Physikalisch-Meteorologisches Observatorium Davos
World Radiation Center

pmod wrc

Calibration Certificate

No. 2007-74-1

Calibration Item

Halogen Lamp (250W)

Manufacturer	CMS Schreder, Innsbruck, Austria
Type	Osram, KS-J1011
Serial number	KS023

Customer

Sezione Agenti Fisici - Radiazione Ultravioletta Solare
Agenzia Regionale per la Protezione dell'Ambiente (ARPA)
Valle d'Aosta
loc. Grande Charrière 44
11020 Saint-Christophe
Italy

Calibration Mark

2007-74-1

Date of calibration

14 February, 2007

Davos Dorf, 24 September, 2008

Dr. Gregor Hülsen
In charge of calibration

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Calibration procedure

Measurement of the spectral irradiance of the test lamp, $E(\lambda)$, was obtained in the range of 250 to 500 nm, every 1 nm. The irradiance of the test lamp is based on a comparison to the average of five 1000 W transfer standards representing the QASUME irradiance reference.
The radiation emitted by the test lamp was measured by the QASUME[1] spectroradiometer (Gröbner et al., 2005). The receiving area of the detector has a diameter of 10 mm.

Calibration condition

Experimental Setup:	The calibration of the test lamp was performed in the laboratory of PMOD/WRC. The temperature of the laboratory was 20.0 $\pm$ 4.0° C, the humidity 40.0 $\pm$ 5.0%. The setup is shown in Figure 1 and is explained in the user's manual of the 'KS-J1011 Portable Field Calibrator Unit' from CMS Schreder.
Measurement Geometry:	The test lamp was mounted in a lamp calibration unit with the filament in a horizontal position. The vertical optical axis passed through the center of the filament with the detector on the exit port of the calibration unit. The test lamp was oriented by the alignment spikes. The distance from the lamp reference point to the reference plane of QASUME was fixed by the calibration unit.
Lamp current:	6.3000 $\pm$ 0.0005 A Lamp ramp-up time was 1.1 min, the ramp-down time was 0.7 min and the burn time 47.7 min
Lamp voltage:	28.47 $\pm$ 0.04 V The voltage was measured with separate wires to the connectors of the lamp holder.

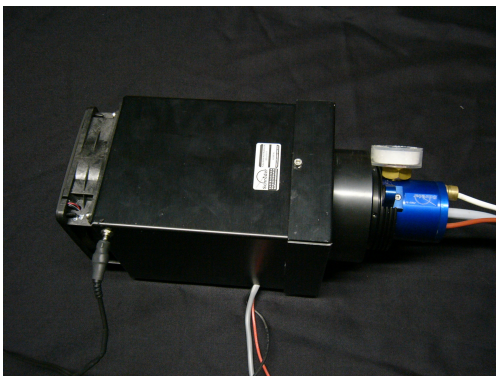

Figure 1: Picture of the test lamp as mounted in the experimental setup.

[1]The QASUME spectroradiometer B5503 is made available by the Institute of Health and Consumer Protection of the Joint Research Centre of the European Commission, Ispra, Italy through a collaboration agreement with PMOD/WRC.

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Lamp irradiance $E(\lambda)[\mathrm{mWm^{-2}nm^{-1}}]$:

λ[nm]	$E(\lambda)$	λ	$E(\lambda)$	λ	$E(\lambda)$	λ	$E(\lambda)$	λ	$E(\lambda)$	λ	$E(\lambda)$
250	**4.142E-01**	292	**3.152E+00**	334	**1.291E+01**	376	**3.567E+01**	418	**7.511E+01**	460	**1.322E+02**
251	**4.392E-01**	293	**3.287E+00**	335	**1.328E+01**	377	**3.641E+01**	419	**7.628E+01**	461	**1.337E+02**
252	**4.676E-01**	294	**3.415E+00**	336	**1.362E+01**	378	**3.710E+01**	420	**7.744E+01**	462	**1.352E+02**
253	**4.850E-01**	295	**3.527E+00**	337	**1.401E+01**	379	**3.783E+01**	421	**7.859E+01**	463	**1.368E+02**
254	**5.121E-01**	296	**3.681E+00**	338	**1.441E+01**	380	**3.858E+01**	422	**7.976E+01**	464	**1.384E+02**
255	**5.386E-01**	297	**3.828E+00**	339	**1.480E+01**	381	**3.938E+01**	423	**8.107E+01**	465	**1.400E+02**
256	**5.793E-01**	298	**3.968E+00**	340	**1.526E+01**	382	**4.014E+01**	424	**8.223E+01**	466	**1.416E+02**
257	**6.179E-01**	299	**4.124E+00**	341	**1.566E+01**	383	**4.095E+01**	425	**8.335E+01**	467	**1.432E+02**
258	**6.566E-01**	300	**4.296E+00**	342	**1.606E+01**	384	**4.183E+01**	426	**8.468E+01**	468	**1.448E+02**
259	**6.883E-01**	301	**4.431E+00**	343	**1.649E+01**	385	**4.259E+01**	427	**8.588E+01**	469	**1.464E+02**
260	**7.239E-01**	302	**4.627E+00**	344	**1.696E+01**	386	**4.345E+01**	428	**8.711E+01**	470	**1.480E+02**
261	**7.603E-01**	303	**4.806E+00**	345	**1.736E+01**	387	**4.426E+01**	429	**8.851E+01**	471	**1.496E+02**
262	**8.056E-01**	304	**4.973E+00**	346	**1.786E+01**	388	**4.514E+01**	430	**8.971E+01**	472	**1.513E+02**
263	**8.457E-01**	305	**5.146E+00**	347	**1.831E+01**	389	**4.594E+01**	431	**9.090E+01**	473	**1.528E+02**
264	**8.939E-01**	306	**5.324E+00**	348	**1.877E+01**	390	**4.685E+01**	432	**9.216E+01**	474	**1.544E+02**
265	**9.400E-01**	307	**5.547E+00**	349	**1.925E+01**	391	**4.775E+01**	433	**9.345E+01**	475	**1.561E+02**
266	**9.966E-01**	308	**5.807E+00**	350	**1.974E+01**	392	**4.859E+01**	434	**9.486E+01**	476	**1.577E+02**
267	**1.039E+00**	309	**6.084E+00**	351	**2.024E+01**	393	**4.947E+01**	435	**9.608E+01**	477	**1.594E+02**
268	**1.103E+00**	310	**6.209E+00**	352	**2.071E+01**	394	**5.099E+01**	436	**9.749E+01**	478	**1.610E+02**
269	**1.156E+00**	311	**6.334E+00**	353	**2.128E+01**	395	**5.232E+01**	437	**9.883E+01**	479	**1.629E+02**
270	**1.211E+00**	312	**6.580E+00**	354	**2.176E+01**	396	**5.411E+01**	438	**1.002E+02**	480	**1.645E+02**
271	**1.268E+00**	313	**6.778E+00**	355	**2.231E+01**	397	**5.401E+01**	439	**1.016E+02**	481	**1.663E+02**
272	**1.329E+00**	314	**7.008E+00**	356	**2.285E+01**	398	**5.411E+01**	440	**1.029E+02**	482	**1.679E+02**
273	**1.397E+00**	315	**7.251E+00**	357	**2.347E+01**	399	**5.506E+01**	441	**1.044E+02**	483	**1.696E+02**
274	**1.459E+00**	316	**7.457E+00**	358	**2.393E+01**	400	**5.599E+01**	442	**1.057E+02**	484	**1.712E+02**
275	**1.546E+00**	317	**7.696E+00**	359	**2.455E+01**	401	**5.708E+01**	443	**1.071E+02**	485	**1.730E+02**
276	**1.595E+00**	318	**7.984E+00**	360	**2.508E+01**	402	**5.805E+01**	444	**1.085E+02**	486	**1.748E+02**
277	**1.657E+00**	319	**8.204E+00**	361	**2.570E+01**	403	**5.903E+01**	445	**1.099E+02**	487	**1.766E+02**
278	**1.716E+00**	320	**8.495E+00**	362	**2.628E+01**	404	**6.004E+01**	446	**1.114E+02**	488	**1.782E+02**
279	**1.750E+00**	321	**8.752E+00**	363	**2.690E+01**	405	**6.109E+01**	447	**1.128E+02**	489	**1.798E+02**
280	**1.844E+00**	322	**9.018E+00**	364	**2.745E+01**	406	**6.206E+01**	448	**1.142E+02**	490	**1.817E+02**
281	**1.987E+00**	323	**9.324E+00**	365	**2.809E+01**	407	**6.309E+01**	449	**1.157E+02**	491	**1.836E+02**
282	**2.089E+00**	324	**9.613E+00**	366	**2.871E+01**	408	**6.416E+01**	450	**1.172E+02**	492	**1.852E+02**
283	**2.182E+00**	325	**9.912E+00**	367	**2.938E+01**	409	**6.523E+01**	451	**1.187E+02**	493	**1.869E+02**
284	**2.276E+00**	326	**1.023E+01**	368	**3.004E+01**	410	**6.623E+01**	452	**1.202E+02**	494	**1.887E+02**
285	**2.375E+00**	327	**1.053E+01**	369	**3.072E+01**	411	**6.738E+01**	453	**1.216E+02**	495	**1.906E+02**
286	**2.476E+00**	328	**1.082E+01**	370	**3.137E+01**	412	**6.845E+01**	454	**1.230E+02**	496	**1.922E+02**
287	**2.574E+00**	329	**1.115E+01**	371	**3.205E+01**	413	**6.946E+01**	455	**1.245E+02**	497	**1.940E+02**
288	**2.683E+00**	330	**1.148E+01**	372	**3.280E+01**	414	**7.061E+01**	456	**1.261E+02**	498	**1.957E+02**
289	**2.794E+00**	331	**1.185E+01**	373	**3.351E+01**	415	**7.175E+01**	457	**1.275E+02**	499	**1.976E+02**
290	**2.918E+00**	332	**1.218E+01**	374	**3.417E+01**	416	**7.282E+01**	458	**1.291E+02**	500	**1.994E+02**
291	**3.029E+00**	333	**1.256E+01**	375	**3.491E+01**	417	**7.392E+01**	459	**1.306E+02**		

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Expanded uncertainty of measurement u is 4.5 %.
Expanded uncertainty of measurement u relative to the QASUME irradiance reference is 1.0 %.

The reported expanded uncertainty of measurement **u** is stated as the standard uncertainty of measurement multiplied by the coverage factor $\mathrm{k} = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Comments:

The absolute spectral irradiance is traceable to the primary irradiance standard of the Physikalisch-Technische Bundesanstalt (PTB), Germany, through the transfer standards F300, F304, F324, F330, F376 (Gröbner and Sperfeld, 2005).
The lamp has an emission line at 396 nm of about 4 %.

References

J. Gröbner and P. Sperfeld. Direct traceability of the portable QASUME irradiance scale to the primary irradiance standard of the PTB. *Metrologia*, 42:134–139, 2005.

J. Gröbner, J. Schreder, S. Kazadzis, A. F. Bais, M. Blumthaler, P. Görts, R. Tax, T. Koskela, G. Seckmeyer, A. R. Webb, and D. Rembges. Traveling reference spectroradiometer for routine quality assurance of spectral solar ultraviolet irradiance measurements. *Appl. Optics*, 44:5321–5331, 2005.

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