition "Temperature of a Planckian radiator whose radiation has the same chromaticity as that of a given stimulus."  4.26 Correlated color temperature: Added "Temperature of a Planckian radiator having the chromaticity nearest the chromaticity associated with the given spectral distribution on a modified 1976 UCS diagram where u′,v′ are the coordinates of the Planckian locus and the test stimulus." | According to IEC 60050-845@IEC 2020 |
| 4.27 Response time | 3.22 Slew rate | Changed the term "Slew rate" to "Response Time," and modified its definition to: "Time required for the change in detector output to reach, after a step variation of a steady detector input, a specified percentage of its final value. Rise time is ... and fall time is...." (please refer to the draft for details). | Firstly, the term commonly used in international standardization systems to characterize the ability to respond to input signals is "Response Time," and the term "Slew rate" is rarely seen. Secondly, "Slew rate" merely characterizes the performance parameter of the amplifier's ability to track input signals and cannot fully represent the overall response performance of the detector.  The definitions of response time, rise time, and fall time are based on IEC 60050-845@IEC 2020. |
| 4.28 Photometric center | / | "Point in a source from which the photometric distance law operates most closely in the direction of maximum intensity." | Based on IEC 60050-845@IEC 2020 |
| 4.29.Reference center<of the DUT> | / | "The point related to (usually within) the DUT to be placed at the goniometer reference point.  Ideally, this should be the photometric centre of the DUT. However,...... based on the device geometry and the size, shape and position of the light source within the DUT, can be used (see 8.3, 8.5). ” | In goniophotometry, the photometric center is an idealized concept. In practice, the reference center of the measured object is more commonly used in measurement, so the definition is supplemented here. There are also further explanations of related content in 8.3 Alignment and 8.5 Reference Center |
| 5.MEASUREMENT PRINCIPLES | 4. MEASUREMENT PRINCIPLES  4.1. Photometric Distance Law  4.2. Measurement of Angular Luminous Intensity Distribution  4.3. Recommended Measuring Planes  4.3.1. 'Pencil beams'  4.3.2. 'Fan Beams'  4.4. Colorimetry  4.4.1. Tristimulus measurement  4.4.2. Spectral measurement  5 Models and Functions  5.3 Talbot's law  6 measurement equipment | 5. MEASUREMENT PRINCIPLES  5.1. Photometric Distance Law  5.2. Coordinate systems  5.3. Photometric measurement  5.3.1. Spectrophotometry Measurement (based on spectrum)  5.3.2. Integral Method Measurement  5.4. Colorimetric measurement  5.4.1. Spectral measurement  5.4.2. Integral method measurement  5.5. Principle of spectral measurement  5.5.1. Mechanical scanning spectroradiometer  5.5.2. Array-based Spectroradiometer  5.6. Measurement of modulated light  5.6.1. Talbot-Plateau Law  5.6.2. Photometric measurements  5.6.3. Spectroradiometer measurements  5.7. Effective intensity of rhythm light  5.8. Absolute photometry and relative photometry | 1. Added 5.2 Coordinate System:This addition facilitates understanding spatial angles when measuring or describing the distribution of luminous intensity with respect to angles.  2. Removed the original 4.2 Measurement of Angular Luminous Intensity Distribution: Relevant content is covered in 4.17 Goniometer, 4.7.1 Angular Luminous Intensity Distribution and 5.2 Coordinate System  3. Adjust the recommended measurement plane to Chapter 8 Photometry Methods and Requirements: Placing it in the same chapter as measurement procedures enhances intuitive comprehension of the measurement plane.  4. Added 5.6 Measurement of modulated light, 5.7 Effective intensity of rhythmic light, 5.8 Absolute photometry and relative photometry:These additions are based on practical application needs.  5. Integrated relevant content from Chapter 6 and supplemented it to create Sections 5.3 "Photometric Measurement," 5.4 "Colorimetric Measurement," and 5.5 "Principle of spectral measurement": This restructuring improves the flow of the chapters and enhances clarity in section divisions. Principles-related content is consolidated in the new version of Chapter 5, while Chapter 6 focuses primarily on equipment requirements. |
| 5.1 Photometric distance law | 4.1 Photometric distance law | Added "According to the Photometric Distance Law proposed by Lambert in 1760,... Equation 19Photometric Inverse Square Law" | Reference proposal ENG 15-3.1.1.1.2 |
| 5.2 Coordinate system | / | A new chapter is added, see the draft for details | The content refer to CIE 121:1996 / GB/T 22907-2008 and technical documents under development of CIE TC 2-78 . Goniophotometer coordinate system recommendation and pictures from input paper of Germany ENG 16-3.1.1.5.1 |
| 5.3 Photometric measurement  5.4. Colorimetric measurement | 3.23 Spectral mismatch error and correction  6.4 Tristimulus colorimeter | 1. Added:  5.3. Photometric measurement  5.3.1. Spectrophotometry Measurement (based on spectrum)  5.3.2. Integral Method Measurement  5.4. Colorimetric measurement  5.4.1. Spectral measurement  2. The original 3.23 spectral mismatch error and correction is included in 5.3.2  3. The original 6.4 tristimulus colorimeter is revised into 5.4.2 Integral method measurement, adding "The method of measuring the color of a light source using a tristimulus colorimeter is called the integral method. "  4. Add the schematic diagram of photometric integration method | The content is summarized based on the categorization of measurement principles in practical applications. |
| 5.5. Principle of spectral measurement | 6.5 Monochromator  6.6 Spectroscope, spectrometer, spectroradiometer | 1. Integrate and summarize the original contents of 6.5 and 6.6 as follows:  5.5.1 Mechanical scanning spectroradiometer  5.5.2 Array-Based spectroradiometer;  2. Increase the schematic diagram of the array spectroradiometer | The relevant content has been summarized and modified based on the current state of measurement instruments. |
| 5.6 Measurement of modulated light | 5.3 Talbot-Plateau Law | Added 5.6.2 photometric measurement and 5.6.3 spectroradiometer measurement , see the draft for details | Modulated light, as a type of light source, has incomplete measurement descriptions in the original text. Based on the methods commonly used in actual measurements, this section has been supplemented to provide a clearer outline of the procedures for measuring modulated light using both photometers and spectral radiometers. |
| 5.7 Effective Intensity of Rhythm Light | / | new chapter  "The effective luminous intensity of the rhythmic light is calculated according to the Modified Allard Method (MAM) using the convolution method... so that when it is used to deal with the complex waveforms mentioned above, the theoretical calculation results are more consistent with the experiments ." | The first paragraph is based on IALA R0204, and the remaining two paragraphs refer to CIE 229: 2018 5.3 and Annex F |
| 5.8 Absolute photometry and relative photometry | / | new chapter  "For all types of beacon lights, their luminous intensity and luminous intensity distribution ( unit : cd ) can be obtained by direct measurement, and this method is called absolute photometry.... With the application of LED light sources in navigation lights, more and more light sources are integrated in navigation lights and cannot be replaced. The scope of application of relative photometry is increasingly limited, and absolute photometry is more common .” | Summarized based on the current state of measurement instruments. |
| 6 Measurement equipment | 6. Measurement equipment.  6.1. Photometer  6.2. Goniometer type 1.  6.3. "Folding" mirror  6.4. Tristimulus colorimeter  6.5. Monochromator  6.6. Spectroscope, spectrometer, spectroradiometer  6.6.1. Scanning or stepping spectroradiometer  6.6.2. Array-based Spectroradiometer  6.7. Calibrated light sources | 6. Measurement equipment  6.1 Equipment configuration/general rules  6.2 Photometer  6.3 Goniometer  6.4 "Folding" mirror  6.5 Tristimulus colorimeter  6.6. Spectroradiometer  6.7. Calibration light source | 1. After introducing measurement principles in Chapter 5, Chapter 6 primarily provides a concise description and specific equipment requirements for relevant measurement devices to meet measurement needs.  2. Added Section 6.1 "Equipment Configuration/General Rules": This section offers a concise overview of the measurement equipment used, providing readers with an intuitive understanding.  3. Added Section 6.2 "Photometers" and Section 6.3 "Goniophotometers" with equipment performance requirements to fulfill measurement needs.  4. Sections 6.5 and 6.6 have been reorganized and summarized as Section 5.5.1 "Mechanical Scanning Spectroradiometers" and Section 5.5.2 "Array-Based Spectroradiometers." In Section 6.6 "Spectroradiometers," only the equipment requirements have been retained, resulting in a clearer structural framework. |
| 6.1 Equipment configuration/general rules | / | new chapter  "The measuring equipment for measuring the optical performance of the beacon light is mainly a goniophotometer, which is mainly composed of a goniometer, a photometer, and a measurement signal processing system...Luminance meters or spectral luminance meters are also involved in field measurements." | Give a general description of the equipment used in the measurement |
| 6.2 Photometer | 6.1 Photometer | 1. The content of the original 6.1 photometer principle is adjusted to the previous 5.3.2 integral method measurement;  2. Delete the related content about photometric distance law and luminance meter ;  3. Increase the performance requirements for the photometer | 1. Placing the principles section in Chapter 5 "Measurement Principles" is more reasonable, thus eliminating redundancy here.  2. Relevant content regarding photometric distance law is already present in Chapter 5, and the document does not discuss the use of photometers for measurement.  3. To meet measurement requirements, photometers must meet a certain level of performance; otherwise, the reliability of measurement results may be compromised. The performance requirements for photometers are based on ENG 15-3.1.1.1.2 "Measurement and Calculation of Effective Intensity of Aids to Navigation Light." |
| 6.3 Goniometer | 6.2 Goniometer Type 1 | 1. Delete the recommended goniometer type, coordinate system and Figure 19  2. Increase the performance requirements for the goniometer | 1. Relevant content is already present in the Section 5.2 "Coordinate System," and can be directly referenced.  2. Considering that pencil beam aids to navigation lights have relatively small divergence angles, testing necessitates angle intervals not exceeding 0.1°. Therefore, the angle accuracy requirement for the rotating worktable should be within ±0.05°. |
| 6.4 "Folding" mirror | 6.3. "Folding" mirror | Delete equation 9 | Different manufacturers have different ways to obtain the diameter data of the folding mirror, as long as it is ensured that the diameter of the folding mirror should be slightly larger than the cross-sectional size of the optical path formed at this position. |
| 6.5 Tristimulus colorimeter | 6.4. Tristimulus colorimeter | Most of the content is adjusted to 5.4.2 Integral method measurement | Placing it in the measurement principle chapter facilitates a systematic understanding |
| 6.6. Spectroradiometer | 6.5. Monochromator  6.6. Spectroscopes, spectrometers, spectroradiometers  6.6.1. Scanning or stepping spectroradiometers  6.6.2. Array-Based Spectroradiometer.. | The original 6.5 and 6.6 are summarized as 5.5.1 Mechanical Scanning Spectroradiometer and 5.5.2 Array-based Spectroradiometer, and only equipment performance requirements are given in 6.6 Spectroradiometer | Reference CIE S 025/E:2015 "Test Method for LED Lamps, LED Luminaires and LED Modules" for the requirements related to the goniospectroradiometer |
| 6.7. Calibration light source | 6.7. Calibrated light sources | 1. Delete the description of measurement by substitution  2. Delete " For scanning spectroradiometers, that can suffer considerable short-term calibration drift, it is recommended that a spectral irradiance standard reference lamp be used to calibrate the instrument before every measurement session." | 1. Section 6.7 is a description of the calibration light source rather than a description of the calibration method , so delete this part  2. In chapter 9.3.2 of the draft, there is a description of the calibration of scanning spectroradiometers using standard lamps before and after measurement . |
| 7. General measurement conditions | 7. GENERAL LABORATORY PROCEDURES  7.1. Written Procedures and Documentation  7.2. Test Equipment Identification  7.3. Calibration and Traceability  7.4. Identification of Test Items  7.5. Items Under Test  7.6. Environmental Conditions  7.7. Power/Electrical Conditions  7.8. Equipment Warm-up  7.9. Stray and Ambient Light Control  7.10. Source/Data Identification  7.11. Power Monitoring of Item under Test  7.12. Recording System  7.13. Software  7.14. Errors, Uncertainty and Confidence  7.15. Notes/Comments  7.16. Authorised Signatories  7.17. Retention of Data | 7. GENERAL Measurement Conditions  7.1. Test classification  7.2. Requirement for Items Under Test  7.3. Environmental Conditions  7.4. Power/Electrical Conditions  7.5. Equipment Warm-up  7.6. Stray and Ambient Light Control  Annex E Laboratory measurement management | 1. The title of the chapter was changed from "General Laboratory Procedures" to "General Measurement Conditions ": Meeting the necessary measurement conditions is a vital prerequisite for ensuring measurement reliability. The new version supplements and refines the requirements for measurement conditions based on the original draft content. The change to "General Measurement Conditions" aligns better with the content of this chapter. 2. The sections7.1-7.4, 7.10-7.17 are consolidatedinto Annex E : Presenting this content as an informational appendix enhances the structural coherence. 3. Newly added 7.1 Test classification: Summarizing and generalizing based on actual measurement conditions helps readers form an intuitive understanding and aids comprehension. 4. Modified7.2. Requirement for Items Under Test, 7.3. Environmental Conditions, 7.4. Power/Electrical Conditions, and 7.5. Equipment Warm-up: See below for details |
| 7.1 Test classification | / | new chapter  "According to the environment/conditions for measuring the light performance of navigation lights, it can be divided into two types: laboratory measurement and field measurement. ... The relevant parameters can be estimated according to the design parameters and component measurements(another guideline document) ." | Summarize based on the actual application situation, different measurement types have varying requirements for measurement conditions |
| 7.2 Requirements for Items Under Test | 7.5. Items Under Test | 1. "Marine aid-to-navigation light signals should be tested at rated voltage, rather than current or power. The voltage should be monitored, with sense leads attached as close as practical to the lamp inputs or controlling circuitry inputs, and kept constant throughout the measurement process. Current should also be monitored and recorded, to detect any changes in the input power during measurements and allow for correction of measured photometric output (see section A 8.11)." Moved to 7.4 Power /Electrical Conditions  2. Delete "In the case of LED light sources with conditioning circuitry, both the input voltage and current to that circuitry should be monitored. Stand-alone LED are normally rated at a given current rather than voltage because dI/dV is very large at the operating point therefore, in the absence of conditioning circuitry, current should be controlled and monitored rather than voltage.LED aging should be taken into account when carrying out intensity measurements on new beacons and those that have been in service for several years." | 1. All requirements related to electric power/electrical conditions are uniformly adjusted to section 7.4 Electric/electrical conditions to avoid ambiguity between items and their corresponding content.  2. Fluctuations in current and voltage both affect power, hence monitoring of current and voltage is essential. Since monitoring of current and voltage is already addressed in the preceding paragraph, this section has been removed.  The content "Note that all light sources, particularly LEDs and discharge lamps, may require several hundred hours of operation (ageing) prior to being used for measurement purposes." is already present in the previous text. This sentence has been removed to avoid redundancy and any potential confusion for readers. |
| 7.3 Environmental conditions  7.4. Electrical/Electrical Conditions | 7.6 Environmental conditions  7.7. Electrical/Electrical Conditions.. | 1. Modify the indoor environment temperature and humidity requirements:  Original requirement: 25(+5/-10)°C and 60(±10)% relative humidity  Modified to: 25.0°C ±1.2°C for LED light source , 25.0°C ±3.0 °C for other light source; 10 % ~65% relative humidity  2. Add still air ( 0 m/s- 0.25 m/s), dark room environment, no interference factors and other indoor measurement requirements  3. Introduce service conversion factor  4. For a DC power supply equipment, "the output voltage and/or current should be maintained at ±0.1 % or better" is changed to "the output voltage and/or current should be maintained at ±0.2 % or better";  5. For external AC power supply equipment, "the output RMS voltage or current should be maintained within ±0.5%" is changed to "the output RMS voltage or current should be maintained within ± 0.4% . If the rated value is within a range, the middle value shall be taken. The AC power supply should have a specified frequency (50 Hz if there is no special instruction) sinusoidal voltage waveform.” | 1. Proposal ENG 16-3.1.1.2 (refer to CIE S025/E: 2015) recommends a temperature range of 25.0°C ±1.2 °C to control the impact of ambient temperature on light source performance. Since LED performance is more sensitive to temperature than other light sources, the temperature requirements for other types of light sources can be appropriately relaxed from a practical point of view. Therefore, it is stipulated that the indoor measurement temperature of the LED light source should be stable at 25.0 °C ±1.2 °C, and other types of light sources should be stable at 25.0 ° C ±5.0 °C;  2&3. Still air ( 0 m/s- 0.25 m/s), service conversion factor from ENG 16-3.1.1.2 (CIE S025/E: 2015)  4. ±0.4% RMS AC voltage, DC voltage ±0.2%, DC current ±0.2% come from ENG 16-3.1.1.2 ( refer to CIE S025/E: 2015 Test Method for LED Lamps, LED Luminaires and LED Modules ); The AC power supply should be a sine waveform with a specified frequency, in accordance with the IES LM-79 Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products. |
| 7.5. Equipment Warm-up | 7.8. Equipment Warm-up | Add the warm-up stability criterion for practical applications:  "Before measurement, the measured AtoN light shall be operated under the specified character for a long enough time to achieve photometric, electrical stability and temperature balance. ... When the AtoN light under measurement is switched to a different light character or color for subsequent measurement, the stability shall be judged again according to the above conditions before measurement. Record the stabilization time for each measurement" | According to ENG 15-3.1.1.1.2 Measurement and Calculation of Effective Intensity of Aids to Navigation Light |
| 8. Photometry methods and requirements. | 8.1. Standard laboratory photometry  8.2. Alignment  8.3. Photometric system response; V(λ) and f1 '  8.4. Spectral correction  8.5. Measurement of Angular Dependency of Luminous intensity  8.6. Minimum requirements for angular resolution  8.7. Measurement of Time Dependency of Luminous Intensity  8.8. Minimum photometric distance  8.9. Measurement Aperture and Measurement Angle  8.10. Detailed measurement method | 8.1. Standard Laboratory Photometry  8.2. luminous flux Measurement of light sources  8.3. Alignment  8.4. Spectral Correction  8.5. Reference center  8.6. Limiting Photometric Distance  8.7. Measurement Aperture and Measurement Angle  8.8. Measurement of Luminous Intensity and its Angular distribution  8.9. Measurement of rhythm of Light and flash duration  8.10. Detailed Measurement Methods | 1. Modify 8.1 Standard Laboratory Photometry ( see below for details ) , and part of the original 8.1 Standard Laboratory Photometry is moved to the newly added section 8.2 Luminous Flux Measurement of Light Sources;  2. Delete the original 8.3 Photometric System Response; V(λ) and f1 ': Relevant content is already covered in Section 5.3 "Photometry Method," so repetition is unnecessary here.  3. Newly added Section 8.5: As described in Definition 4.29, the reference center of navigation lights is more complex in practical applications. The original draft did not address this aspect. Therefore, this new section is added to provide a more comprehensive understanding. Content is based on the ongoing technical file of CIE TC 2-78 and the proposal ENG 15-3.1.1.1.2 .  4. Modify 8.8 Measurement of Luminous Intensity and its Angular distribution: Based on the original document and the proposal ENG 15-3.1.1.1.2  5. Newly added 8.9 Measurement of rhythm of Light and flash duration: This is a part of the navigation light photometry measurement method, and the content is based on the Chinese transportation industry standard JT/T 761-2022.  6. Modify 8.3. Alignment, 8.4. Spectral correction, 8.5. Reference center, 8.6. Limiting Photometric Distance: See subsequent text for details. |
| 8.1. Standard laboratory photometry | 8.1. Standard laboratory photometry | 1. New added:  "In the laboratory , a goniophotometer is used to obtain angular luminous intensity distribution. If relative photometry is used to measure the navigation lights with replaceable light sources, the luminous flux of the light source shall be measured with an integrating sphere photometer.  The angular luminous intensity distribution over time was measured using a fast photometer in the goniophotometer.  Photodetectors that meet specific sampling frequency and time measurement accuracy requirements (see 8.9 ) are suitable for the measurement of light rhythm and flash period, and the measurement of flash period can also be realized by a stopwatch. ”   1. Delete:   "The measurement of the luminous intensity of a light source in the laboratory is usually carried out by taking an illuminance reading, in lumens per metre squared (lux), of the light source at a measured distance, in metres. The luminous intensity in candelas may then be calculated by multiplying the illuminance by the square of the distance, this is known as the Photometric Distance Law ... A goniometer is usually employed to facilitate the measurement of intensity against angle ” | 1. 8.1 Added a summary to explain the equipment used in standard laboratory photometric measurement and its corresponding measurement parameters 2. Content previously mentioned in the earlier sections, including terminology definitions and measurement principles, will not be reiterated. |
| 8.3 Alignment | 8.2 Alignment | Added examples of alignment operations in real applications:  "As shown in the figure below, the AtoN lamp to be measured is fixedly installed on the rotating workbench to make sure the reference center of the AtoN lamp coincides with the rotating center of the rotating workbench... The photometer should be aligned with the reference center of each light-emitting area during measurement, and the data of each light-emitting area shall be reported” | According to ENG 15-3.1.1.1.2 Measurement and Calculation of Effective Intensity of Aids to Navigation Light |
| 8.4. Spectral correction | 8.4. Spectral correction | Added content about correction factor: "If the SCF cannot be obtained, a strict alternative method can be used to obtain the correction factor..The correction factor will have an associated uncertainty from the spectroscopic measurement process and the relevant calibration details of the equipment used in the measurement. " | According to ENG 15-3.1.1.1.2 Measurement and Calculation of Effective Intensity of Aids to Navigation Light |
| 8.6 Limiting Photometric Distance | 8.8 Minimum photometric distance | Add "For example, when the AtoN light is in the steady light state, the initial distance between the photometer and the AtoN light is 20 times the diameter of the lens of the measured AtoN light . Then, move the photometer so that the relative distance between the photometer and the reference center of the AtoN light increases by 1 m each time, and measure the luminous intensity at each distance until that the three reading changes (maximum subtract minimum) divided by the last value is less than 0.5%” | According to ENG 15-3.1.1.1.2 Measurement and Calculation of Effective Intensity of Aids to Navigation Light |
| 8.8. Measurement of Luminous Intensity and its Angular distribution | 8.5 Measurement of Angular Dependency of Luminous Intensity  4.2 Measurement of Angular Luminous Intensity Distribution  4.3 Recommended measuring planes  8.6 Minimum Requirements for Angular Resolution  8.7 Measurement of Time Dependency of Luminous Intensity | 8.8.1. General  8.8.2. Recommended Measuring Planes  8.8.3. Luminous intensity distribution measurement  8.8.4. Measurement of Specification Peak Intensity  8.8.5. Measurement of Specification Peak Intensity of array AtoN light | 1. The original content of Section 8.5 is reorganized as Section 8.8.1 General.  2. The original content of Section 4.2 is moved to Section 8.8.2.  3. Add Section 8.8.3 "Luminous intensity distribution measurement" Section 8.8.4 "Measurement of Specification Peak Intensity" and Section 8.8.5 "Measurement of Specification Peak Intensity of array AtoN light". These sections are based on the proposal ENG 15-3.1.1.1.2 and provide improved measurement operational details. The original content of Sections 8.6 and 8.7 is incorporated within these new sections. |
| 8.8.1 General | 8.5 Measurement of Angular Dependency of Luminous Intensity | Deleted "A goniophotometer consists of a goniometer (tilt and turn) table, on which the item under test is mounted, and a distant photometer that measures the light emanating from the item. As the goniometer is moved or stepped through various angular positions, the photometer records the luminous intensity at each angle. There is an important relationship between the angular resolution of the goniometer and the measurement angle of the photometer (see section A 9.9). ” | The relevant content is already covered in the definition of the goniophotometer. Redundant and repetitive content should be removed. |
| 8.8.2 Recommended Measuring Planes | 4.3 Recommended measurement plane | Modified "For omnidirectional lights with one colour only, at least three planes should be measured (e.g. with horizontal angle φ = -120˚, φ =0˚, φ = +120˚)."to "For omnidirectional lights with one colour only, at least three planes three equally spaced vertical planes shall be measured, one of which shall include the characteristic vertical plane where the 10% percentile luminous intensity lies" | In the original 8.6.1, "A minimum of three equidistant vertical profiles should be recorded, one of which should be taken at a position where the on-axis intensity is close to the 10th percentile value for the horizontal profile", so the relevant requirements are unified and clarified |
| 8.8.3.-  8.8.5 | 8.6 Minimum Requirements for Angular Resolution | Merge the original 8.6, 8.7 with the relevant content in the proposal ENG 15-3.1.1.1.2 to form 8.8.3-8.8.5 | The content of the original draft and the content of the proposal ENG 15-3.1.1.1.2 Measurement and Calculation of Effective Intensity of Aids to Navigation Light have been consolidated. 8.7 Measurement of Time Dependency of Luminous Intensity essentially aims to measure the effective intensity of the rhythmic light, so it is directly included in the relevant chapters as a note. |
| 9.1 Standard Laboratory Colorimetry | 9.1 Standard Laboratory Colorimetry | 1. "When measuring the overall colour of a light, the measurement may be carried out by placing the beacon in an integrating sphere."revised to "For the light with only one color or the same color, the overall color of the light can be measured at close range or by placing the beacon light in an integrating sphere. ”  2. Deleted "The junction temperature of an LED is proportional t its wavelength"  3. Added "When the tristimulus colorimeter is used, multiple measurements can be taken within the flash duration to take the average; when the spectroradiometer is used, the integration time can be set as the flash duration, that is, the average color within this time can be obtained." | 1. Modify and improve the original description  2. The statement is not rigorous  3. Provide a specific and detailed description of the method for measuring the average color within the flash duration. |
| 9.3 Measurement System Spectral Response | 9.3.Measurement System Spectral Response | Added content about the colorimeter spectral mismatch correction factor: " For the selected calibration light source, the relative spectral responsivity of the colorimeter can be expressed in the form of normalized spectral responsivity... is the relative spectral responsivity . " | According to GB/T 28197/CIE 179-2007Methods for characterizing tristimulus colorimeters for measuring the color of light |
| 9.7 Measurement procedure | / | Add Measurement procedures of  9.7.1. Tristimulus colorimeter  9.7.2.Spectroradiometer  See the draft for details | 9.7.1:According to GB/T 7922-2008Method of measuring the color of light sources  9.7.2: According to GB/T 28197-2011/CIE 179-2007 Methods for characterizing tristimulus colorimeters for measuring the color of light |
| 9.8. Detailed measurement method | 9.7. Detailed measurement method | Delete "Measurement uncertainties for both methods are currently under review" | The original document was drafted a long time ago, and the two methods are currently relatively mature |
| 10.1.1 Main values of symmetrical/asymmetrical intensity distribution | 10.1.1 Main Values of a Symmetric Intensity Distribution  10.1.2.Reduced Values for Type Testing or Type Approval | 1.10.1 Add "If possible, try to give detailed data in tabular form , such as giving the table of luminous intensity versus angle"  2. 10.1.1 Modify the maximum intensity of the reference axis Imax to reference intensity I0 , and the following text in 10.1 is also modified accordingly.Delete the figure 28 asymmetrical luminous intensity distribution | 1. Enhance the format of measurement reports to provide additional useful reference information.  2. For the potential non-uniform distribution in practical applications, when calculating the beam divergence angle, the intensity value that should be primarily employed is the reference intensity I0 value along the reference axis. If the actual maximum value is not on the reference axis, it should be clearly stated along with the intensity value and angle during the measurement, referring to IALA R0203 for vertical divergence angle. Figure 29 is sufficient to illustrate the method of calculating the beam divergence in practical applications. |
| 10.1.2.Main values for Omnidirectional Beacons (fan beams) | 10.1.3. Main values for Omnidirectional Beacons (fan beams) | 1. Add "See 8.8.3 for angular resolution when measuring for horizontal distribution profiles "  2. Delete "It is important therefore, to ensure that the peak intensity (I0) in flashing mode is measured at the character specified and clearly labelled so as not to be confused with the fixed (continuous) intensity."  3. Amend "Measurements in a minimum of three vertical planes, preferably including and equidistant from the reference vertical plane or datu" to "Measurements in a minimum of three vertical planes, including and equidistant from the plane where 10th percentile intensity lies" | 1. The10th percentile intensity is related to the obtained data results. If the angular resolution of the measurement is different, the obtained results may be different. Therefore, the description of angular resolution during measurement is given here.  2. The intensity distribution is measured under the constant light state, so it does not involve the rhythmic light state to measure the peak intensity.  3. Unify the requirements of the vertical distribution measurement planes that appear in the context |
| 10.1.3.Rotating Beacons (pencil beams) | 10.1.4.Rotating Beacons (pencil beams) | 1. Modify"Graphs of the vertical and horizontal profiles should be plotted between the points where the intensity falls below **5**% of maximum." to "Graphs of the vertical and horizontal profiles should be plotted between the points where the intensity falls below 1% of maximum."  2. " The horizontal angular intensity variation may be converted to a time-dependent profile at specific rotation rates for calculation of the effective intensity and flash duration" is revised to "Based on the horizontal distribution diagram of the luminous intensity of the rotating beacons measured in the non-rotating state (that is, the luminous intensity - angle correspondence) and the rotating rate of the rotating beacons (that is, the angle -time correspondence ), the horizontal angular intensity variation may be converted to a time-dependent luminous intensity profile at specific rotation rates for calculation of the effective intensity and flash duration." | 1. The minimum requirement of the draft for the angular resolution of the rotating aids to navigation is that both the horizontal and vertical distribution maps reach 1% intensity point (8.6.2 of the original document, 8.8.3.1 of the revised version), and this is unified here.  2. Supplementary explanations are provided for the conversion methods at specific rotation rates. |
| 10.3 Flash duration | 10.3 Flash duration | Add "In cases where LED lights may have intensity spikes, pulse width modulation (PWM), a convolutional method may be used to determine the flash duration , see Annex G." | According to the proposal ENG 9-8.5 Implementation of the Convolution Function to Determine Flash Duration |
| 10.4 Effective intensity | 10.4 Effective intensity  "The ratio of continuous intensity to flashing (peak or effective) intensity may be calculated and used to scale the 10th percentile figure." | 1. Amended to "Through the ratio of continuous intensity of the beacon light at the same angular position to flashing (peak or effective) intensity, the effective luminous intensity at the 10th percentile can be calculated correspondingly"  2. Added"When a group of flashes make up a flash character, each flash should be measured one by one, and its effective light intensity should be calculated, the reported effective intensity shall be that of the lowest individual flash effective intensity ." | Supplementary explanation to the original text |
| 10.10 Nominal range | 10.10 Nominal range | Added "The nominal range of a light used as a marine AtoN is the maximum distance at which a light can be seen, as determined by the nominal conditions / in the nominal conditions. The nominal conditions are meteorological visibility 10 NM and the threshold of illuminance on the eye of the observer 2 × 10‐7 lx for night time nominal range and 1 × 10‐3 lx for day time nominal range." | According to ENG15-3.1.1.4 Definition of Nominal Range |
| Annex D Detailed Measurement Method - Spectroradiometry | Annex D Detailed Measurement Method - Spectroradiometry  "To calibrate or characterize a spectroradiometer system, it is often necessary to use a spectral radiance or irradiance standard lamp ." | 1. Modified to "To calibrate or characterise the spectroradiometer system, it is usually necessary to use a spectral radiant flux or irradiance standard lamp."  2. Delete the calculation part in the result of D.4  3. Delete the example table in D.5  4. Delete D.6 | 1. The data unit of the calibration lamp in the subsequent content is milliwatts per nanometer wavelength ( mW ·nm -1 ), which is consistent with the data unit of the spectral radiant flux standard lamp.  The data unit for the spectral radiance standard lamp should be watts per square meter per nanometer per steradian (W·m-2·nm-1·sr-1).  2.There is an error in the calculation process. Radiant flux is obtained by multiplying irradiance by the radiation area, not by the square of the distance.  3. The example table lacks complete calculation information and may mislead readers. Formulas for tristimulus values and chromaticity coordinates have been provided in previous sections (4.22-4.23), and nowadays these calculations are often automated by computers, eliminating the need for manual calculations.  4. There are errors in the calculation content. Please refer to the formula in Definition 4.7 (Formula 8) for the correct calculation. |

1. Input document number, to be assigned by the Committee Secretary [↑](#footnote-ref-1)