Technical specifications of C-type Goniophotometer System with mirror arrangement for measurements of Photometric and Colorimetric parameters of Lamps, Luminaires and SSL Lighting Devices

1.	**Goniophotometer and Goniospectroradiometric measurement System**	
	Item	**Minimum Features/Parameters/Standard requirements**
(i)	Goniophotometer system and working principle	C-type mirror goniometric system fully automated with computerized system & software The Goniometer should be configured for operation with both Photometer & Spectroradiometer modes, Mode selection should be fully automatic
(ii)	Goniophotometer in accordance with	-EN 13032-1, type 3.1 -LM 75-01, type 3.3.2 -CIE Publication No. 70 (1987) Fig. 18, Fig. 19
(iii)	National and International Standards to be fulfilled by the complete system (limited to sections applicable to goniophotometric and goniospectroradiometric procedures only)	**Indian Standards** IS 16106: 2012 for Solid State Lighting Products IS 16107 (Part-5/Sec-1): 2012 for LED Luminaire IS 16103 (Part-2): 2012 for LED Modules for general lighting IS 16102 (Part-2): 2017 for Self-ballasted LED lamps IS 10322 (Part-5/Sec-1): 2012 for Fixed General purpose luminaire IS 10322 (Part-5/Sec-2): 2012 for Recessed luminaire IS 10322 (Part-5/Sec-3): 2012 for Road & Street light luminaire IS 10322 (Part-5/Sec-4): for portable luminaire IS 10322 (Part-5/Sec-5): for flood light luminaire IS 13383 (Part-1): 1992: Method of photometric measurement of luminaires for use in interior lighting IS 13383 (Part-2): 1992: Method of photometric measurement of luminaires for road & street lighting **Corresponding equivalent IEC and CIE Standards:** IEC 62612:2013, IEC 62717:2014, LM 79:2008, IEC 62722-2-1, EC 60598-2-1, EC 60598-2-2, EC 60598-2-3, EC 60598-2-4, EC 60598-2-5, CIE Publication no. 24 (TC 2.4) 1973 and CIE Publication no. 27 (TC 2.4) 1973 **American Standards** IESNA LM-79-08 Approved method: Photometric and Electrical measurement of Solid State Lighting Products

		IESNA LM 35-02 Approved method for the Photometric Testing of Floodlights Using High Intensity Discharge or Incandescent Filament Lamps IESNA LM 31-95 Photometric Testing of Roadway Luminaires Using Incandescent Filament and HID Lamps IESNA LM 41-98 Photometric Testing of Indoor Fluorescent Luminaires IESNA LM 42-72 Computing Visual Comfort Ratings for Interior Lighting IESNA LM 46-98 Photometric Testing of Indoor Luminaires Using HID or Incandescent Filament Lamps IESNA TM-30-15 Method for Evaluating Light Source Color Rendition **CIE Technical Reports and Standards** S-025: Test Method for LED Lamps, LED Luminaires, and LED Modules 43:1979 Photometry of Floodlights 69:1987 Methods of Characterizing Illuminance Meters and Luminance Meters 70:1987 The Measurement of Absolute Luminous Intensity Distributions 84:1989 The Measurement of Luminous Flux 121:1996 The Photometry and Goniophotometry of Luminaires 127:1997 Measurement of LEDs 13.3:1995 Method of Measuring and Specifying Colour Rendering properties of Light Sources **European Standard** EN 13032-1 Light and Lighting Measurement and presentation of photometric data of lamps and luminaires, Part 1: Measurement and file format EN 13032-4 Light and Lighting Measurement and presentation of photometric data of lamps and luminaires, Part 1: LED Lamps, Modules, and Luminaires **Further Standards** ANSI/NEMA/ANSLG C78.377-2008 ENERGY STAR Program Requirements for Integral LED Lamps: Eligibility criteria Version 1.4 Appendix A OR as per Bureau of Energy Efficiency (BEE) India's Energy Star rating

1.1	**Goniometer**	
	Item	**Minimum Features / Parameters / Standard requirements**
(i)	Size of the device under test (DUT)	Object of size up to 2000 mm or larger in diagonal length and up to 800 mm in height
(ii)	Weight of DUT	Object of weight up to 50 kg or higher should be measurable
(iii)	Method of alignment and orientation	Motorized height adjustment of test object Remote controlled built-in laser alignment system for accurate alignment Remote controlled motorized adjustment of counter weight
(iv)	Height adjustment of DUT	Up-down adjustment of luminaire should be motorized with remote control Adjustment range: ≥ ±150mm
(v)	Angle accuracy	C-axis 0.1° or better γ-axis 0.1° or better As per requirements of CIE S 025 (A certificate traceable to NMI / ISO/IEC 17025:2005 or latest, accredited laboratory should be submitted with the system)
(vi)	Angular encoder	Optical type
(vii)	Stray light correction	Provision of integrated stray-light correction
(viii)	Emergency stop function	Emergency stop control at goniometer and control unit to stop component movements at once

1.2	**Mirror**	
(i)	Mirror Size	Allows for measurement and testing of DUT of diagonal length up to 2000 mm
(ii)	Mirror reflectance and flatness	Silver rear coated and suited for LED (narrow beam) sources Deviation in uniformity of reflectance and flatness ≤ 1.5% as required in fulfillment of EN 13032, Annex C (Manufacturer's certificate should be provided in support of above, traceable to ISO/IEC 17025:2005 or latest, accredited laboratory)
(iii)	Polarization effect of mirror	≤ 0.2% for luminous flux measurement ≤ 0.3% for luminous intensity measurement (In accordance with IES LM 79-08 Sec. 9.3.5 and as per requirements of CIE S 025, Table D.3) Test reports should be submitted, issued by a NMI-MRA participant laboratory, verifying the mirror contribution to polarization for luminous flux and intensity distribution testing of identical system
(iv)	Mirror samples	A sample of size 10cm x 10cm (approximately) of the mirror, employed in the Goniophotometer, should be delivered with the system for future reference for re-calibration of photometer head and verification of Goniophotometer's mirror characteristics for uncertainty estimations incurred due to flatness, reflectance and spectral influence of the mirror (Suppliers should submit certificates covering uncertainties due to above mentioned factors of mirror)

1.3	**Photodetectors**	
(i)	Type of photodetectors	V(λ) corrected Silicon photodetector
(ii)	Range of illuminance measurement of photodetector	0.0002 lx - 80,000 lx or better at 10m distance (0.02 cd - 8×10^6 cd or better at 10m distance)
(iii)	Spectral match of detector f_1'	f_1' ≤ 1.5% including the spectral influence of the mirror(s) Supplier should submit calibration report issued by ISO/IEC 17025:2005 or latest, accredited metrology institute participant in CIPM-MRA Multipoint calibration in the wavelengths range of the V(λ) function
(iv)	Accuracy class of photometer f_{total}	• f_{total} ≤ 3.0% including influence of the mirror (for the perpendicular light incidence Cosine response f_2=0 and the maximum value for f_{total} is 3%, as per the statement at point no.3, below the table 3 of EN 13032-01:2004) (As per DIN 5032 Part 7 Class L, EN 13032-01:2004 Table 3) • Supplier should submit value of $f_{total,}$ as per EN 13032-01:2004 Table 3, quoting each contributing component values for $f_{total,}$ at the time of submission of tender documents • Supplier quoting lower values for any component(s) of f_{total} than those nominal values stated in EN 13032-01 Table 3, should submit calibration report in support of uncertainty claim for the components, issued by ISO/IEC 17025:2005 or latest accredited metrology institute participant in CIPM-MRA at the time of submission of tender documents
(v)	Spectral mismatch correction factor f^*	f^* ≤ 1.0% including spectral influence of mirror as per CIE S-025/E:2015 Annex. C.3.5 Supplier should submit a test report issued by ISO/IEC 17025:2005 or latest accredited metrology institute participant in CIPM-MRA Factor correction by means of software correction or by employment of on-board spectrometer should not be incorporated
(vi)	Photometric linearity	Absolute responsivity of the photometer against a light source with distribution temperature 2856K at more than three given illuminance levels between 10lx and 10klx ≤ 0.1% or better at each illuminance level A certificate issued by a NMI of an identical photometer should be submitted
(vii)	Thermostatic stabilization	Photometer heads should be temperature stabilized
(viii)	Signal amplification	Signal amplification should be built-in the photometer head for loss free transmission over cable
(ix)	Calibration method	Calibration against a Photometric standard lamp via the mirror reflection

		All calibration hardware and software should be included in the scope of supply
(x)	Photometric test distances	The System should be capable of testing at multiple test distances (both far and near field) covering low intensity as well as high intensity sources (e.g. for DUT of diagonal size up to 2000mm measurement distance should not be less than 30m)
(xi)	Method of switching from one test distance to another	Switching shall be fully automatic and software controlled

1.4	**Colorimeter (Spectroradiometer to be deployed with mirror goniometer for goniospectroradiometry)**	
(i)	Spectral range	360nm-780nm
(ii)	Detector Type	CCD type with TE cooling, Good stability with more than 90% quantum efficiency at peak wavelength, low readout noise, low dark current (≤1200 e^-/pixel/s at 25°C) for low level light detection with minimum no. of effective pixels: 1024×122, each having effective pixel size of 24×24µm (max.) OR better image sensor
(iii)	Spectral resolution	≤ 3.0 nm at FWHM
(iv)	Color coordinates accuracy	≤0.002 in color coordinates (x, y) Supplier should submit certificate issued by ISO/IEC 17025:2005 or latest, accredited body
(v)	Field of view	Should be adjustable to mirror distance and diameter
(vi)	Measurement /test distance	Measurements should be made via the mirror reflection As per requirement of LM 79-08 Sec.12.2 and CIE S 025 for color distribution measurements via spectrometer under the far field conditions
(vii)	Stray light correction	Should be equipped with integrated stray light correction
(viii)	Method of switching between goniophotometric and goniospectrometric tests	Should be fully automatic and no manual hardware and/or test object re-configuration or alignment check required

(ix)	Calibration method	Calibration against a spectral irradiance standard lamp via mirror reflection (As per requirements of CIE S 025 Sec. 4.5.3.2 and LM 79-08-Sec. 12.2) All calibration hardware and software should be included with certificates traceable to a National Metrology Institute
(x)	Spectral irradiance standard lamp	Should be supplied with certificate issued by a National Metrology Institute
(xi)	Software functions for colorimetry with Goniospectroradiometer	Software for computer controlled operation of spectroradiometer in conjunction with the goniometer for computer based operation, measurement, system calibration, and automatic test report generation for particular measurement of the spectral values and subsequent calculation of the colorimetric characteristics
1.5	**Goniophotometric and Goniospectroradiometric Measurement Speed**	
(i)	Measurement speed for goniophotometer and Goniospectroradiometer	Supplier should indicate the scan speed, method and specify the total measurement time for DUT after stability
(ii)	Testing time for street light, flood light after stability	Supplier should indicate the scan speed, method and specify the total measurement time for DUT after stability
(iii)	Testing time for absolute luminous flux of a symmetric light source after stability	Supplier should indicate measurement time required and method
1.6	**Luminaire mounting jigs and lamp holders**	
(i)	Test objects mounting jigs	Universal type of jigs to be provided for mounting ceiling, downlights, panel lights, street light, flood light, post top light etc.
(ii)	Measuring lamp holders	4 wire contact, gold plated, Kelvin type lamp-holders for line sense, holders at lamp base for lamp types B22, G5, G13 with ballast, E40, E26/27, E14, E12, GU10, GX5.3 Inclusion of suitable adapters for easy connection
1.7	**Power Sources and meters for powering test objects**	
(i)	AC power source	(a) Voltage range 0-250 V, Current Range: 0-12A (min) at 50 Hz (stability: ≤ ±0.5%) with voltage & current uncertainty ≤ 0.2% (As per requirement of CIE S 025/E:2015 Sec. 4.3.2)

		(b) Separate Source to be provided for DUT of less than 30W The input current shall be monitored and regulated to within ±0.5% of the rated rms value during photometric measurements as per IS:16105-2012
(ii)	DC power source	Voltage range: 0-120V, Current Range: 0-15A (min), with voltage and current uncertainty of ≤ 0.1%, the ripple voltage ≤ 2% of the DC output voltage as per requirement of IS:16105-2012
(iii)	Power Analyzer	Power analyzer with harmonics package with voltage/current accuracy: ≤ ± 0.2% Test/Calibration report from a laboratory accredited as per ISO/IEC 17025:2005 or latest, to be provided in support of above As required by CIE S 025/E:2015 Sec. 4.3.2 calibration uncertainty of AC voltmeter: ≤ 0.2% and DC voltmeter: ≤ 0.1%
(iv)	Power source integration	Complete software control for computerised operations & data acquisition of power sources and power meter, all other applicable electrical parameters and recording of DUT stabilization as per EN 13032-04 and IES LM 79 parameters
(v)	Display and control unit integration	Housing of all display and control electronics units in a separate electronics rack
1.8	**Flicker Measurement System (With software evaluation) for**	
(i)	Flicker frequency	
(ii)	Flicker Percentage	
(iii)	Flicker index	
(iv)	Portrayal of test results in tabular and in graphical form	
1.9	**Integrated temperature measurement system for the Goniophotometer system**	
(i)	Temperature measurement and monitoring system	Temperature sensors for measurement and recording the ambient laboratory temperature in the vicinity of DUT and also for measurement on the surface of DUT as per the requirement of CIE S 025 (EN 13032-04)
(ii)	Temperature monitoring and data generation	Temperature data should be recorded online during the photometric and spectroradiometric measurements. The data should be recorded and handled by the controlling software and should appear in the test reports

1.10	**PC and Software**	
(i)	Computer System und Software	Online UPS for running the complete setup with at least 2 hours of backup Standard PC- included OS Windows (latest version), compatible with the software Monitor: Screen size: 32 inches (Approx.) - Laser colour printer Software required for computer based performance of electrical control (sense and feedback of DUTs, performance of goniophotometric/goniospectroradiometric testing, evaluation of test results, report generation
(ii)	Pre-programmed test for routine measurements	The software should provide routine programmes employed for common measurements for general lighting applications, floodlight, indoor, roadway
(iii)	Custom routines	Software should enable the user to program custom routines for specific measurements
(iv)	Report generation	The software should enable automatic test report generation, documentation and visualization and export of any test data in EXCEL format (MS Office)
(v)	Reported data formats for photometrics	ASCII file format EULUMDAT file Format EULUMDAT/s file format IESNA 86 format IESNA 91 format IESNA 95 format IESNA 2002 format CIE publication 102:1993 format EN 13032-1: 2004 format CIBSE Technical Memorandum TM 14 LM 79-2008
(vi)	Photometric parameters measured	Luminous intensity distribution Luminous flux (zonal and total) Total spectral radiant flux (radiometric)
(vii)	Colorimetric parameters calculated from goniospectroradiometric measurements	The colorimetric parameters should be presented given as spatially averaged values, weighted to intensity, over the angular range of light emission in orientation on IES LM 79-08 Chap 12

		Reported parameters include: -Chromaticity coordinates -Correlated color temperature -Color rendering indices R1-R16 + Ra -7 step MacAdam's Ellipses (according to current ANSI bin definition) and Δ u', Δ v' as required by Energy Star requirement -Weighted CRI -CRI in accordance with IES TM 30 -Calculation of CQS -Flexible selection of n-step MacAdam ellipse portrayal around average color point -3-D interactive portrayal of the measured colorimetric parameters -Plot of numerous spectra displayed simultaneously in diagram format -Built-in verification procedure for spectroradiometer: The system should be capable to perform absolute calibration of the spectrometer in terms of luminous intensity values, measured in the far field: W/(m² nm) or W/(sr nm) by the SI photometer.
(viii)	Further Quantities calculated by software	Beam angle, isocandela, isolux, luminaire efficiency, glare, utilization coefficient, voltage, current power, THD, maximum ratio of space to height etc.
(ix)	CIE/IES operational inter-conversion	Software should also enable measurement / inter-conversion of data between CIE C-gamma and IES L, V coordinate systems. Data output selectable in various units (lux, candela, and footcandle)

1.11	**System Calibration and verification of performance**	
(i)	Standard lamps for goniophotometer	**4 (FOUR)** luminous flux standard lamps (incandescent at 2856K) with certificate traceable to NMI Provision of suitable lamp holder for connection to goniophotometer enabling electrical connection of line and sense leads to power source/wattmeter in system rack for system calibration purposes
(ii)	Standard lamps for goniospectroradiometer	**4 (FOUR)** FEL type Halogen incandescent lamps for calibration of the spectroradiometer via the mirror with certificate issued for lamp CCT, x, y; voltage, current, issued by a National Metrology Institute Provision of suitable lamp holder for connection to goniospectroradiometer enabling electrical connection of line and sense leads to power source/wattmeter in system rack for system calibration purposes **4 (FOUR)** Quartz Halogen incandescent lamps for calibration of spectral radiant flux with certificate issued by a National Metrology Institute
(iii)	Absolute calibration of goniophotometer	Issuance of Manufacturer's Certificate with indication of measurement uncertainty The difference between measured lumen value with the mirror goniophotometer and that of certificate value of the calibrated luminous flux standard lamps shall lie within the certificate uncertainties of the flux standards
(iv)	Test of the mirror	Test of the mirror for variation in reflectance and flatness according to EN 13032-1, Annex A, Issuance of Manufacturer's Certificate
(v)	Test of polarization of the mirror	Verification of polarization of the mirror under employment with a calibration certificate issued by a National Metrology Institute for the polarization effect
(vi)	Calibration of the relative spectral irradiance responsivity of the photometer heads and mirror	-Calibration of the relative spectral irradiance responsivity of the photometer head(s) and mirror assembly -Verification of the f_1' quality index of the photometer head and mirror assembly for the V(λ) correction according to EN 13032-1 - Verification of the spectral mismatch indices of the photometer head and mirror assembly as required with specific spectra in accordance of CIE 127:2007 Fig. 2

		Certificate to be issued by a National Metrology Institute
(vii)	Verification of system alignment	Verification of alignment of optical path to be demonstrated by means of a distance laser with calibration certificate traceable to a National Metrology Institute along with Manufacturer's Certificate
(viii)	Verification of color measurement system	Delivery and operation of a reference SSL light source with calibration certificate issued by a National Metrology Institute for the -Chromaticity coordinates -Correlated color temperature -Color rendering indices R1-R16 + Ra The color parameters measured (at given points along the vertical axis C and the mirror axis γ of the goniometer) should lie within the given certificate uncertainties.
(ix)	Colorimeter	An independent tristimulus colorimeter with NMI traceable certificates for verification of color coordinates and color temperature with 4-digit displays for X, Y, Z and x,y,Y and CCT
1.12	**Pre-requisites for installation and After Sales Service Support**	
(i)	Laboratory Planning	Provision of layout diagram (with sizes of components), other necessary site requirement including electrical requirement and ambient conditions in the Laboratory, namely, Air Conditioning, Temperature, Relative Humidity etc.
(ii)	Installation	Installation of the complete system, verifications and demonstration of functionality of all options/modes on site as per the specifications
(iii)	Software Support	Technical issues related to all kind of software, that is used to operate the Goniophotometer and to generate reports
(iv)	Hardware Support	Technical issues related to Hardware and its operation should be resolved
(v)	Guarantee / warranty	(a) At least three years guarantee on vital components of the system from the date of satisfactory installation & commissioning of the equipment (b) Warranty of at least five years on performance of the system up to the indented specifications after the expiry of guarantee period (c) Guarantee that Supplier/manufacturer will supply spare parts, as and when required, for a period of at least ten years after the expiry of warranty period

(vi)	Performance certificates	Production of at least 3 performance certificates from user Institute / Organization (preferably from NMIs and Govt. Sector) where Instrument/System of similar type & capacity has been supplied / installed
(vii)	Annual maintenance contract (AMC)	Provision of at least five years of AMC on parts and spares including optics, electronics, detectors along with service charges after the successful installation and verification of performance
(viii)	Training at place of installation	At least four persons from NPL should be trained free of cost for all types of instrument related work viz. operation etc. for at least 5 working days at the place of installation
(ix)	Training at Manufacturer site	1. Training of two persons at the manufacturing site should be provided. Numbers of days of training for two persons are to be indicated with break up cost in the price bid which include air fare, boarding, lodging etc. 2. Training duration for two persons at the manufacturing work are to be mentioned only in the technical bid