NPL REPORT
DQL-OR 013

Report on Ceravision consultancy Joint Industry Project

Laura Crane

NOT RESTRICTED

November 2005

Laura Crane
Quality of Life Division

ISSN 1744 - 0610

National Physical Laboratory
Hampton Road, Teddington, Middlesex, TW11 0LW

Approved on behalf of the Managing Director, NPL
by Dr Julie Taylor, Quality of Life Division

1. Scope

This report describes an investigation to determine the total luminous flux output and relative spectral irradiance of a prototype projector lamp.

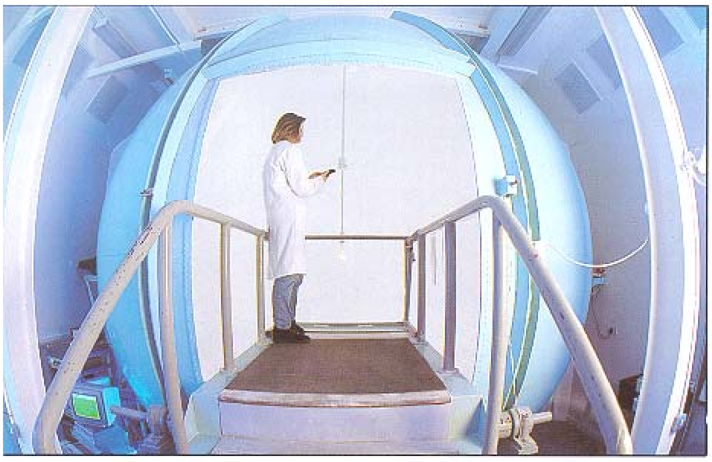
Ceravision Ltd is developing an electrode-less, microwave-driven high intensity compact lamp; they claim this is the first electrode-less bulb using waveguides to couple the microwave power to the bulb. It is targeted at the desktop and rear projection television market, but needed traceable measurements to demonstrate the total luminous flux output of the new lamp to potential customers in Japan.

The aim of the investigation was to provide Ceravision with a calibrated measurement of the total luminous flux of the lamp described above. Additional information about the relative spectral power distribution of the lamp was also required to provide the most accurate measurement, by allowing the values to be corrected for spectral mismatch.

This investigation was funded under the DTI Measurement for Innovators Programme as a ‘Consultancy’ project. The project was undertaken by the National Physical Laboratory and Ceravision.

2. Measurement Performed at NPL

Total luminous flux is a measure of the amount of light emitted from a source in all directions (i.e. the full solid angle of 4π steradians). The NPL total luminous flux scale is derived at the $\pm$ 0.3% level from the luminous intensity scale by use of a specially constructed goniometer. NPL has a range of integrating spheres and goniophotometers available to measure luminous flux; which is used for a particular measurement depends on the size and power of the test lamp. In this case, the 4.6 m integrating sphere was selected as the most appropriate facility to use.



The total luminous flux was measured by comparison with NPL standard lamp sources, using the 4.6 m integrating sphere and a photometer with a spectral response corrected to correspond closely to the CIE photopic standard observer function. The NPL standard lamps were of a specially constructed tungsten filament type and were run from a stabilised dc supply.

The test source was powered using purpose built equipment operated by the Ceravision employees. A platform was suspended in the centre of the sphere on which the lamp holder was mounted. Power cables were fed through a port to the power supply outside the sphere. The lamp was placed in the holder, then ignited. Following this, the Ceravision engineer adjusted a potentiometer to maximise the output from the lamp.

A correction was applied to allow for the effect of the residual difference between the CIE photopic standard observer function and the measured spectral response of the photometer, taking into account the spectral reflectance of the sphere coating. In order to calculate the correction it was necessary to know the relative spectral power distribution (SPD) of the source. The SPD is used to calculate a colour correction factor (CCF). The CCF was then applied to the total luminous flux results.

The spectral power distribution of the Ceravision test source was measured using a high quality spectroradiometer measurement facility. A spectroradiometer disperses the broadband light across a detector using an optical grating. A schematic of the facility is shown in the Figure 1. The SPD for the test source is obtained by the method of substitution, comparing the readings obtained for that source with those obtained for a standard source of known SPD.

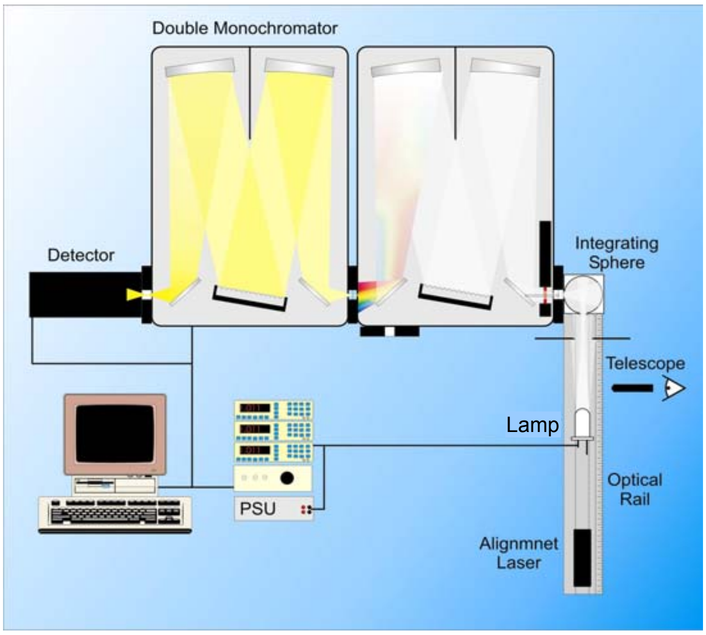


Figure 1: Schemtic of spectroradiometer system

3. Results of Measurements Performed at NPL

All measurements were performed at NPL on 8th November 2005 using the facilities described above and in accordance with NPL quality procedures. Ceravision engineers were on site to operate the test source as this required specialist knowledge of the prototype lamp. NPL employees carried out the required measurements and the analysis of the results.

3.1.1 Total luminous flux

The total luminous flux of the Ceravision test source, including corrections for the spectral response of the photometer, is given below.

Total luminous flux: 5840 ± 140 lm

The total luminous flux output depends on the electrical conditions. The power supplied to the lamp was set by the Ceravision employees using equipment specifically designed for the prototype source. This was not under NPL control and information regarding this equipment should be obtained from Ceravision. Any deviation from the conditions on the day may cause variations to the value stated above.

3.1.2 Uncertainty statement

The expanded uncertainty of the photometric measurements was estimated to be ± 2.4 %. This includes an assumption for the repeatability of the test source of 1%. This was based on a number of values recorded during the measurement run.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The results and uncertainties refer to the on-the-day values and no allowance has been made for subsequent drift.

3.2 Relative Spectral Power Distribution

Figure 2 shows the relative spectral power distribution for the Ceravision test source over the spectral range 385 – 780 nm. Measurements were taken at intervals of 5 nm. The test source was aligned with the longest dimension of the source in line with the optical axis of the bench. The distance between the source and the sphere entrance was approximately 0.5 m. The angle of light collection from the bulb was not optimised, and any variation in output with angle was not assessed. A table giving the spectral power distribution of the source is given in Appendix A, along with the uncertainty associated with the measurement at each wavelength band.

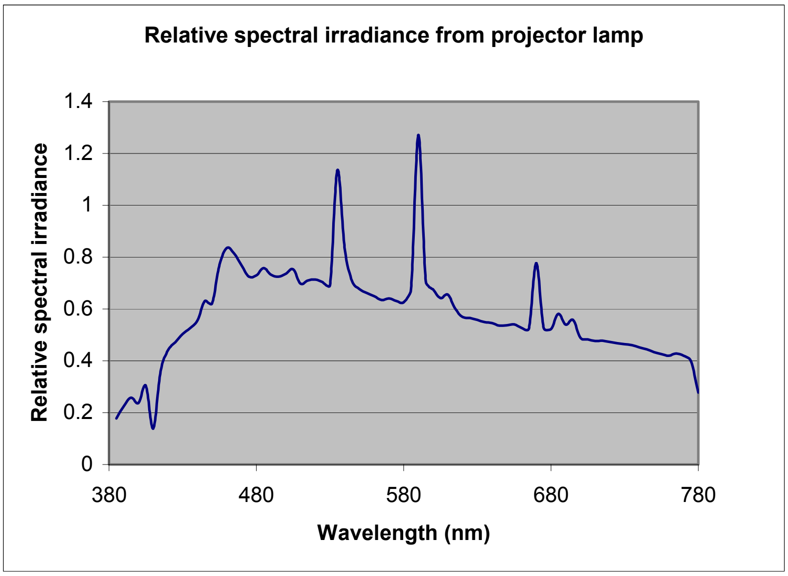


Figure 2: Relative spectral power distribution for Ceravision test source

4. Summary

The measurements made at NPL provide Ceravision with traceable values for the total luminous flux and relative spectral power distribution of the source under test. The results show that the total luminous flux of the test source is approaching 6000 lm. The spectral power distribution of the lamp is fairly flat across most of the visible part of the spectrum, with peaks corresponding to elements of the within the lamp.

The successful measurement of the prototype source will enable Ceravision to promote the product in new markets, such as Japan. Any new product developments could also be measured using a similar approach and the performance compared with confidence.

Appendix A – Relative Spectral Power Distribution Values

Ceravision Test Source 1

Wavelength nm	Rel SPD	Uncertainty %	Wavelength nm	Rel SPD	Uncertainty %
385	0.268	4.5	585	1.024	4.0
390	0.340	4.5	590	1.923	4.0
395	0.391	4.5	595	1.070	4.0
400	0.358	4.0	600	1.021	4.0
405	0.459	4.0	605	0.970	4.0
410	0.210	4.0	610	0.991	4.0
415	0.545	4.0	615	0.909	4.0
420	0.667	4.0	620	0.861	4.0
425	0.713	4.0	625	0.854	4.0
430	0.761	4.0	630	0.844	4.0
435	0.796	4.0	635	0.831	4.0
440	0.840	4.0	640	0.824	4.0
445	0.954	4.0	645	0.811	4.0
450	0.941	4.0	650	0.812	4.0
455	1.167	4.0	655	0.819	4.0
460	1.264	4.0	660	0.797	4.0
465	1.230	4.0	665	0.792	4.0
470	1.160	4.0	670	1.174	4.0
475	1.095	4.0	675	0.797	4.0
480	1.103	4.0	680	0.789	4.0
485	1.146	4.0	685	0.879	4.0
490	1.107	4.0	690	0.817	4.0
495	1.095	4.0	695	0.844	4.0
500	1.112	4.0	700	0.739	4.0
505	1.139	4.0	705	0.729	4.0
510	1.055	4.0	710	0.721	4.0
515	1.074	4.0	715	0.723	4.0
520	1.079	4.0	720	0.715	4.0
525	1.064	4.0	725	0.708	4.0
530	1.045	4.0	730	0.702	4.0
535	1.717	4.0	735	0.696	4.0
540	1.257	4.0	740	0.683	4.0
545	1.069	4.0	745	0.671	4.0
550	1.023	4.0	750	0.655	4.0
555	1.000	4.0	755	0.645	4.0
560	0.982	4.0	760	0.635	4.0
565	0.959	4.0	765	0.648	4.0
570	0.969	4.0	770	0.634	4.0
575	0.953	4.0	775	0.604	4.0
580	0.946	4.0	780	0.421	4.0