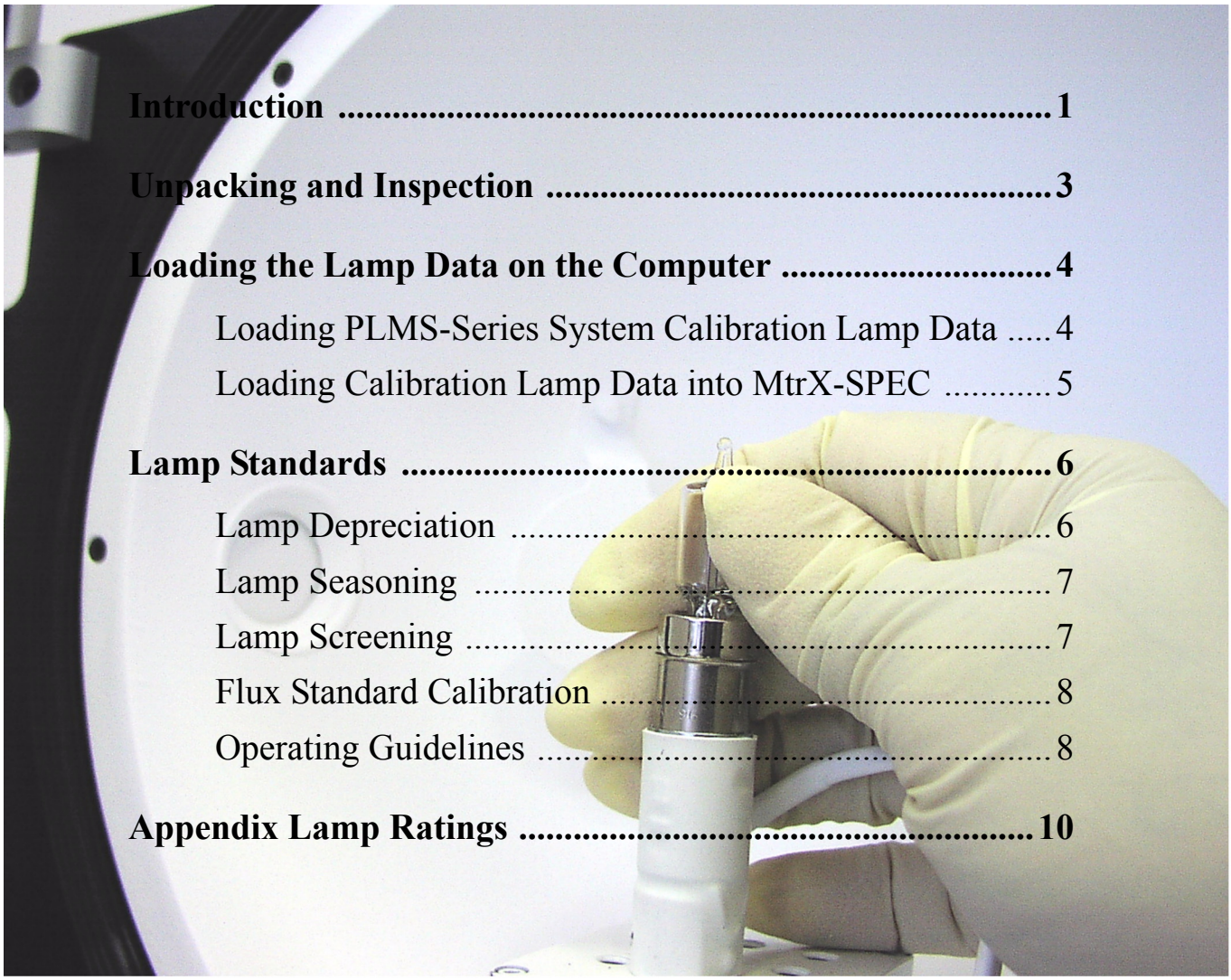
Flux Standards



Introduction 1

Unpacking and Inspection 3

Loading the Lamp Data on the Computer 4

Loading PLMS-Series System Calibration Lamp Data 4

Loading Calibration Lamp Data into MtrX-SPEC 5

Lamp Standards 6

Lamp Depreciation 6

Lamp Seasoning 7

Lamp Screening 7

Flux Standard Calibration 8

Operating Guidelines 8

Appendix Lamp Ratings 10

Introduction

An integrating sphere is the ideal optical device for collecting and measuring the luminous or radiant flux from a spatially distributed light source. Integrating sphere light measurement systems typically use the comparison method as the means of light measurement. The comparison technique employs a calibrated light source with a known flux output for comparison to the light emission of a test lamp. A flux standard is an incandescent lamp that serves this purpose. The calibration data for all Labsphere luminous and spectral radiant flux standards is traceable to the National Institute of Standards and Technology (NIST) standards.

Labsphere manufactures two types of flux standards for use as calibration lamps in our light measurement systems. A total flux standard typically is mounted in a lamp post configured socket positioned inside the integrating sphere so that all light is transmitted isotropically onto the surrounding sphere walls. A total flux standard has the part name prefix "SCL" and is calibrated for luminous and spectral radiant flux. The second type of flux standard is called a "forward flux standard". Forward flux standards have the "FFS" part name prefix and are directional in their emission. A forward flux standard typically mounts outside the integrating sphere or other radiation collection device.

The SCL-600 is a low output flux standard for use in the LMS-100 and LMS-200 light measurement integrating spheres. This standard is calibrated in units of luminous flux (lm) and spectral radiant flux (W/nm) across the spectrum 350 - 1050 nm. The SCL-1400 flux standard generates higher light emission than the SCL-600 and is use in the LMS-400, LMS-650 and LMS-760 spheres. A third flux standard is the miniature SCL-050. This spectral flux standard is utilized in certain custom light measurement systems. The cor-

rect total flux standard and lamp socket for a light measurement sphere is included in the light measurement system package. All luminous and spectral radiant flux standards are sold separately as well. Calibration data is provided in hard copy and electronic text format on a CDROM.

Following the recommendations of national laboratories for photometric calibration, calibrated total luminous and radiant flux standards are sold in sets of three screened and seasoned lamps. The use of three lamps prolongs the useful life of each lamp as they may be used interchangeably. The multiple lamp set allows the user to check the lamps against each other to verify calibration data over time, and to determine if any damage has occurred during handling or shipping.

Flux Standard	Labsphere Part No.	LMS Compatibility	Electrical Wattage	Approximate Luminous Output	Lamp Base	Lamp Current	Power Supply
SCL-050	AS-02528-001	LMS-040	4.4 W	50 lm	3.2 mm bi-pin	1.050 A	LPS-100-0105
CSFS-050	AS-02528-000	LMS-040	4.4 W	50 lm	3.2 mm bi-pin	1.050 A	LPS-100-0105
SCL-600	AS-01335-000	LMS-100 LMS-200	35 W	450 lm	SC Bayonet	2.600 A	LPS-100-0260
SCL-1400	AS-01342-000	LMS-400 LMS-650 LMS-760	75 W	1400 lm	Miniature Screw	2.680 A	LPS-150-0268
CSFS-600	AS-01336-000	LMS-100 LMS-200	35 W	450 lm	SC Bayonet	2.600 A	LPS-100-0260
CSFS-1400	AS-01343-000	LMS-400 LMS-650 LMS-760	75 W	1400 lm	Miniature Screw	2.680 A	LPS-150-0268
FFS-100-400	AS-2768-100	LMS-100 LMS-200 HMS-1011 HMS-2011	50W	900 lm	Port Frame	4.160 A	LPS-150-0416
FFS-100-1000	AS-2768-200	LMS-400 LMS-650 LMS-760 HMS-4011	100W	2400 lm	Port Frame	8.330 A	LPS-100-0833

Table 1. Flux standards and their collection device and lamp power supply compatibility. The CSFS-600 and CSFS-1400 flux standard sets consist of three seasoned lamps in an attractive protective box.

A forward flux standard features a directional emission and mounts typically onto the external sample port of an integrating sphere or hemispherical collection device. Two forward flux standards are available: FFS-100-400 and FFS-100-1000. The standards are calibrated for both luminous and spectral radiant flux across the spectrum 350 - 1050 nm. Calibration data is provided in hard copy and electronic text format on a CDROM.

Part numbers and characteristics of Labsphere flux standards are provided in Table 1.

Unpacking and Inspection

Your flux standard(s) was thoroughly inspected and calibrated before shipping. Carefully check the components after unpacking for any damage that may have occurred during shipping. This inspection should include examining each standard for shipping damage and verifying the correct calibration data is present for each bulb. If there is any such damage, file a claim immediately with the freight carrier and contact the Labsphere Customer Service Department at

 **(603) 927-4266**.

The system includes the following components:

- Flux standard, marked with calibration serial number
- Protective wooden box with lamp socket (CSFS sets only)
- Calibration certificate
- Calibration CDROM
- Instruction Manual

Loading the Lamp Data on the Computer

The calibration data loading procedures for flux standards depend on the type system that applies. The calibration data for spectral lamp measurement systems (CSLMS, CSLMS LED, FS2-Series, HMS-Series) must be loaded onto the host computer and imported into LightMtrX. The luminance calibration factor for photopic lamp measurement systems can be loaded into the SC 6000 flash memory.

Loading PLMS-Series System Calibration Lamp Data

The photopic calibration data for a flux standard consists of a single calibration factor that the user should enter into flash memory of the SC 6000. The user must calculate his calibration factor by performing a user calibration and dividing the luminous flux from the standard lamp calibration certificate by the detector current.

1. Close the integrating sphere and take a detector dark current reading from the SC 6000.
2. Open the integrating sphere and load the calibration lamp onto the test pedestal.
3. Power up the lamp power supply and calibration lamp. Allow a warm-up period of 20 minutes.
4. Close the integrating sphere and record the detector current measurement from the SC 6000.
5. Correct the detector current measurement recorded in the previous step for dark current.

6. Obtain the luminous flux value from the calibration certificate and divide this number by the corrected detector current measurement calculated in the previous step. This is your calibration factor. Pay attention to the units.
7. Enter the calibration factor into the SC 6000 flash memory using the procedure in the SC 6000 manual.

Loading Calibration Lamp Data into MtrX-SPEC

Lamp standard calibration data for use with Labsphere CSLMS, CSLMS LED or FS2 spectral lamp measurement systems is stored in an electronic text file on a calibration floppy disk or CDROM. The label on the disk is inscribed "Calibration Disk" along with the serial numbers of the lamp standards included with the shipment. The electronic files can be identified by the type standard (SCL-600, SCL-1400, FFS, etc.) and lamp serial number. The serial number is assigned by a Labsphere technician just prior to calibration and written on the base of the standard. The filename of the calibration file for an SCL-1400 standard with serial number C58, for example, is "SCL-1400 C58.txt".

The electronic files accompanying Labsphere flux standards must reside in the STANDARD folder of the LightMtrX root directory on your computer. The MtrX-SPEC software searches this directory whenever a user calibration is performed. The files are copied automatically to this destination when the user clicks the **Import** button in the Calibration Editor.

1. Load the calibration CDROM into the computer drive.
2. Launch MtrX-SPEC and invoke the Calibration Editor.
3. Click **Import** at the bottom of the screen.
4. Browse to find the calibration data on the CDROM and highlight all the data. Click **Open** to copy the flux standard data to your computer and enter the lamp data into the Windows Registry.

Lamp Standards

The tungsten-halogen lamps used in Labsphere luminous and spectral flux standards are selected for their stability and reproducibility. Except for the calibration, the lamps used for the luminous or spectral applications are identical. Each standard is carefully screened and seasoned at our manufacturing facility under the guidelines recommended by NIST, and calibrated to the highest degree of accuracy. The same flux standards can be purchased in the uncalibrated format. The optical characteristics for Labsphere flux standards are provided in the appendix.

Lamp Depreciation

Over the lifetime of a typical incandescent lamp, the tungsten filament evaporates with a corresponding reduction in filament diameter as the evaporated materials plate out on the envelope wall. The black material deposited on the inside of the lamp envelope restricts heat flow as well as luminous flux, causing a further increase in filament resistance such that the lamp output is reduced significantly with age. This aging process occurs in all flux standards and the photometry industry takes certain steps to reduce the impact of lamp aging. These steps include the use of current regulated power circuits for incandescent lamp operation in lieu of voltage control, the utilization of quartz lamp envelopes, and the introduction of halogen gases into the lamp for purposes of filament regeneration. The long-term luminous output for a typical tungsten-halogen lamp operated at a constant rated current is illustrated by the graph in Figure 1. Despite the impact of lamp aging, gas-filled tungsten-halogen lamps possess the best physical and optical characteristics for integrating sphere use. A more complete discussion of tungsten-halogen lighting can be found in any photometry textbook or on the Internet.

The tungsten-halogen lamps utilized in Labsphere systems should be operated at a regulated electrical current. Current regulation is the preferred method of powering illuminators in photometric applications because the voltage drop across the socket and electrical cabling is not always re-producible. The 35 W standards are seasoned and calibrated in our calibration laboratory at a de-rated lamp current to accommodate the capabilities of previous lamp power supply instrumentation. The most current lamp power supply instrumentation now operates at a fixed lamp current.

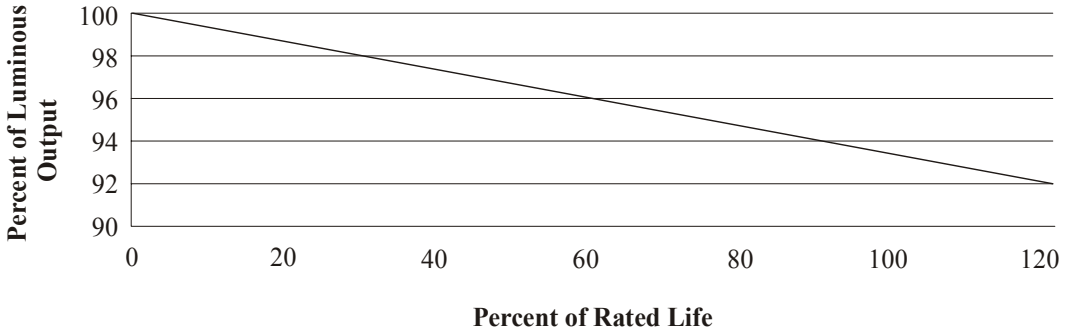


Figure 1. Typical lamp depreciation of a tungsten-halogen lamp.

The useful calibration life of a luminous or spectral radiant flux standard is far less than the manufacturer's specified lifetime, and the curve in Figure 1 demonstrates this fact. Labsphere declines to make specific recommendations on this issue because the calibration lifetime observed by our customers depends on the measurement accuracy required and the operating tempo employed. The user can monitor the aging process of a lamp standard by saving the initial user calibration files when the standard is first place into service and performing a sample scan on the calibration lamp at routine time intervals.

Lamp Seasoning

The luminous flux output of new incandescent lamps tends to drop very quickly over the first few percent of rated lamp life. The reduction in output can be as high as 10% or more during this period. Labsphere flux standards are seasoned for a specified period prior to calibration and shipment. All three Labsphere flux standards are seasoned in their base-down orientation at the manufacturer's voltage rating for 10 hours. Should time not permit the normal seasoning procedure, certain rules for accelerated seasoning times may apply.

Lamp Screening

A lamp screening procedure is performed by the calibration laboratory on each flux standard following the seasoning procedure in the previous paragraph. The screening is performed on a population of 12 seasoned

lamps. Each lamp is loaded into an integrating sphere, one at a time, and operated for a period of 10 minutes, after which the light output of the lamp is measured and recorded. This process is repeated for a total of three times after which a statistical mean of all the lamps is computed. A standard deviation and coefficient of variation for each lamp is then calculated and evaluated for purposes of reproducibility. Any lamp with a coefficient of variation greater than 0.5% is removed from production.

Flux Standard Calibration

Calibration data for Labsphere flux standards is recorded in a 20-inch diameter integrating sphere using the comparison method and a working standard of spectral radiant flux. The working lamp standard is identical in construction to the flux standard under calibration. The calibration of the working flux standard is updated on a yearly basis.

During the calibration procedure, a regulated current is applied through each lamp mounted in a Kelvin lamp socket using a precision shunt and voltmeter. Spectral data is collected by a Labsphere diode array spectrometer instrument and compared to the standard data in a manner similar to that used by Labsphere light measurement systems. A 20-minute warm-up period is applied each time before collecting data, and the process is repeated for a total of three times over three consecutive days. A single set of spectral flux data is recorded from the average of the three spectral scans.

The calibration certificate from a spectral flux calibration includes the luminous flux value as well the spectral radiant flux data. The luminous flux value is used to calculate the SC 6000 calibration factor; the spectral flux data is entered into the Labsphere MtrX-SPEC software application. The spectral radiant flux is reported in 71 spectral values across the 350 - 1050 nm spectrum in units of Watts/nm on the calibration certificate. Additionally, the spectral data is written to a CDROM for downloading to the latest Labsphere light measurement software. There are two calibration files for each flux standard - one file with data recorded at 10 nm intervals and one file at 1 nm intervals. Either calibration file can be used during user calibration to generate an accurate MtrX-SPEC KCurve. The calibration data for all Labsphere flux standards is traceable to NIST standards.

Since the FFS-100-400 and FFS-100-1000 standards are calibrated to forward flux rather than total spatial flux, the entire illuminator must be returned to Labsphere after depreciation for subsequent lamp replacement and re-calibration.

Operating Guidelines

Operators should handle flux standards with care. Do not subject the lamp filament to mechanical shock. Do not touch the bulb with your fingers and always ramp up the lamp current slowly during operation. Where possible, lamp standards should be stored in a protective box. Prior to each use, the bulb should be wiped clean of all dust with a soft, lint-free cloth before loading into the integrating sphere.

Unless described otherwise, the calibration data for all flux standards is collected with the lamp in the base-down orientation. If your test lamps are operated normally at some other orientation, of course, the standard should be mounted inside the integrating sphere in the roughly the same configuration as the test lamps.

The lamp current output of the LPS-100 and LPS-150 Series lamp power supplies is fixed. The LPS-100-0260, for example, provides the correct lamp current to the 35 Watt standards; the LPS-150-0268 powers

the SCL-1400. The lamp current for a particular flux standard is always correctly listed in the calibration certificate accompanying the standard.

Appendix Lamp Ratings

Part ID	Lamp	Manufacturer's Ratings
SCL-600	Sylvania 796RD	35W, 12.8V, 2.73A, 300hrs
SCL-1400	GE Q75CL	75W, 28V, 2.68A, 1350lm, 2000hrs
SCL-050	Gilway 187-1	4.4W, 4.2V, 1.05A, 50lm, 3000K, 650hrs
FFS-100-400	Gilway L9389	50W, 12V, 4.16A, 900lm, 3000K, 2000hrs
FFS-100-1000	Gilway L9390	100W, 12V, 8.33A, 2400lm, 3000K, 2000hrs