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Light Resin Curing Devices - A Hazard Evaluation

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Light Resin Curing Devices - A Hazard Evaluation

Abstract

An evaluation has been made of optical hazards to the eye from 18 specified lamps designed for curing dental composite plastic fillings.

Radiation source in all of the investigated units were incandescent lamps of the tungsten metal halide type. Ultraviolet and visible radiation was measured with a calibrated EG&G 585 spectroradiometer system. Tables and diagrams of spectral radiance ($Wm^{-2}nm^{-1}sr^{-1}$) are given.

Hazard evaluations based on the ACGIH Threshold Limit Values of ultraviolet and visible radiation gave the following results:

1. Ultraviolet radiation is of no concern (<= 0.8 Wm^{-2} UVA at 10 cm).
2. Reflexes from teeth are harmless.
3. Retinal thermal injury hazard (permanent burn damage) is diminutive and non-existent if the equipment is handled with sense (irradiation of an unprotected eye at a distance less than 10 cm should be avoided).
4. Retinal photochemical (blue-light) injury may appear after direct viewing of the end of the fiber-optics cable. A table with safe exposure time for each apparatus is given. Proper protective goggles can eliminate the blue-light hazard.

Keywords (chosen by the author)
Dental lamps, Plastic-curing, Optical radiation, Eye-hazard.

Number of pages
27

LIGHT RESIN CURING DEVICES - A HAZARD EVALUATION

Anders Glansholm

This report has been worked out in an effort to give answers to some of the questions concerning curing devices used in the odontology. Recently such questions have frequently been submitted to the Institute of Radiation Protection and have mainly dealt with hazards from an ergophthalmologic point of view.

Overexposure to visible radiation may result in thermal damages in the retina, which are permanent, or retinal photochemical injuries (blue light injuries) which are considered to be reversible.

A sample of devices in the market has been investigated and the results have been compaired to existing recommended exposure limits.

The radiation in all subjects is emitted from halogen bulbs i.e. filament lamps. In earlier devices high pressure mercury lamps could be found the ultraviolet radiation of which was used. This is recognized as an out of fashion technique since the composites of today are cured by visible radiation, mainly in the short wavelength range.

The conclusions that can be drawn after the physical measurements and some calculations are the following.

* The ultraviolet radiation level is very low. The device which produced the highest level of ultraviolet radiation gave an irradiance of 0.8 W/m^2 at a distance of 10 cm within the wavelength interval 315-400 nm (UVA). This irradiance could be compared to 50 W/m^2 which can be achieved in Sweden by the sun. Shortwave ultraviolet radiation was not detectable. Thus the ultraviolet radiation could be omitted from the hazard discussions.

* Reflexes from the teeth are harmless.

* Thermal damages in the retina are not likely. If the devices are handled with reasonable care thermal damages will not occur. Carefully handling implies that the output tip should not be directly viewed at a shorter distance than 10 cm.

* Blue light hazards exist if the radiant output is directly viewed. In the summary-of-results table the longest safe exposure time intervals for the different devices are shown. Exposures that may give blue light hazards are principally accumulative in time. The shown exposure time intervals therefore represent the summed up total exposure in a 24-hours period of time. Thus the hazard is dependent on the total time of operation in a working day and, abowe all, the aiming of the beam. If curing procedures are frequent while the output tip is directed towards the dentist's eyes, adequate eye-protectors should be worn.

MEASUREMENTS

Instrumentation Spectroradiometer EG&G 585
Monochromator 585-24D (UV) and 585-22D (visible),
Detector 585-62

The spectroradiometer was equipped with, and calibrated with, an aperture 2.8 mm diameter.

Calibration source: General Electric DXW 1000 W, calibrated by the Swedish Testing Institute, Borås.

Computer HP 85 and Multimeter Fluke 8840 A

The spectral irradiance within 250-800 nm was recorded in 10 nm steps, the aiming of the object adjusted for maximum meter reading. The measurement distance (a) was 0.4 m. The diameter of the radiant tip was measured with a caliper.

The maximum spectral radiance as a mean value over the radiant tip is given by the formula

$L_v = E_v/\omega$ where L_v = spectral radiance
E_v = spectral irradiance
ω is the visual solid angle occupied by the radiant tip as seen from the instrument.

If the diameter of the radiant tip is denoted by d and the measurement distance is a, yields:

$$L_v = \frac{E_v \cdot a^2 \cdot 4}{d^2 \cdot \pi}$$

In addition to the direct radiation measurements some measurements of radiation reflected from teeth were also performed. The similar instruments and evaluation principles were used.

RECOMMENDED EXPOSURE LIMITS

The spectral radiance within the visible range was weighted against the spectral hazard factors given by the American Conference of Governmental Industrial Hygienists (A.C.G.I.H.) according to the table below.

Wavelength λ (nm)	Burn hazard R_v	Blue hazard B_v
400	1.0	0.1
410	4.0	0.4
420	9.0	0.9
430	9.8	0.98
440	10.0	1.0
450	9.4	0.94
460	8.0	0.8
470	6.2	0.62
480	4.5	0.45
490	2.2	0.22
500-600	1.0	$10^{((450-\lambda)/50)}$
600-700	1.0	0.001
700-1060	$10^{((700-\lambda)/515}$	0.001

The applicable exposure limits are:

Burn hazard

$$\Sigma\, L_v \cdot R_v \cdot \Delta\lambda < \frac{1}{\alpha\sqrt{t}}$$

t = exposure duration (1 μs < t < 10 s)

L_v is given in $W/cm^2 sr$

α is the visual angle (plane angle) to the source

Blue hazard

$$\Sigma\, L_v \cdot B_v \cdot \Delta\lambda < \frac{100}{t} \quad (J/cm^2\, sr) \qquad t < 10^4 \text{ s}$$

or

$$\Sigma\, L_v \cdot B_v \cdot \Delta\lambda < 0{,}01 \quad (W/cm^2\, sr) \qquad t > 10^4 \text{ s}$$

The longest safe exposure durations (t) are thus given by:

Burn hazard $t = \left(\frac{1}{\alpha \cdot \Sigma L_v R_v \Delta\lambda}\right)^2$ Blue hazard $t = \frac{100}{\Sigma L_v B_v \Delta\lambda}$

RESULTS

Direct exposure

The longest safe exposure durations for each device are shown in the table below.

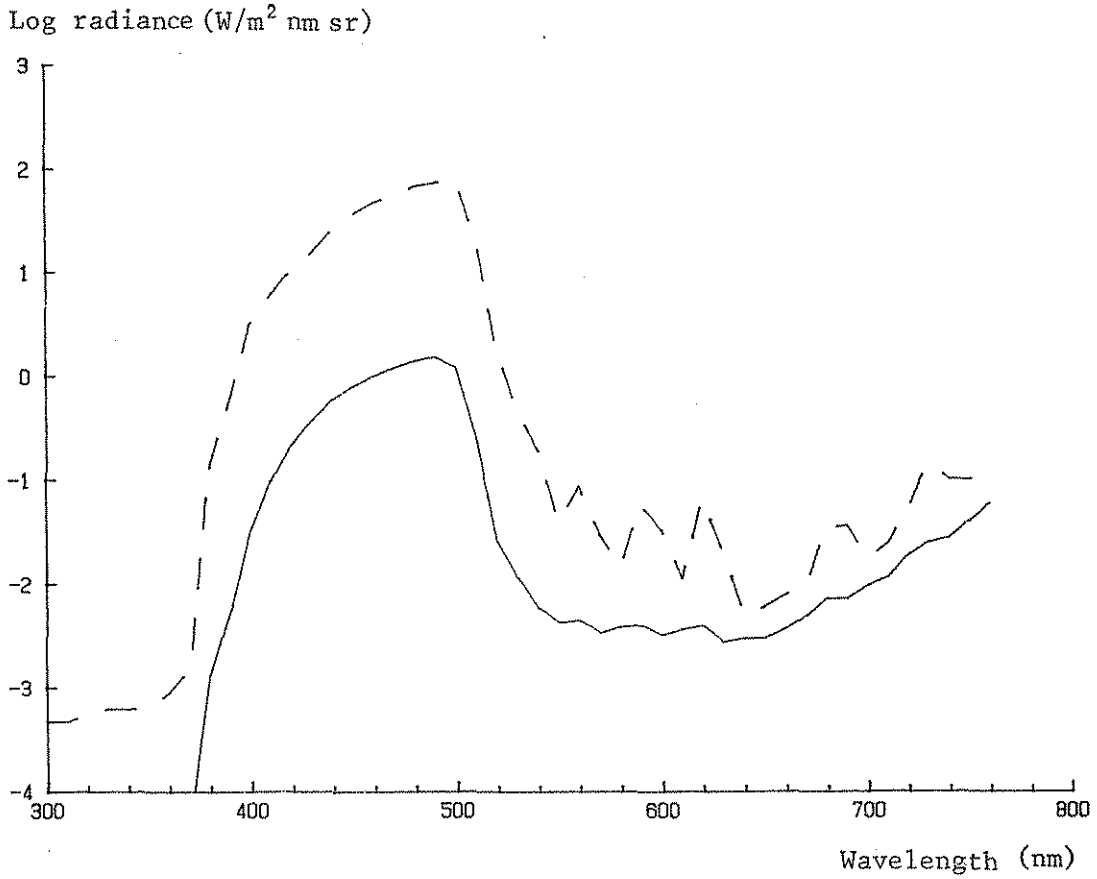
The expression for the burn hazard exposure limit includes the visual angle of the source. The longest safe time is therefore dependent on the viewing distance. Calculations have been done for two distances; 5 cm which is probably unrealistically short but is choosen to represent a worst case, and 20 cm which is more likely. The burn damage process is known to be very fast. Doubtless the longer exposure times calculated are not biological realities but rather pure mathematical consequences. If a burn damage has not occurred within 10 seconds (the limit within t is defined) it is the author's belief that it will not occur at all.

The blue light hazards are, on the contrary, accumulative and long total exposure times may be relevant. Mathematically the exposure limit is also independent of distance. As shown in the table shorter safe exposure durations than 4 minutes have been found.

Type	Burn hazard		5 cm		20 cm		Blue hazard	
	ϕ (mm)	$\Sigma L_v R_v \Delta\lambda$ (W/cm^{2}sr)	α	t (s)	α	t (s)	$\Sigma L_v B_v \Delta\lambda$ (W/cm^{2}sr)	t (s)
Command II	5.5	2.215	0.11	17	0,028	269	0,2195	455
Focus	8.0	1,842	0,16	12	0,04	184	0,1611	620
Heliomat H2								
Polymer.	4.8	2,052	0,096	26	0,024	413	0,2001	500
PI		0,747		193		3086	0,0561	1785
C		1.221		73		1166	0,0728	1370
D2		4,150		6		101	0.2103	476
D1		0.813		165		2646	0,0385	2564
OL		2.325		20		322	0,0070	$>10^4$
Luxor	6,7	4.418	0,134	3	0,034	45	0,4391	227
Prismalite	5,2	2.127	0.104	20	0.026	327	0.2122	471
Solid State								
Curing 1	5,2	2,149	0.104	20	0.026	320	0.2135	468
Curing 2		2.007		23		367	0.1992	502
Clear		4.460		5		74	0.2060	485
Green		0.406		561		9000	0,0061	$>10^4$
Translux								
Clear	5.6	2.898	0.112	10	0,028	151	0.2772	360
Blue		2.219		16		259	0.2101	475
Translux CL	7.2	4.434	0.144	2	0.036	39	0,4372	228
Visilux 2	7.0	2.124	0.140	11	0,035	181	0.2109	473

Reflected radiation

Some experiments were done where reflected radiation from teeth was measured. Of these measurements the results of the most insulting situation found are described here. The spectral curve below (solid line) shows the radiance of a front tooth which is irradiated with the Solid State 200, filter curing 1. The positioning was adjusted for maximum meter reading. The distance between the radiant tip and the tooth was about 1 cm and the measurement distance was 30 cm. The dashed line in the same diagram shows the original radiance at direct viewing of the unit used.

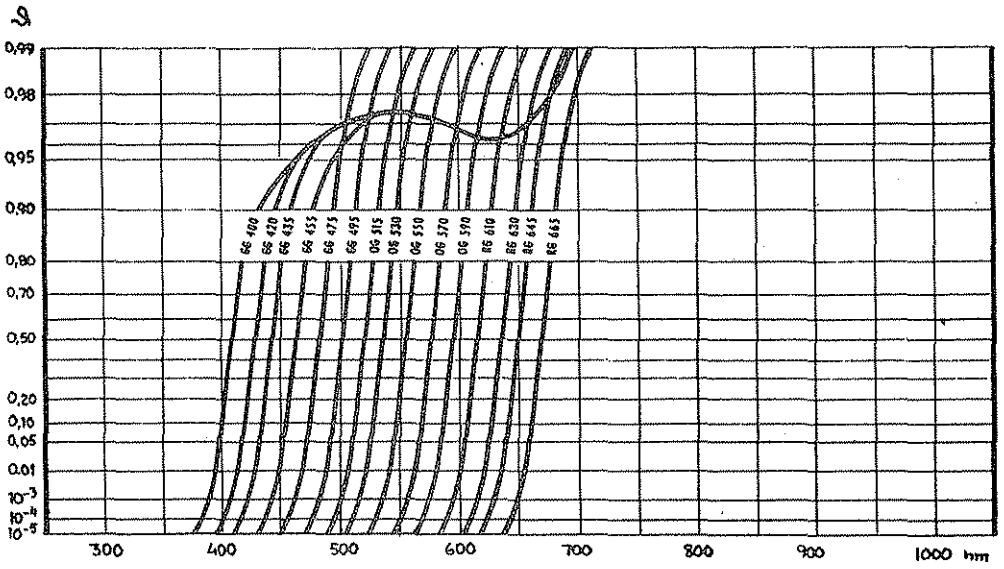


Evaluated according to A.C.G.I.H. the longest safe exposure durations are 18000 seconds (at 5 cm) to avoid burn hazards and 22000 seconds for blue light hazards. The conclusion is that the reflexes are harmless. Reflexes from curved metal surfaces of tools commonly used by dentists show figures of the same order of magnitude. Reflexes from plane, good mirrors should, however, be regarded as equal to the radiant tip itself.

EYE-PROTECTORS

The important requirement for an eye-protector lens is that the blue light (400-500 nm) should be damped. Technically such a damping is easily achieved in yellow or orange filters made of glass or plastic. As an example very typical spectral transmittance curves for some filters (Schott) are shown. Among these filters OG 515 or OG 530 might work excellently as radiation hazard reducing filters. There is no need of particular considerations concerning damping or resistance against ultraviolet radiation.

Transmittance



Wavelength

A drawback with selective filters, like those discussed, is that they certainly will disturb the colour perception when worn. Furthermore some disturbance will remain for some minutes in a reversed way after that the eye-protector has been taken off, due to colour adaptation.

The only way to aviod colour vision disturbances is to use neutral density filters. However, these will offer strongly reduced visibility. They could be used only if moderate performance from a protective point of view is required. The blue light hazards are linearly dose-dependent. Thus a neutral density filter transmitting say 20 % will allow a total exposure time which is 5 times as long as the time without an eye-protector.

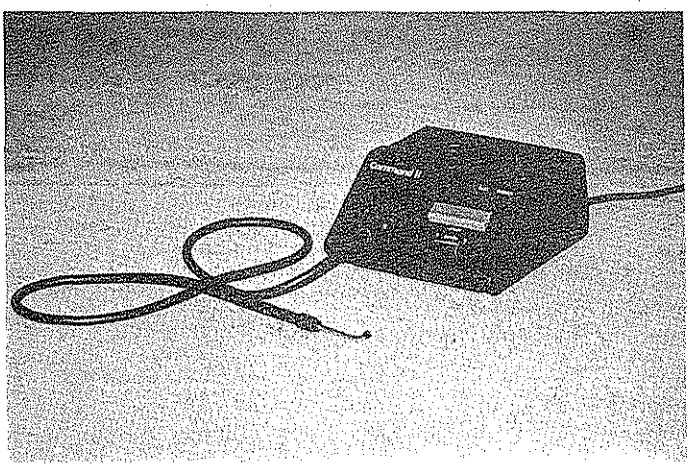
MANUFACTURER:

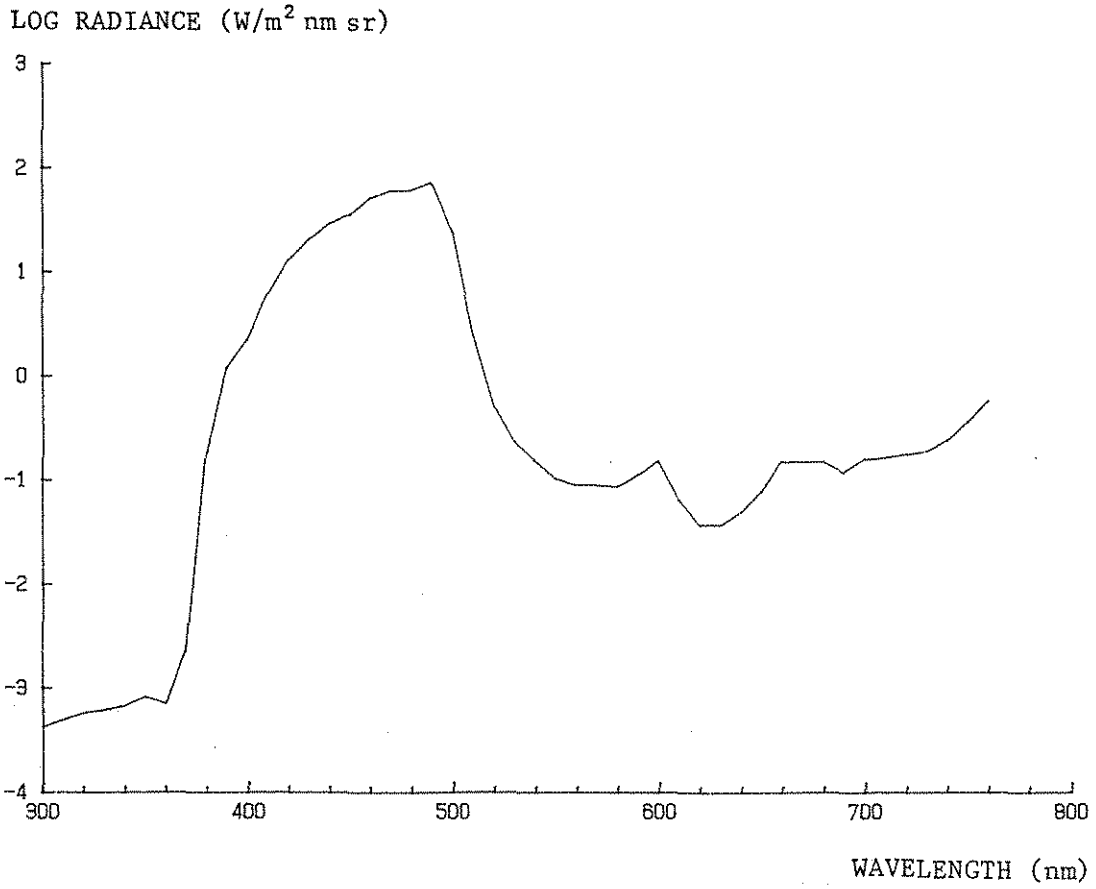
Kerr

TYPE:

Command II

Lamphousing with fiber optics to output handle.





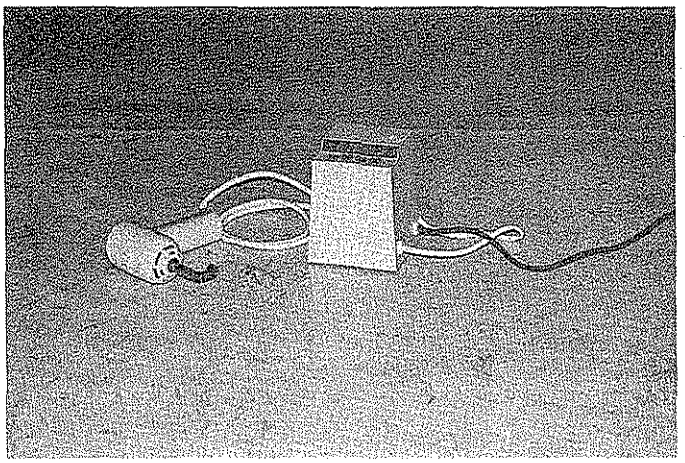
MANUFACTURER:

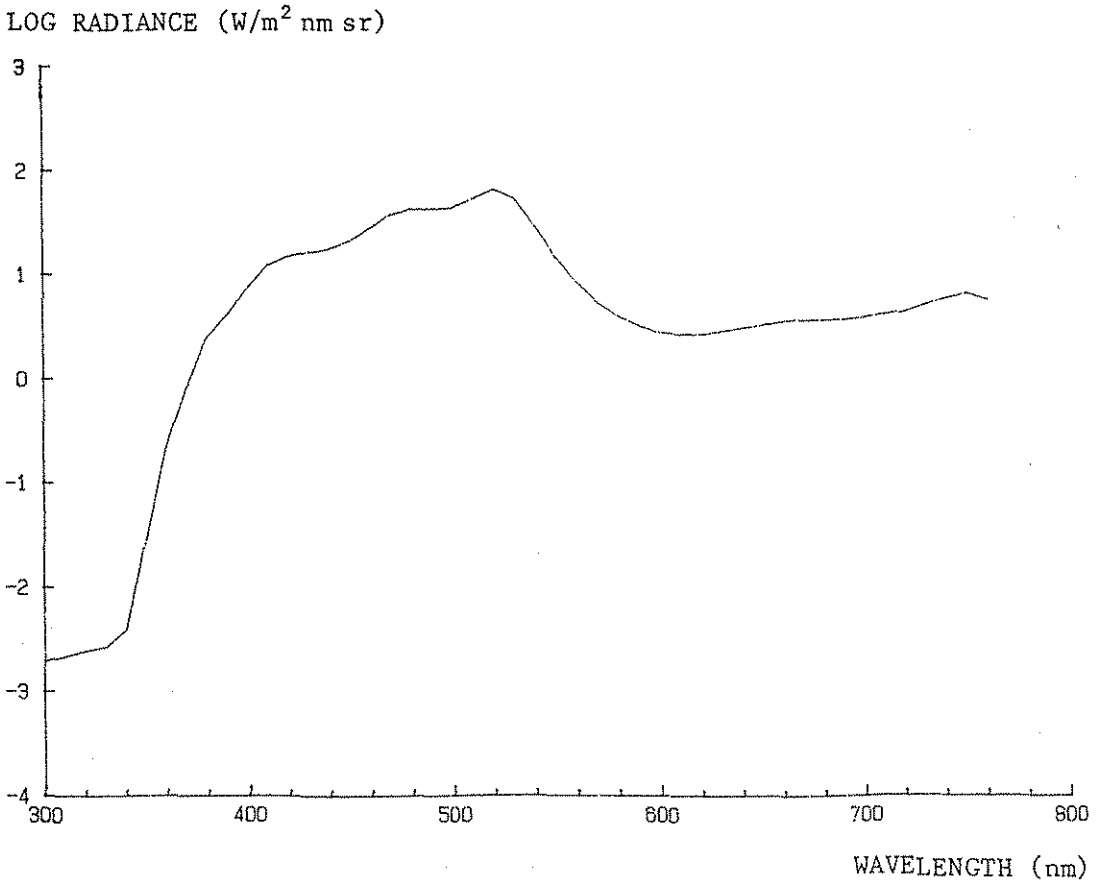
Teledyne Getz
USA

TYPE:

Focus Activator

Handheld lamphousing with short fiber optics output





MANUFACTURER:

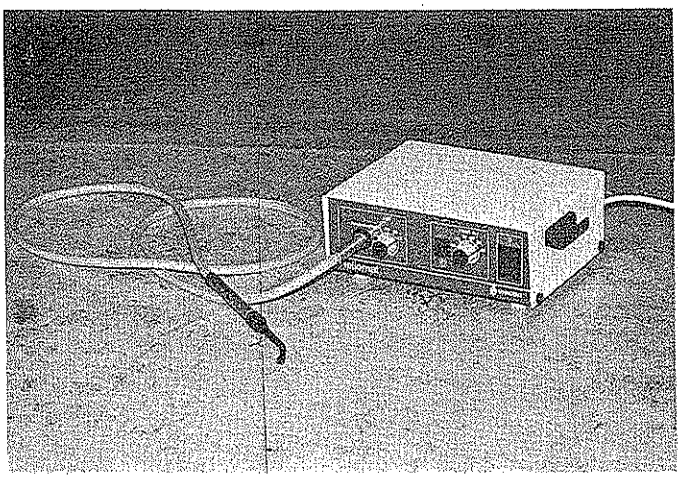
Vivadent
Liechtenstein

TYPE:

Heliomat H2

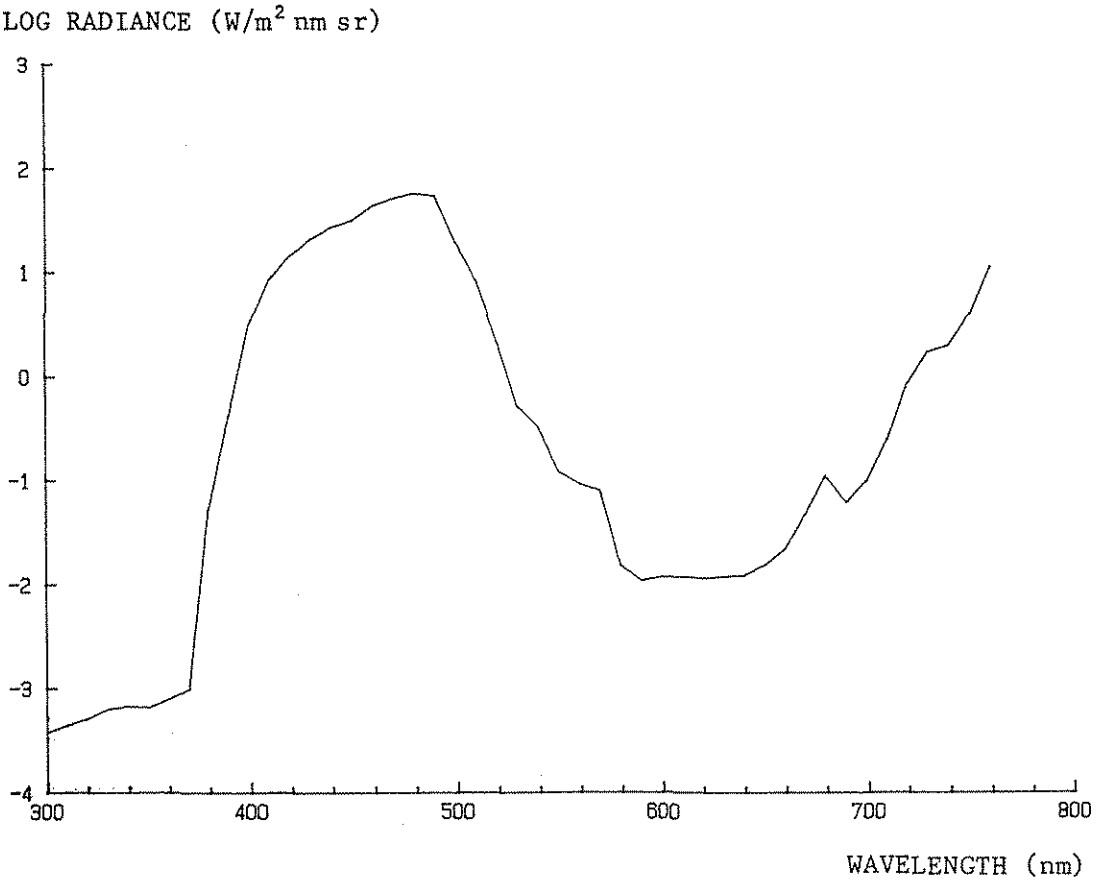
Lamphousing with fiber optics to output handle.

The lamphousing is provided with several different filters in a turrent.



FILTER:

Polymerisation (blue)



MANUFACTURER:

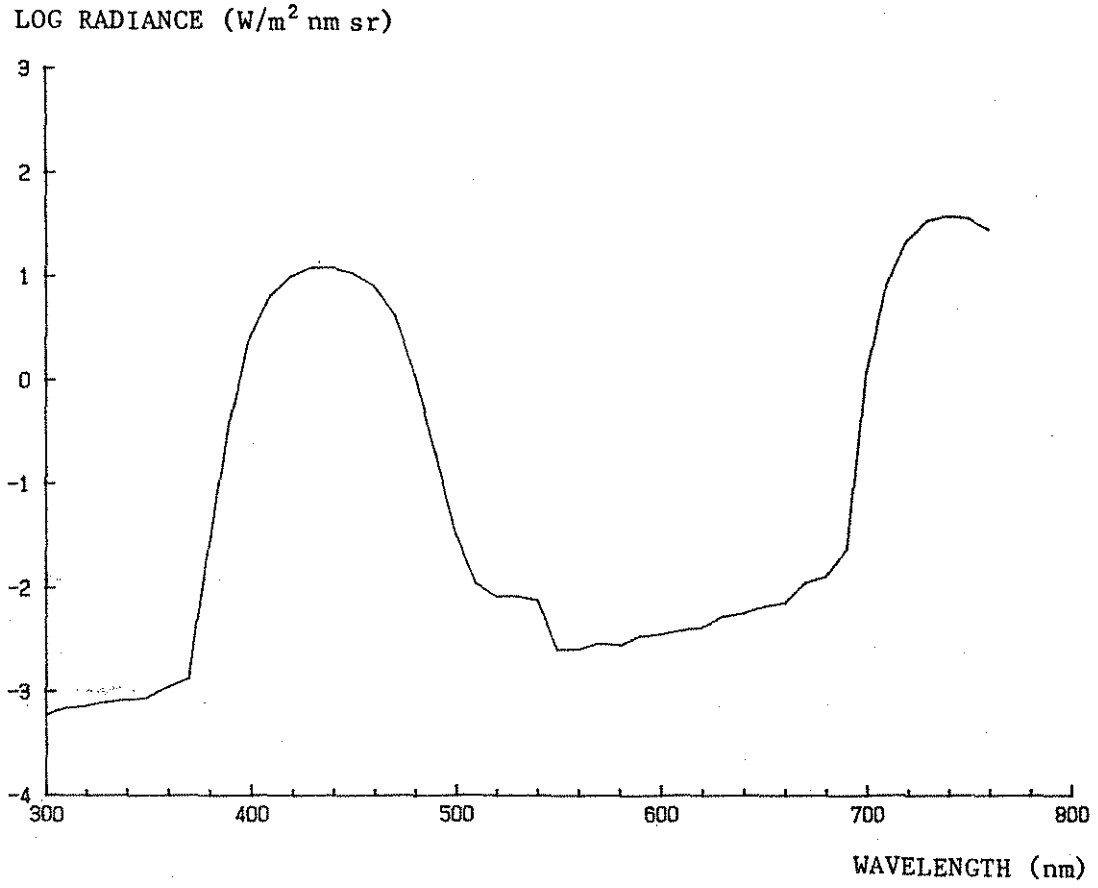
Vivadent
Liechtenstein

TYPE:

Heliomat H2

FILTER:

PI



MANUFACTURER:

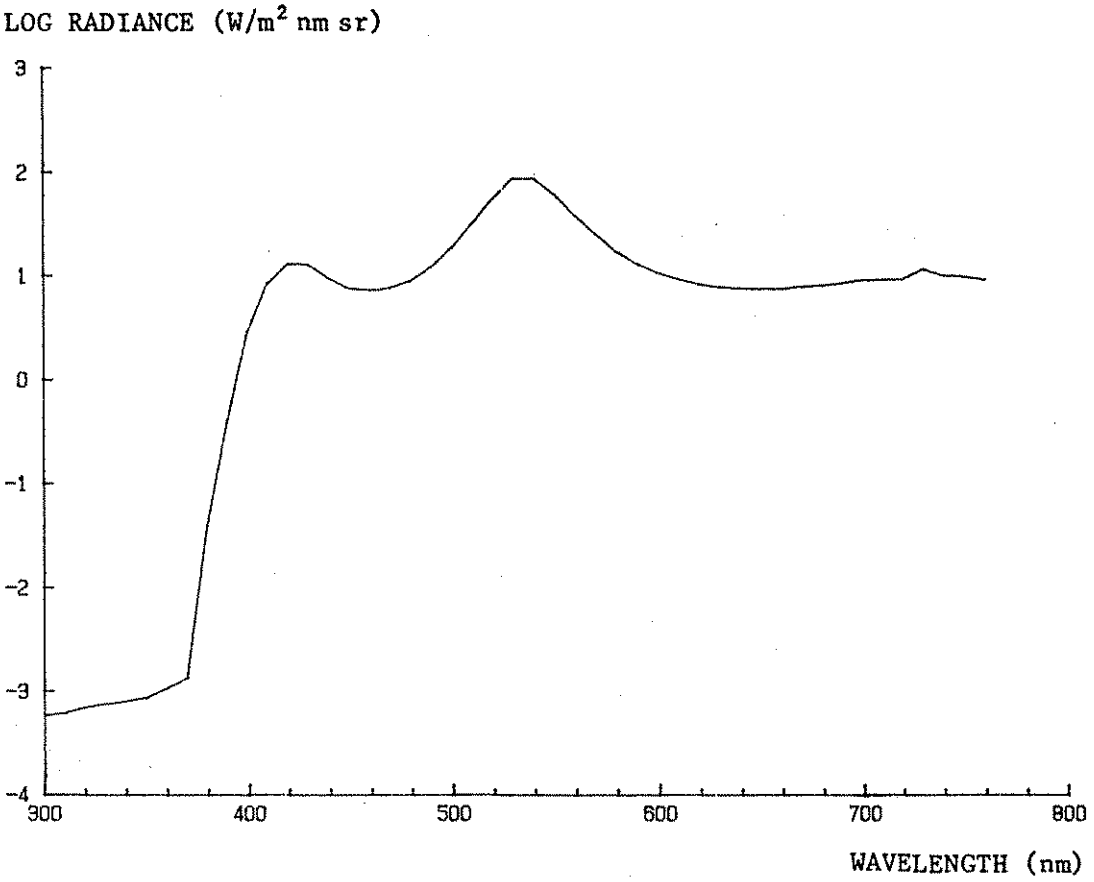
Vivadent
Liechtenstein

TYPE:

Heliomat H2

FILTER:

C



MANUFACTURER:

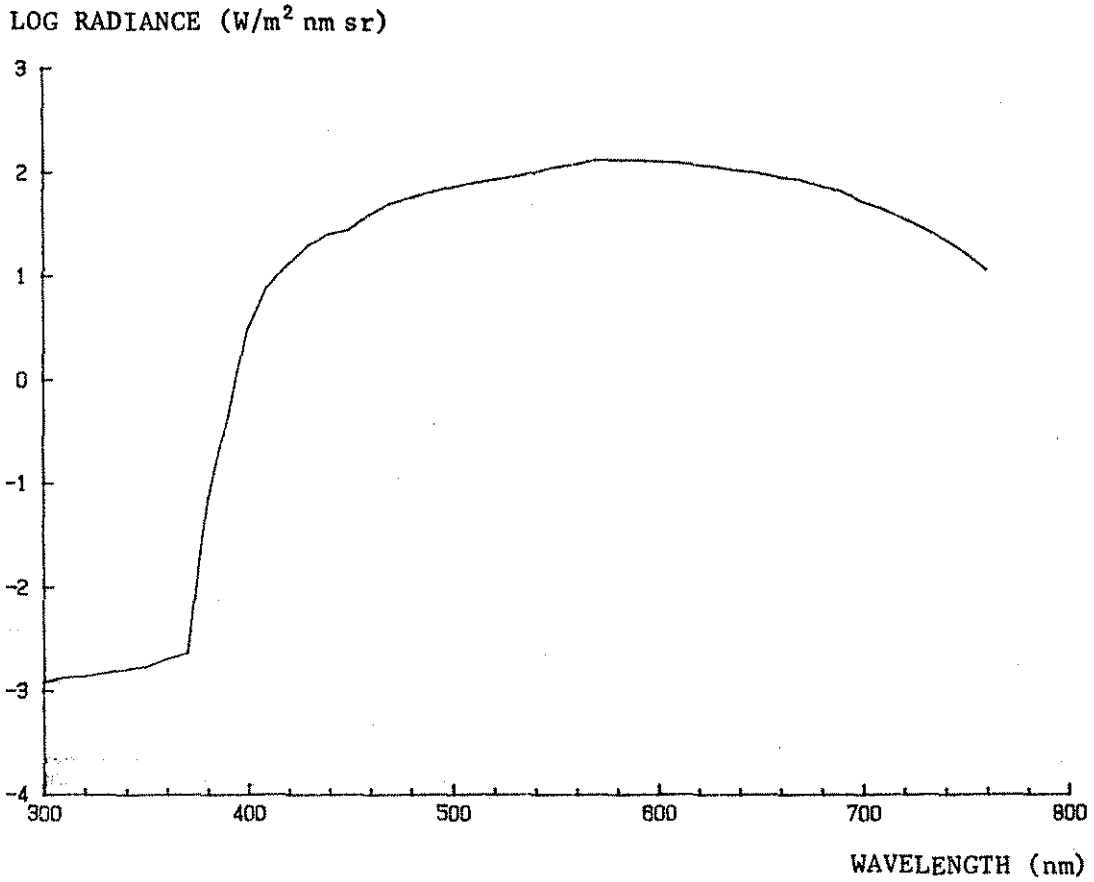
Vivadent
Liechtenstein

TYPE:

Heliomat H2

FILTER:

D2



MANUFACTURER:

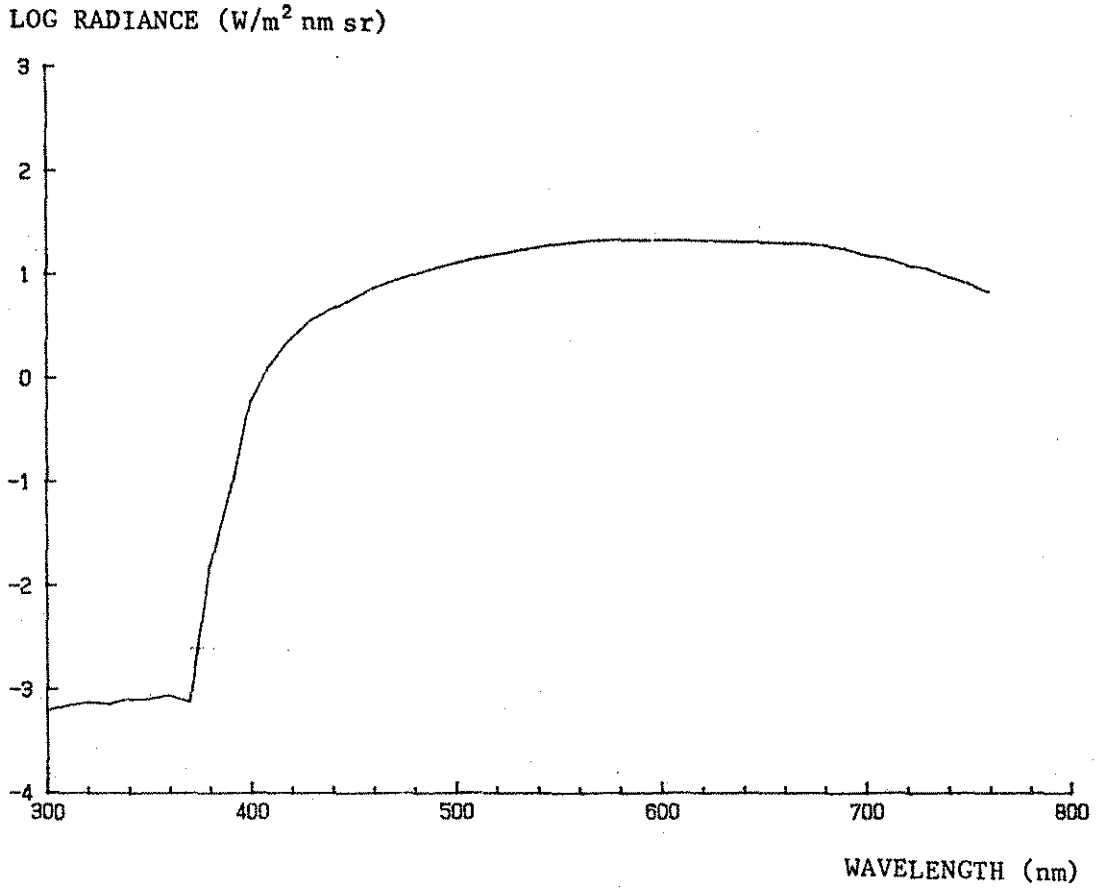
Vivadent
Liechtenstein

TYPE:

Heliomat H2

FILTER:

D1



MANUFACTURER:

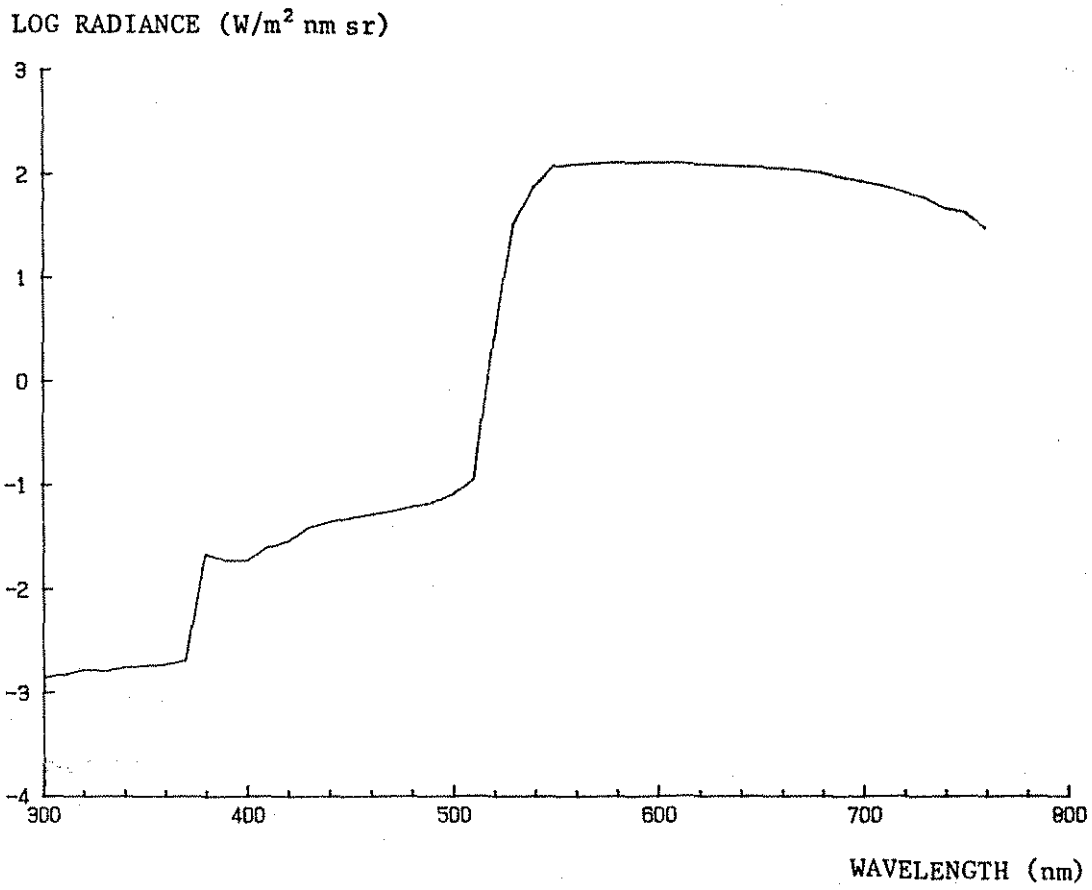
Vivadent
Liechtenstein

TYPE:

Heliomat H2

FILTER:

OL



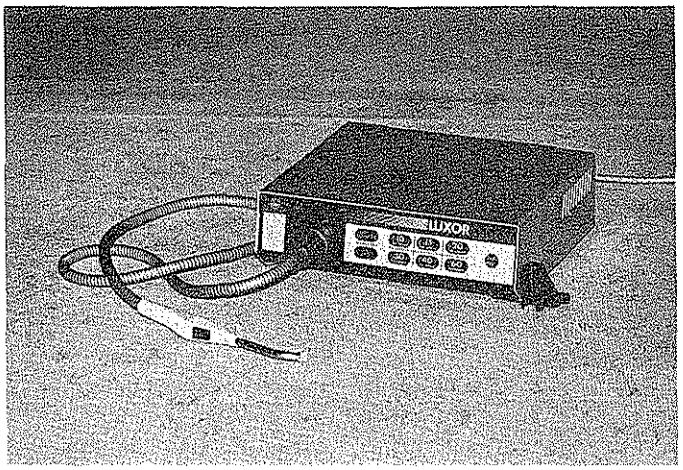
MANUFACTURER:

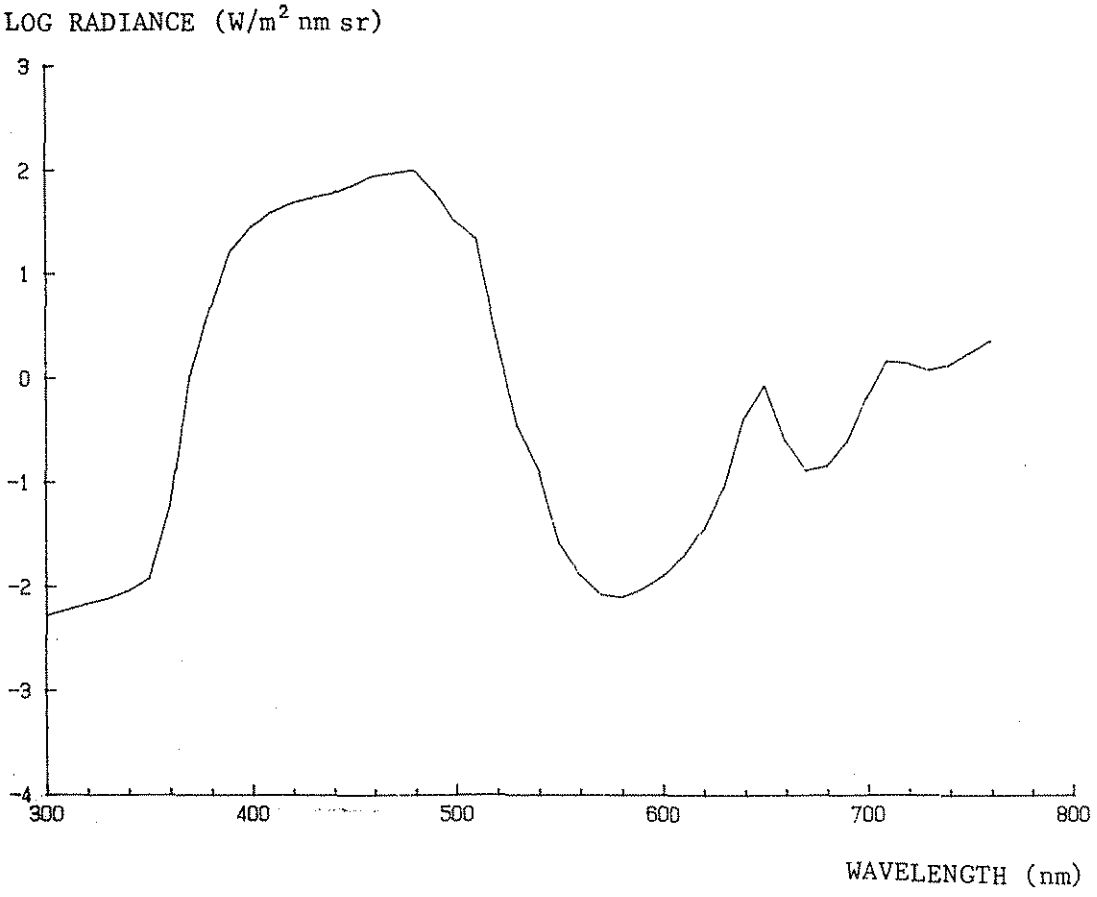
ICI
England

TYPE:

Luxor

Lamphousing with fiber optics to output handle.





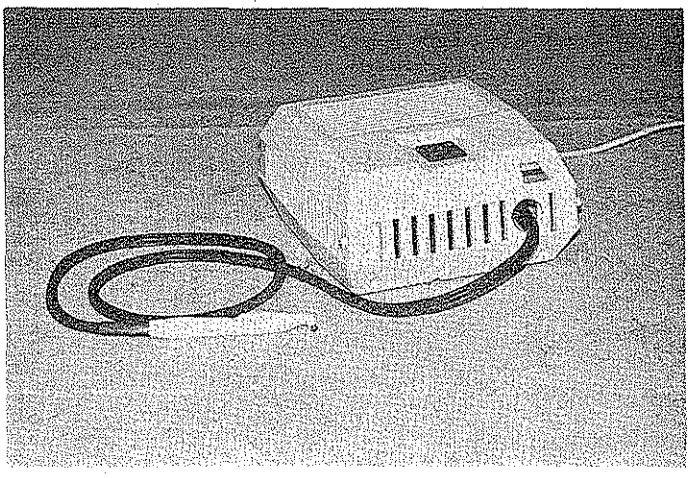
MANUFACTURER:

Dentsply Int. Inc
Canada

TYPE:

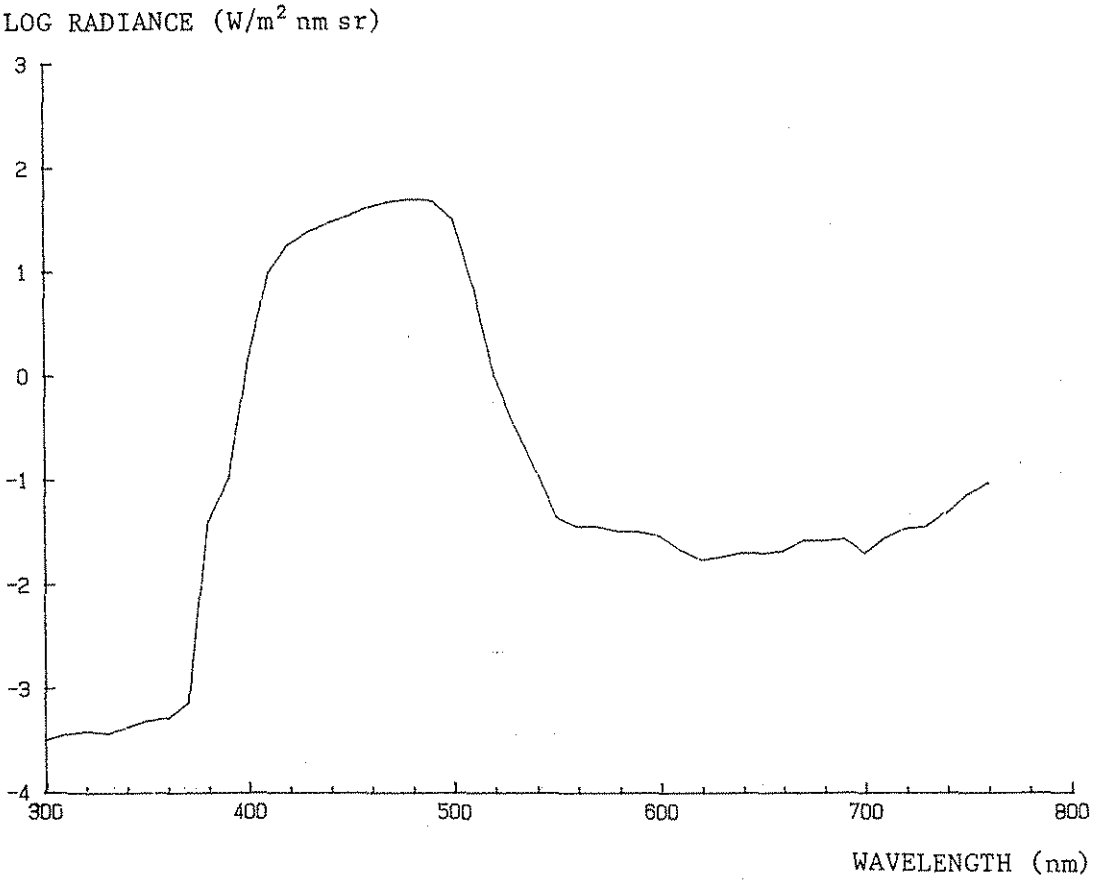
Caulk Prismalite

Lamphousing with fiber optics to output handle.



FILTER:

Clear plastic protector



MANUFACTURER:

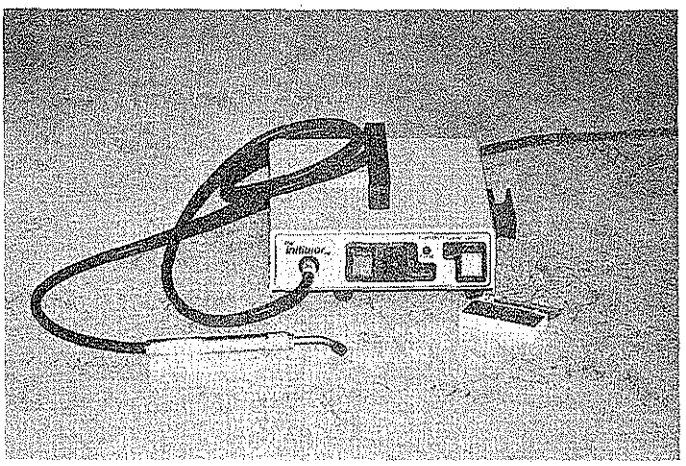
Solid State Systems Corp. USA

TYPE:

Solid State 200

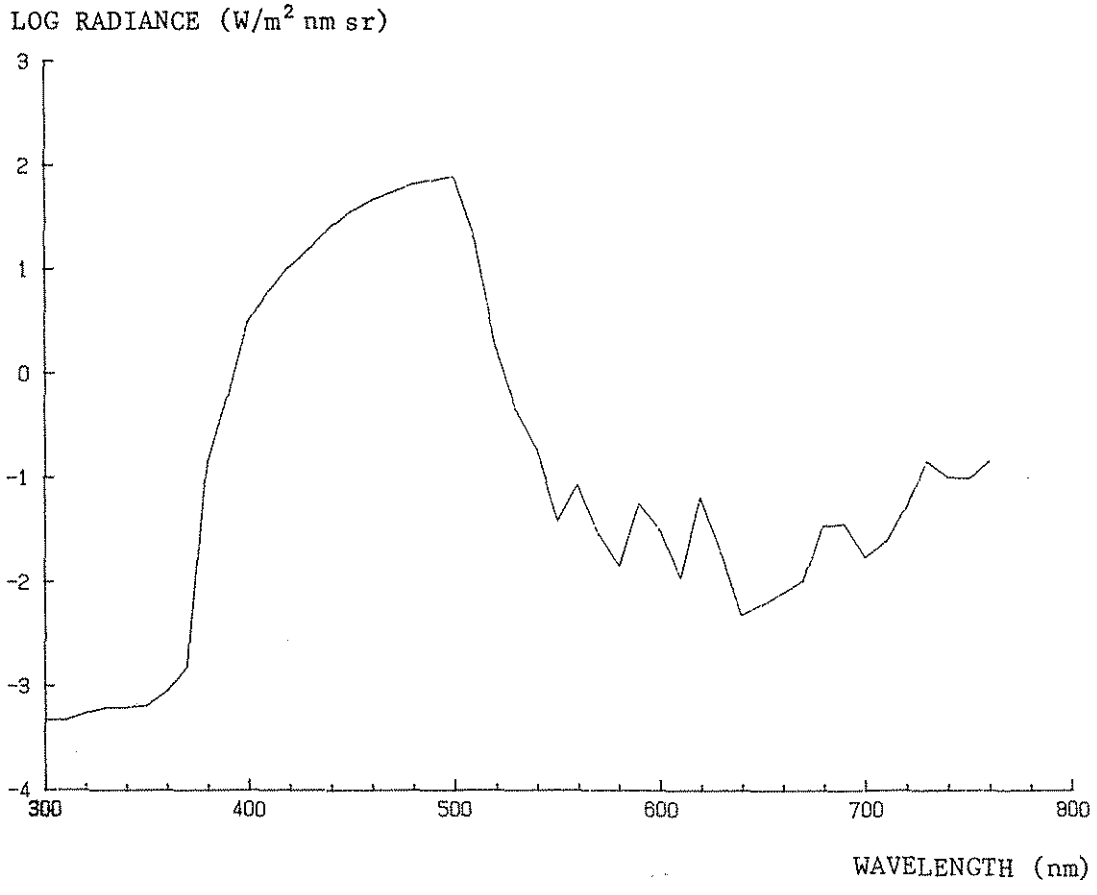
Lamphousing with fiber optics to output handle.

Different filters mountable to output thread.



FILTER:

Curing 1



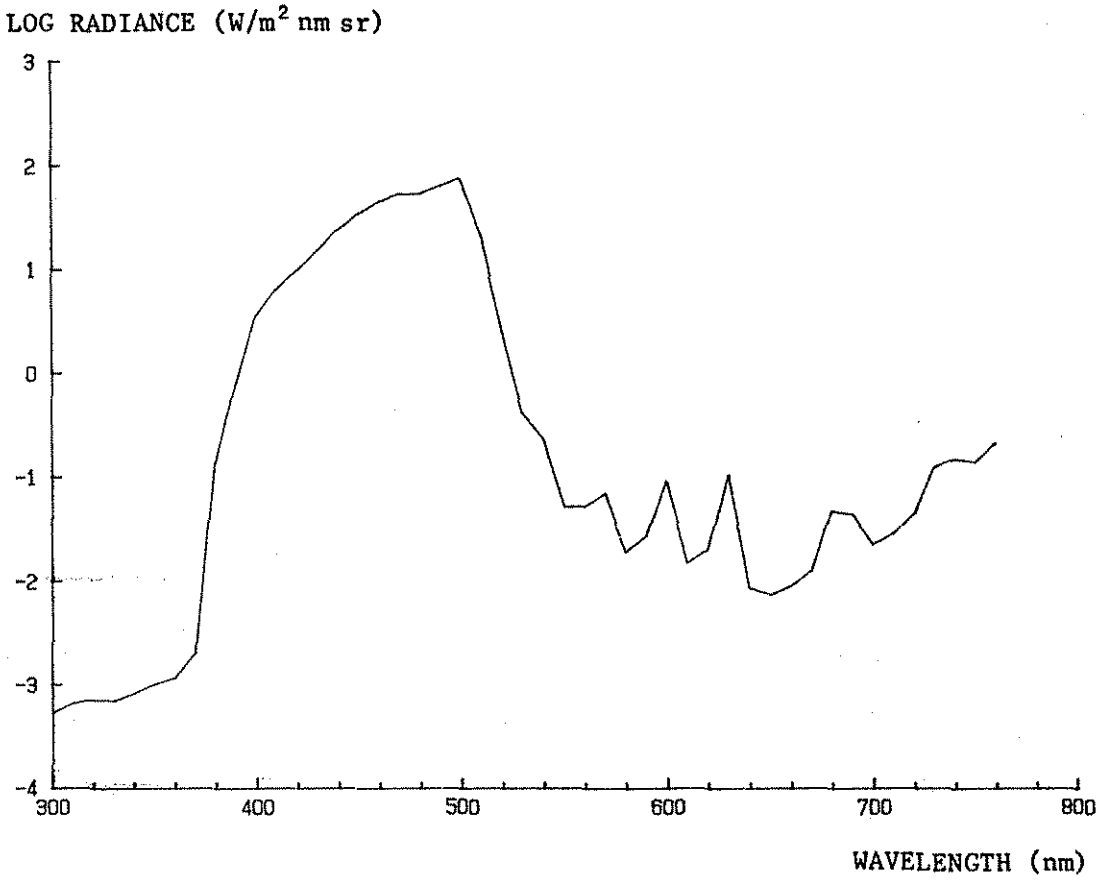
MANUFACTURER:

Solid State Systems Corp. USA

TYPE:
Solid State 200

FILTER:

Curing 2



MANUFACTURER:

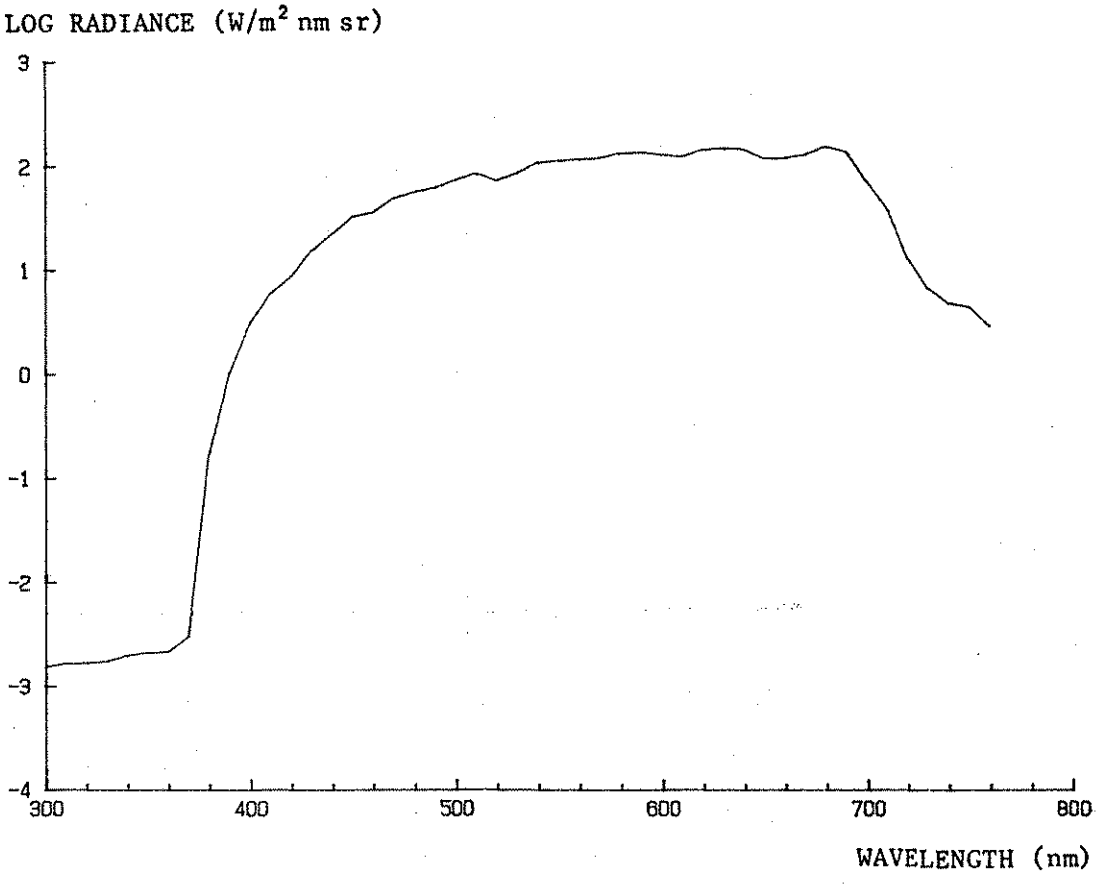
Solid State Systems Corp. USA

TYPE:

Solid State 200

FILTER:

Clear



MANUFACTURER:

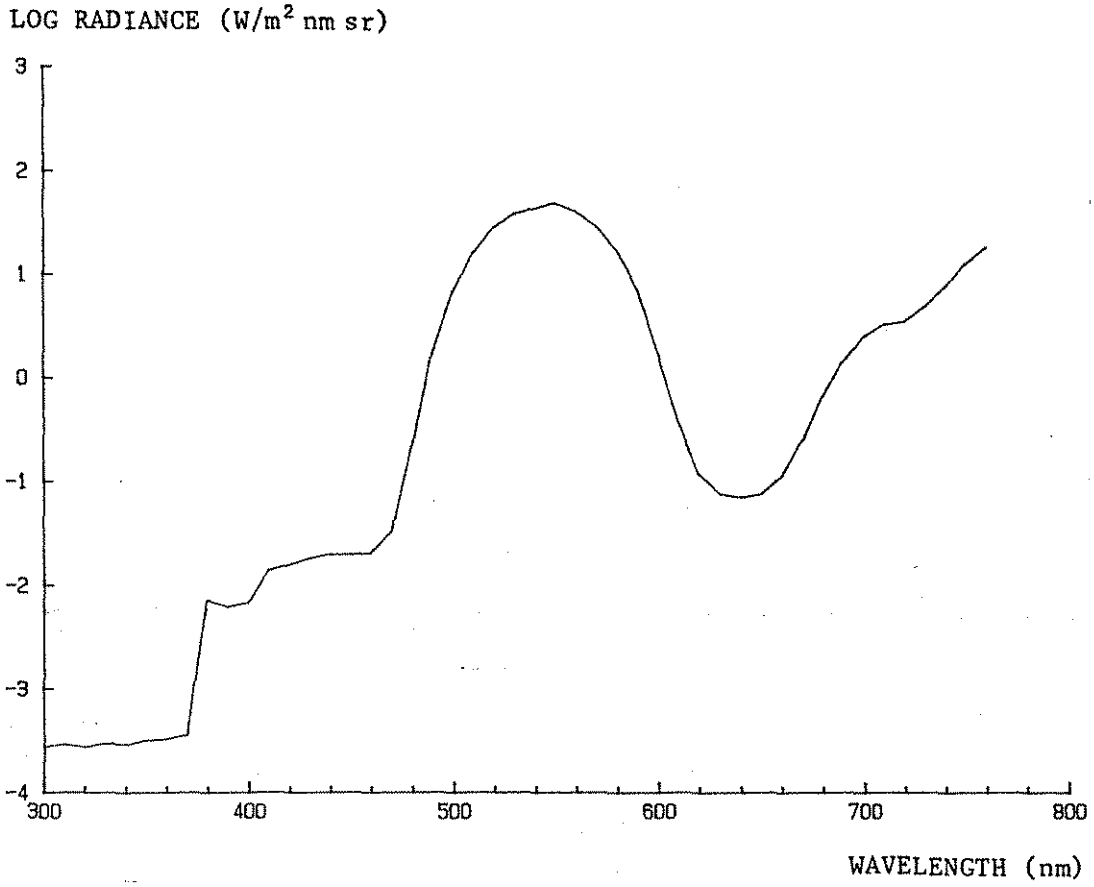
Solid State Systems Corp. USA

TYPE:

Solid State 200

FILTER:

Green



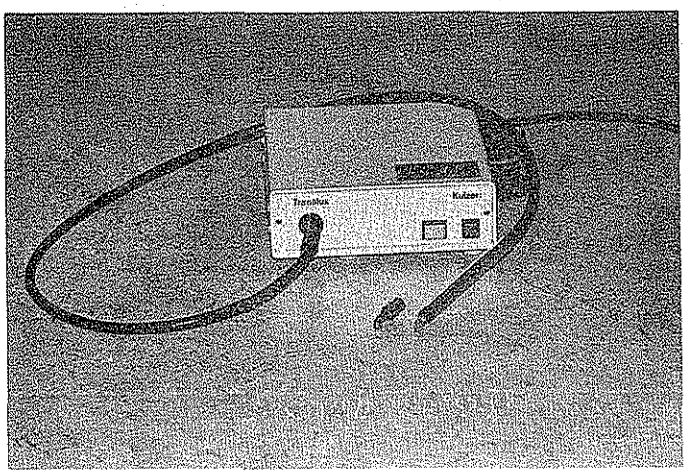
MANUFACTURER:

Kulzer GmbH
Germany

TYPE:

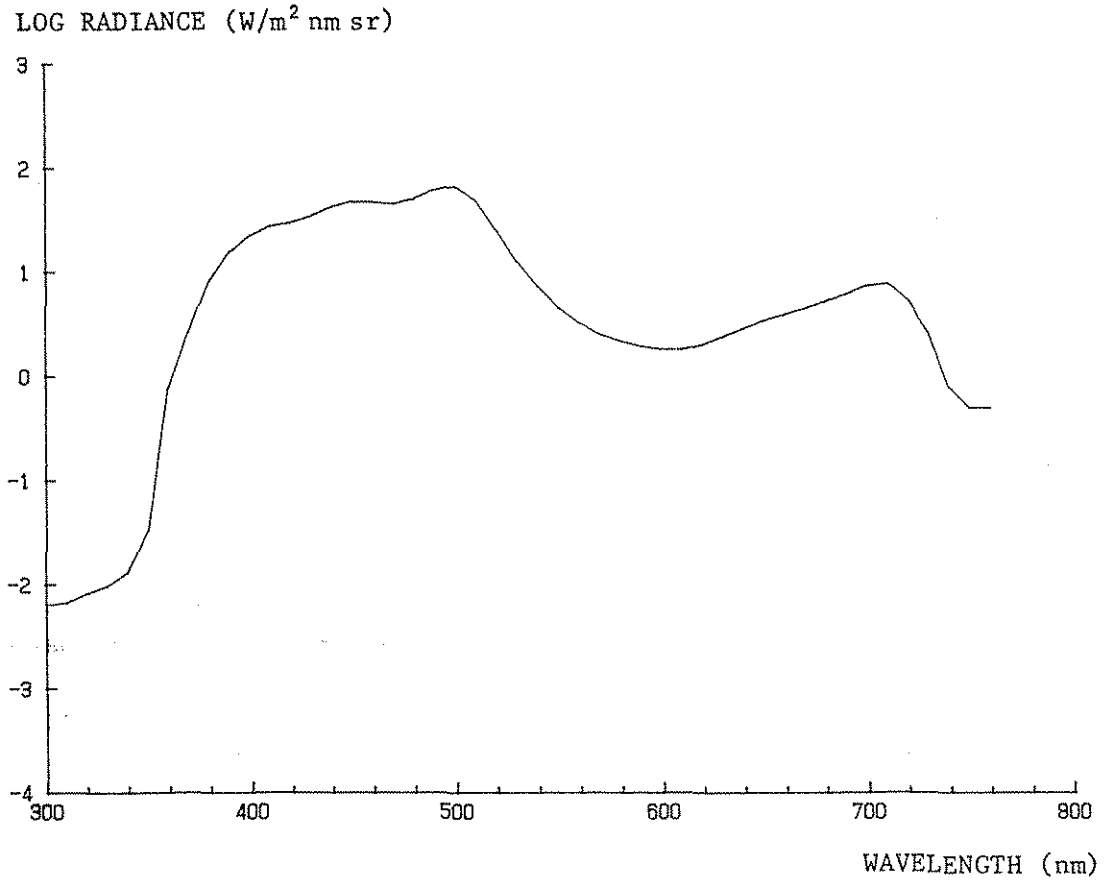
Translux

Lamphousing with fiber optics to output handle. The handle could be provided with clear or blue output tip.



FILTER:

Clear tip



MANUFACTURER:

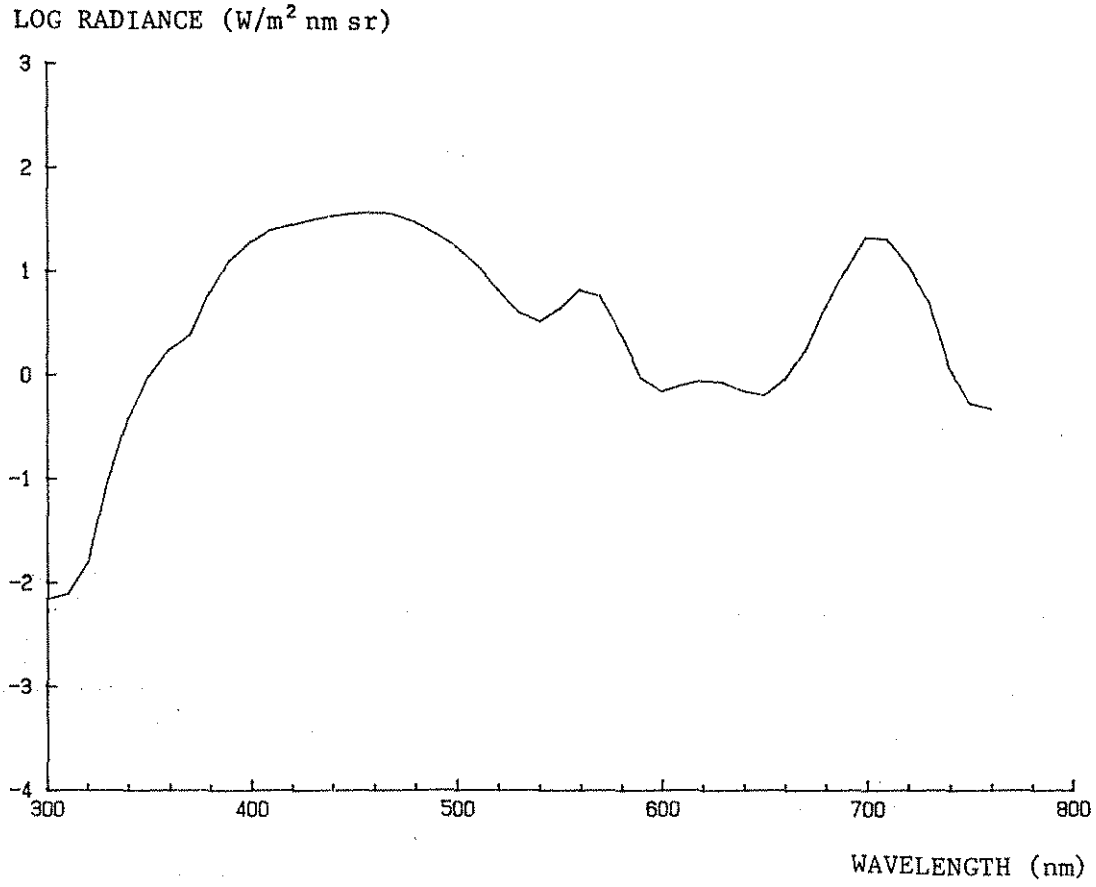
Kulzer GmbH

TYPE:

Translux

FILTER:

Blue tip



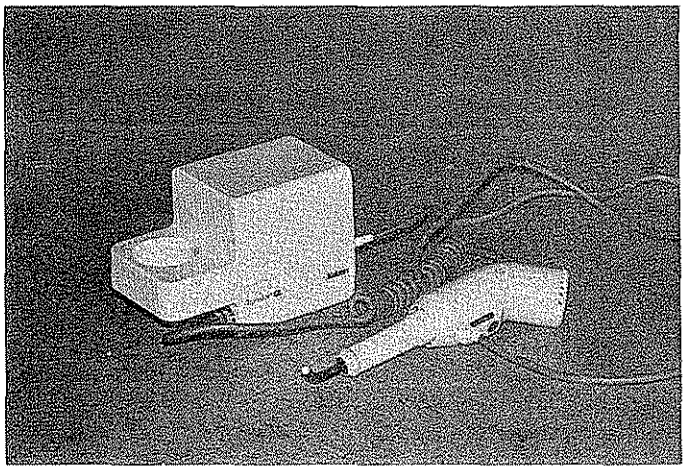
MANUFACTURER:

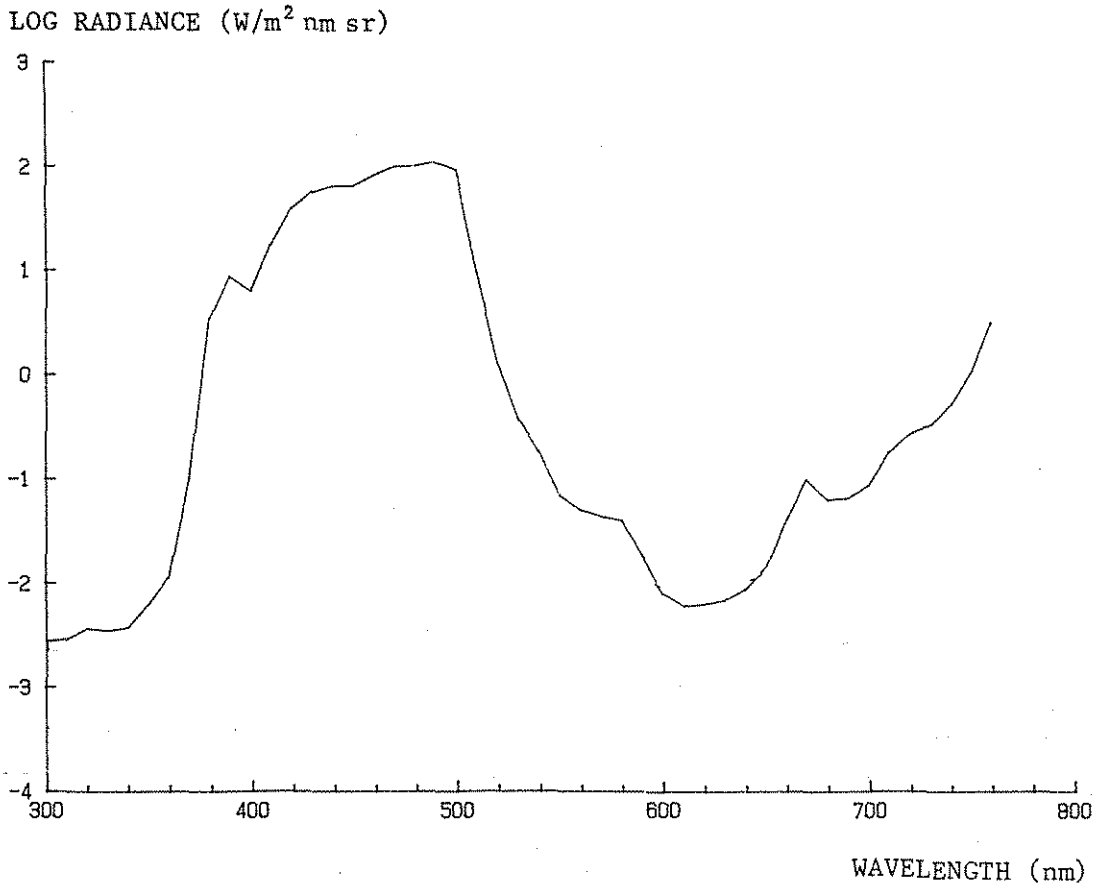
Kulzer GmbH
Germany

TYPE:

Translux CL

Handheld lamphousing with short fiber optics output





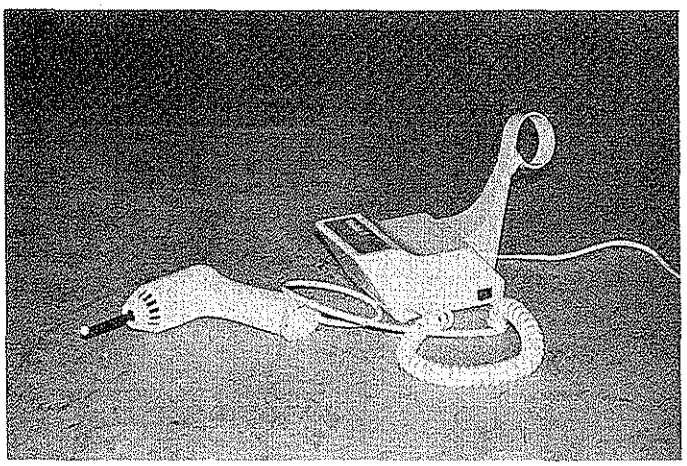
MANUFACTURER:

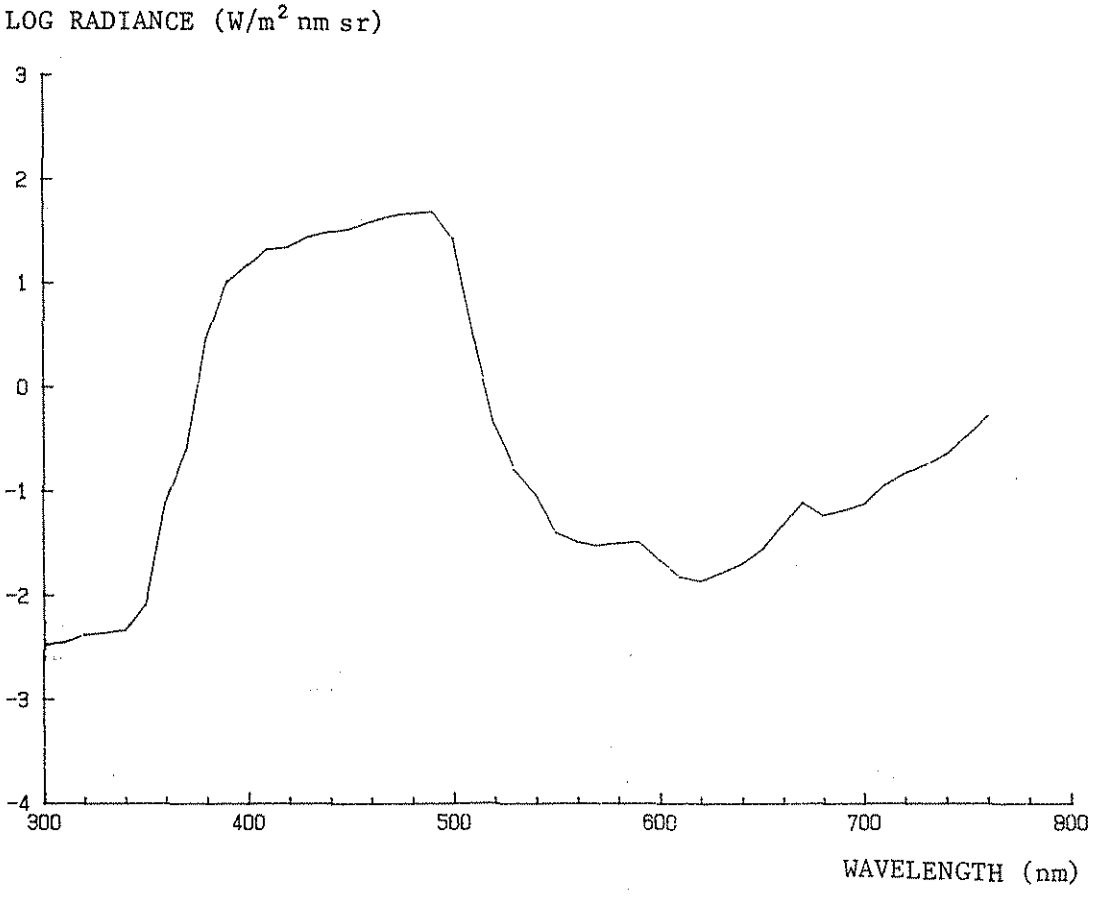
3M/Dental Products
USA

TYPE:

Visilux 2

Handheld lamphousing with short fiber optics output





Spectral radiance (W/m^2 nm sr)

	Command II	Focus	Heliomat poly.	PL	C	D2	D1	OL
300	4.232E-004	1.945E-003	7.756E-004	5.917E-004	7.673E-004	1.225E-003	6.222E-004	1.497E-003
310	4.946E-004	2.161E-003	4.432E-004	6.997E-004	9.099E-004	1.750E-003	8.990E-004	1.483E-003
320	5.722E-004	2.434E-003	5.124E-004	7.295E-004	9.890E-004	1.375E-003	7.467E-004	1.657E-003
330	6.130E-004	2.658E-003	6.265E-004	7.906E-004	1.469E-004	1.469E-003	7.191E-004	1.611E-003
340	6.740E-004	3.866E-003	6.725E-004	8.333E-004	1.931E-004	1.587E-003	7.959E-004	1.751E-003
350	8.207E-004	1.887E-002	8.586E-004	9.694E-004	1.576E-004	1.702E-003	8.036E-004	1.825E-003
360	7.173E-004	2.191E-001	7.936E-004	1.102E-003	1.956E-003	2.014E-003	9.668E-004	1.956E-003
370	8.308E-003	8.134E-001	9.921E-004	1.335E-003	1.921E-003	2.284E-003	7.497E-004	2.015E-003
380	1.773E-001	2.519E+000	5.297E-002	2.523E-002	7.930E-003	7.942E-002	1.511E-002	2.141E-002
390	1.185E+000	4.123E+000	4.209E-001	3.837E-001	4.028E-001	4.223E-001	1.646E-002	1.882E-002
400	2.226E+000	7.644E+000	7.128E+000	2.639E+000	2.905E+000	7.056E+000	5.875E-001	1.876E-002
410	5.161E+000	1.246E+001	9.671E+000	5.565E+000	9.469E+000	1.696E+000	1.351E+000	2.514E-002
420	1.283E+001	1.510E+001	1.451E+001	9.980E+000	1.312E+001	1.316E+001	3.413E+000	3.877E-002
430	2.018E+001	1.677E+001	2.071E+001	1.229E+001	1.298E+001	1.985E+001	7.695E+000	3.558E-002
440	2.884E+001	1.781E+001	2.697E+001	1.207E+001	9.531E+000	2.521E+001	4.577E+000	4.379E-002
450	3.537E+001	3.101E+001	3.135E+001	1.083E+001	7.574E-000	2.771E+001	5.694E+000	4.920E-002
460	5.030E+001	2.784E+001	4.224E+001	8.217E+000	5.269E+000	3.878E+001	7.354E+000	4.187E-002
470	5.989E+001	3.824E+001	5.091E+001	4.343E+000	7.602E+000	4.983E+001	9.543E+000	5.522E-002
480	6.863E+001	4.360E+001	5.704E+001	1.148E+000	3.945E+000	5.615E+001	9.790E+000	5.063E-002
490	7.143E+001	4.328E+001	5.469E+001	2.008E-001	1.209E+001	6.789E+001	1.130E+001	6.729E-003
500	2.444E+001	4.437E+001	1.956E+001	3.303E-002	1.854E+001	7.208E+001	1.272E+001	7.999E-002
510	2.482E+000	5.406E+001	8.356E+000	1.130E-002	3.188E+001	7.879E+001	1.410E+001	1.104E-001
520	5.130E-001	5.637E+001	2.190E+000	8.362E-003	5.523E+001	8.502E+001	1.559E+001	2.458E+000
530	2.317E-001	5.532E+001	5.174E-001	8.418E-003	8.697E+001	9.947E+001	1.688E+001	3.229E+001
540	1.545E-001	2.948E+001	3.265E-001	7.619E-003	9.728E+001	9.976E+001	1.819E+001	7.447E+001
550	1.046E-001	1.475E+001	1.211E-001	2.549E-003	5.230E+001	1.128E+002	1.977E+001	1.179E+002
560	2.930E-002	8.549E+000	9.709E-002	2.551E-003	3.875E+001	1.200E+002	2.078E+001	1.235E+002
570	9.926E-002	5.484E+000	8.036E-002	2.877E-003	2.569E+001	1.329E+002	2.147E+001	1.266E+002
580	8.608E-002	4.037E+000	1.525E-002	2.777E-003	1.751E+001	1.343E+002	2.195E+001	1.302E+002
590	1.105E-001	3.243E+000	1.092E-002	3.403E-003	1.327E+001	1.322E+002	2.180E+001	1.295E+002
600	1.518E-001	2.778E+000	1.179E-002	3.595E-003	1.082E+001	1.296E+002	2.166E+001	1.309E+002
610	6.572E-002	2.640E+000	1.191E-002	3.879E-003	9.469E+000	1.262E+002	2.150E+001	1.294E+002
620	3.734E-002	2.682E+000	1.146E-002	4.197E-003	8.441E+000	1.192E+002	2.146E+001	1.250E+002
630	3.715E-002	2.809E+000	1.189E-002	5.315E-003	7.833E+000	1.136E+002	3.114E+001	1.229E+002
640	4.931E-002	3.017E+000	1.214E-002	5.726E-003	7.574E+000	1.051E+002	2.086E+001	1.190E+002
650	7.638E-002	3.225E+000	1.519E-002	6.665E-003	7.496E+000	9.920E+001	2.074E+001	1.171E+002
660	1.495E-001	3.455E+000	2.164E-002	7.212E-003	7.539E+000	9.090E+001	2.021E+001	1.133E+002
670	1.517E-001	3.649E+000	4.607E-002	1.125E-002	7.916E+000	8.593E+001	2.000E+001	1.097E+002
680	1.506E-001	3.686E+000	1.087E-001	1.286E-002	8.155E+000	7.461E+001	1.899E+001	1.031E+002
690	1.197E-001	3.725E+000	6.142E-002	2.363E-002	8.549E+000	6.641E+001	1.794E+001	9.390E+001
700	1.597E-001	3.897E+000	9.840E-002	1.187E+000	9.141E+000	5.332E+001	1.546E+001	8.596E+001
710	1.659E-001	4.197E+000	2.452E-001	9.432E+000	9.406E+000	4.534E+001	1.446E+001	7.753E+001
720	1.783E-001	4.464E+000	9.356E-001	2.346E+001	9.328E+000	3.652E+001	1.237E+001	6.747E+001
730	1.891E-001	5.260E+000	1.687E+000	3.487E+001	1.164E+001	2.905E+001	1.147E+001	5.989E+001
740	2.372E-001	5.981E+000	1.962E+000	3.857E+001	1.019E+001	2.375E+001	9.526E+000	4.727E+001
750	3.544E-001	6.670E+000	3.696E+000	2.701E+001	9.966E+000	1.630E+001	8.225E+000	4.271E+001
760	5.666E-001	8.798E+000	1.093E+001	2.910E+001	9.359E+000	1.162E+001	6.942E+000	3.054E+001
770	1.195E+000	4.908E+000	1.771E+001	2.345E+001	8.821E+000	8.689E+000	5.533E+000	2.589E+001
780	2.893E+000	3.899E+000	9.427E+000	1.728E+001	7.291E+000	5.745E+000	4.216E+000	1.829E+001
790	8.795E+000	2.507E+000	8.264E+000	1.267E+001	6.603E+000	4.494E+000	3.254E+000	1.457E+001
800	1.045E+001	1.630E+000	7.995E+000	9.402E+000	5.134E+000	4.428E+000	4.474E+000	1.349E+001

Spectral radiance (W/m^2 nm sr)

	Luxor	Prismalite	Solid State Curing 1	Curing 2	Clear	Green
300	5.301E-003	3.180E-004	4.696E-004	5.351E-004	1.546E-003	2.767E-004
310	5.993E-003	3.621E-004	4.702E-004	6.589E-004	1.655E-003	2.912E-004
320	6.818E-003	3.870E-004	5.448E-004	7.141E-004	1.676E-003	2.713E-004
330	7.610E-003	3.693E-004	6.175E-004	6.954E-004	1.735E-003	2.940E-004
340	9.078E-003	4.216E-004	6.151E-004	8.208E-004	1.975E-003	2.873E-004
350	1.185E-002	4.925E-004	6.469E-004	1.004E-003	2.102E-003	3.169E-004
360	5.663E-002	5.230E-004	8.862E-004	1.148E-003	2.164E-003	3.239E-004
370	1.036E+000	7.159E-004	1.490E-003	1.963E-003	2.960E-003	3.540E-004
380	4.752E+000	3.989E-002	1.437E-001	1.788E-001	1.660E-001	7.097E-003
390	1.690E+001	1.040E-001	6.038E-001	7.912E-001	1.010E+000	6.177E-003
400	2.884E+001	1.476E+000	3.172E+000	3.527E+000	3.893E+000	6.717E-002
410	3.968E+001	1.014E+001	6.177E+000	6.325E+000	6.016E+000	1.395E-002
420	4.866E+001	1.878E+001	1.046E+001	9.710E+000	9.744E+000	1.601E-002
430	5.485E+001	2.510E+001	1.569E+001	1.498E+001	1.556E+001	1.877E-002
440	6.047E+001	3.044E+001	2.556E+001	2.419E+001	2.266E+001	2.012E-002
450	7.236E+001	3.573E+001	3.598E+001	3.416E+001	3.337E+001	2.021E-002
460	8.856E+001	4.302E+001	4.637E+001	4.465E+001	3.709E+001	2.085E-002
470	9.480E+001	4.879E+001	5.543E+001	5.392E+001	5.052E+001	3.272E-002
480	1.019E+002	5.119E+001	6.649E+001	5.377E+001	5.819E+001	2.173E-001
490	6.345E+001	4.930E+001	7.212E+001	6.418E+001	6.431E+001	1.753E+000
500	3.302E+001	3.350E+001	7.873E+001	7.631E+001	7.606E+001	6.740E+000
510	2.279E+001	7.449E+000	2.089E+001	2.292E+001	8.828E+001	1.620E+001
520	2.559E+000	1.021E+000	1.815E+000	3.563E+000	7.575E+001	2.824E+001
530	3.559E-001	3.356E-001	4.639E-001	4.209E-001	8.851E+001	3.798E+001
540	1.396E-001	1.224E-001	1.907E-001	2.369E-001	1.121E+002	4.302E+001
550	2.726E-002	4.480E-002	3.943E-002	5.169E-002	1.176E+002	4.903E+001
560	1.330E-002	3.630E-002	8.520E-002	5.277E-002	1.214E+002	4.113E+001
570	8.595E-003	3.610E-002	2.947E-002	6.926E-002	1.240E+002	2.964E+001
580	7.989E-003	3.249E-002	1.473E-002	1.932E-002	1.385E+002	1.716E+001
590	9.513E-003	3.215E-002	5.674E-002	2.678E-002	1.421E+002	7.375E+000
600	1.258E-002	2.949E-002	3.304E-002	9.101E-002	1.343E+002	1.744E+000
610	1.893E-002	2.170E-002	1.134E-002	1.523E-002	1.297E+002	3.730E-001
620	3.524E-002	1.733E-002	6.482E-002	2.014E-002	1.502E+002	1.211E-001
630	8.952E-002	1.840E-002	1.358E-002	1.938E-001	1.565E+002	7.758E-002
640	4.119E-001	2.004E-002	4.851E-003	8.685E-003	1.510E+002	7.097E-002
650	8.517E-001	2.000E-002	6.014E-003	7.410E-003	1.239E+002	7.514E-002
660	2.552E-001	2.096E-002	7.770E-003	8.917E-003	1.258E+002	1.105E-001
670	1.349E-001	2.638E-002	1.016E-002	1.261E-002	1.337E+002	2.490E-001
680	1.475E-001	2.642E-002	3.464E-002	4.716E-002	1.610E+002	5.526E-001
690	2.465E-001	2.743E-002	3.641E-002	4.436E-002	1.443E+002	1.426E+000
700	6.552E-001	2.023E-002	1.754E-002	2.280E-002	7.477E+001	2.511E+000
710	1.477E+000	2.922E-002	2.444E-002	2.850E-002	4.065E+001	3.323E+000
720	1.425E+000	3.457E-002	5.162E-002	4.427E-002	1.357E+001	3.524E+000
730	1.217E+000	3.608E-002	1.438E-001	1.247E-001	6.912E+000	4.770E+000
740	1.717E+000	4.976E-002	1.020E-001	1.495E-001	4.973E+000	7.431E+000
750	1.714E+000	7.331E-002	9.879E-002	1.412E-001	4.559E+000	1.255E+001
760	2.247E+000	9.358E-002	1.428E-001	2.124E-001	2.995E+000	1.803E+001
770	2.590E+000	1.846E-001	2.830E-001	3.958E-001	2.213E+000	2.186E+001
780	2.297E+000	3.213E-001	7.543E-001	8.048E-001	2.579E+000	2.481E+001
790	2.244E+000	5.404E-001	1.855E+000	1.672E+000	4.734E+000	2.846E+001
800	2.396E+000	9.904E-001	2.181E+000	1.913E+000	7.639E+000	3.570E+001

Spectral radiance (W/m^2 nm sr)

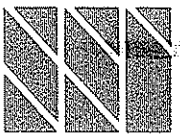
	Translux clear	Translux blue	Translux Cl…	Vistlux 2
300	6.387E-003	6.991E-003	2.769E-003	1.358E-003
310	6.615E-003	7.810E-003	2.969E-003	3.538E-003
320	8.080E-003	1.534E-002	3.625E-003	4.155E-003
330	9.547E-003	9.837E-002	3.482E-003	4.355E-003
340	1.278E-002	3.838E-001	7.759E-003	4.621E-003
350	3.246E-002	9.514E-001	6.157E-003	7.922E-003
360	7.582E-001	1.720E+000	1.143E-002	7.731E-003
370	2.631E+000	2.368E+000	9.972E-002	2.480E-001
380	8.182E+000	6.131E+000	7.421E+000	2.949E+000
390	1.590E+001	1.264E+001	8.723E+000	1.022E+001
400	2.258E+001	1.892E+001	6.427E+000	1.476E+001
410	2.835E+001	2.469E+001	1.769E+001	2.101E+001
420	3.048E+001	2.781E+001	3.943E+001	2.223E+001
430	3.492E+001	3.136E+001	5.677E+001	2.765E+001
440	4.254E+001	3.403E+001	6.595E+001	3.066E+001
450	4.824E+001	3.623E+001	6.605E+001	3.290E+001
460	4.752E+001	3.773E+001	8.319E+001	3.328E+001
470	4.556E+001	3.594E+001	1.012E+002	4.383E+001
480	5.033E+001	3.050E+001	1.029E+002	4.662E+001
490	6.182E+001	2.359E+001	1.108E+002	4.838E+001
500	6.718E+001	1.757E+001	9.527E+001	3.685E+001
510	5.036E+001	1.176E+001	1.005E+001	3.871E+000
520	2.619E+001	6.897E+000	1.336E+000	4.425E-001
530	1.289E+001	4.126E+000	3.819E-001	1.608E-001
540	7.452E+000	3.332E+000	1.889E-001	9.475E-002
550	4.639E+000	4.358E+000	7.179E-002	4.034E-002
560	3.333E+000	6.643E+000	5.204E-002	3.282E-002
570	2.569E+000	5.860E+000	4.489E-002	2.982E-002
580	2.181E+000	2.532E+000	4.095E-002	3.151E-002
590	1.927E+000	9.485E-001	1.897E-002	7.277E-002
600	1.810E+000	7.115E-001	8.018E-003	2.192E-002
610	1.803E+000	8.110E-001	6.170E-003	1.525E-002
620	2.003E+000	8.915E-001	6.332E-003	1.373E-002
630	2.376E+000	8.615E-001	6.867E-003	1.619E-002
640	2.844E+000	7.181E-001	8.698E-003	2.000E-002
650	3.398E+000	6.469E-001	1.414E-002	2.741E-002
660	3.871E+000	9.002E-001	4.024E-002	4.639E-002
670	4.450E+000	1.718E+000	9.975E-002	7.878E-002
680	5.202E+000	4.388E+000	6.464E-002	6.021E-002
690	6.105E+000	1.024E+001	6.625E-002	6.642E-002
700	7.350E+000	2.145E+001	9.727E-002	7.578E-002
710	7.744E+000	2.089E+001	1.813E-001	1.155E-001
720	5.441E+000	1.195E+001	2.725E-001	1.496E-001
730	2.626E+000	5.302E+000	3.347E-001	1.793E-001
740	7.874E-001	1.212E+000	5.152E-001	2.270E-001
750	4.967E-001	5.390E-001	1.022E+000	3.386E-001
760	5.016E-001	4.766E-001	3.125E+000	5.316E-001
770	7.729E-001	6.584E-001	1.063E+001	9.928E-001
780	1.329E+000	1.094E+000	3.380E+001	1.900E+000
790	2.256E+000	1.835E+000	2.568E+001	4.191E+000
800	3.559E+000	2.564E+000	7.497E+000	1.081E+001

HITTILLS UTGIVNA SSI-rapport 1985

Rapport-nummer	Titel (undertitel)	Författare
01	Radon till bostäder	Miljölaboratoriet
02	Occupational exposure to ionizing radiation	Jan Olof Snihs
03	Non-occupational exposure to ionizing radiation	Jan Olof Snihs
04	Collective Doses from Recycling of Contaminated Scrap Metal	Curt Bergman Ragnar Boge
05	Mätstationer för gammastrålning - mätresultat 1984	Per Einar Kjelle
06	Hushållens innehav av beredskaps-broschyr och jodtabletter	Örjan Hultåker
07	Avveckling och friklassning av R1-reaktorn	Curt Bergman Bo Tage Holmberg
08	Radioaktiva ämnen i byggnadsmaterial	Hans Möre
09	Konstanskontroller av riksmätplatsens normaler 1984	Jan-Erik Grindborg Margareta Ljungberg
10	Emergency Planning for Radiation Accidents in Sweden	Gunnar Bengtsson
11	Granskningspromemoria: markdeponerinsanläggning vid OKG	Curt Bergman et al
12	Åttonde mötet med sektion 1, CCEMRI, BIPM	Lennart Lindborg
13	Persondosmätningar. Årsrapport 1984	Albert Kiibus
14	Radiation Protection Aspects of Waste Acceptance Criteria	Curt Bergman et al
15	Isotopkommittérapporter 1983	Gunilla Hellström Ingemar Malmström
16	Laserskydd	Anders Glansholm
17	Föroreningar i radioaktiva läkemedel	Lennart Darte Lars E Olsson
18	The Swedish National Laboratory for Radiation Standards	Lennart Lindborg et al
19	New Recommendations for Dose Equivalent	Gunnar Bengtsson
20	Verksamhetsberättelse Budgetåret 1984/85	Statens strålskyddsinstitut

HITTILLS UTGIVNA SSI-rapport 1985

Rapport-nummer	Titel (undertitel)	Författare
21	Kärnkraftindustrins -aktivitetsutsläpp -yrkesexponeringar Första kvartalet 1985	Huvudenhet för kärnenergi
22	Granskning av Barsebäcks kraftstation, block 1 och 2, 1985	Huvudenheten för kärnenergi
23	Radiation Exposure Management	Jan Olof Snihs
24		
25	Kärnkraftindustrins - aktivitetsutsläpp - yrkesexponeringar Andra kvartalet 1985	Huvudenhet för kärnenergi
26	Light Resin Curing Devices - A Hazard Evaluation	Anders Glansholm



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