Designation: E490 – 00a(Reapproved 2006)

Standard Solar Constant and Zero Air Mass Solar Spectral Irradiance Tables[1]

This standard is issued under the fixed designation E490; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 These tables define the solar constant and zero air mass solar spectral irradiance for use in thermal analysis, thermal balance testing, and other tests of spacecraft and spacecraft components and materials. Typical applications include the calculation of solar absorptance from spectral reflectance data and the specification of solar UV exposure of materials during simulated space radiation testing.

1.2 These tables are based upon data from experimental measurements made from high-altitude aircraft, spacecraft, and the earth's surface and from solar spectral irradiance models.

1.3 The values stated in SI units are to be regarded as standard. Other units of measurement are included for information purposes only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E349 Terminology Relating to Space Simulation

3. Terminology

3.1 *air mass* (optical air mass) (AM), *n*—the ratio of the path length or radiation through the atmosphere (l_m) at any given angle, Z degrees, to the sea level path length toward the zenith (l_z).

$$AM = l_m/l_z \cong \sec Z \text{ , for } Z \leq 62° \quad (1)$$

Symbol: AM1 (air mass one), AM2 (air mass two)

3.2 *astronomical unit* (AU), *n*—a unit of length defined as the mean distance between the earth and the sun, that is, 149 597 890 ± 500 km.

3.3 *integrated irradiance, n*—spectral irradiance integrated over a specific wavelength interval from λ_1 to λ_2, measured in $W \cdot m^{-2}$, Symbol:

$$E_{\lambda 1-\lambda 2} = \int_{\lambda 1}^{\lambda 2} E_\lambda d\lambda \quad (2)$$

3.4 *irradiance at a point on a surface (E) , n*—quotient of the radiant flux incident on an element of the surface containing the point, by the area of that element, measured in $W \cdot m^{-2}$.

3.5 *irradiance, spectral (E), n*—the irradiance per unit wavelength interval at a specific wavelength, or as a function of wavelength measured in $W \cdot m^{-2} \cdot \mu m^{-1}$.

3.6 *solar constant, n*—the total solar irradiance at normal incidence on a surface in free space at the earth's mean distance from the sun (1 AU).

3.7 *zero air mass* (AMO), *n*—the absence of atmospheric attenuation of the solar irradiance at one astronomical unit from the sun.

3.8 Additional definitions will be found in Terminology E349.

4. Solar Constant

4.1 The solar constant is 1366.1 $W \cdot m^{-2}$. This value is the mean of daily averages from six different satellites over the 1978 to 1998 time period, all measured with absolute cavity radiometers, as reported by Fröhlich and Lean (**1**) [3]. The standard deviation of this mean value is 425 ppm, with a 0.37 % minimum-to-maximum range (1363 to 1368 $W \cdot m^{-2}$).

4.2 Table 1 summarizes the results in different units, and Table 2 presents the total solar irradiance at various planetary distances from the sun.

[1] These tables are under the jurisdiction of ASTM Committee E21 on Space Simulation and Applications of Space Technology and are the direct responsibility of Subcommittee E21.04 on Space Simulation Test Methods.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The boldface numbers in parentheses refer to the list of references at the end of these tables.

TABLE 1 The Solar Constant in Alternative Units

Solar constant = 1366.1 $W \cdot m^{-2}$ [SI unit]
= 0.136 61 $W \cdot cm^{-2}$
= 136.61 m $W \cdot cm^{-2}$
= 1.3661 × 10^{6} $erg \cdot cm^{-2} \cdot s^{-1}$
= 126.9 $W \cdot ft^{-2}$
= 1.959 $cal \cdot cm^{-2} \cdot min^{-1}$ (±0.03 $cal \cdot cm^{-2} \cdot min^{-1}$)
= 0.0326 $cal \cdot cm^{-2} \cdot s^{-1}$
= 433.4 $Btu \cdot ft^{-2} \cdot h^{-1}$
= 0.1202 $Btu \cdot ft^{-2} \cdot s^{-1}$
= 1.956 $Langleys \cdot min^{-1}$
The calorie is the thermochemical calorie-gram and is defined as 4.1840 absolute joules.
The Btu is the thermochemical British thermal unit and is defined by the relationship: 1 Btu (thermochemical)/(°F·lb) = 1 cal·g (thermochemical)/(°C·g).
The Langley, however, is defined in terms of the older thermal unit the calorie·g (mean), that is, 1 Langley = 1 cal·g (mean)·cm^{-2}; 1 cal·g (mean) = 4.190 02 J.

TABLE 2 Solar Irradiance at the Planets

Planet	Solar Irradiance, $W \cdot m^{-2}$		
	Mean	Perihelion	Aphelion
Mercury	9116.4	14447.5	6271.1
Venus	2611.0	2646.4	2575.7
Earth	1366.1	1412.5	1321.7
Mars	588.6	715.9	491.7
Jupiter	50.5	55.7	45.9
Saturn	15.04	16.76	13.53
Uranus	3.72	4.11	3.37
Neptune	1.510	1.515	1.507
Pluto	0.878	1.571	0.560

5. Solar Spectral Irradiance (Zero Air Mass)

5.1 The zero air mass solar spectral irradiance is based on data from satellites, space shuttle missions, high-altitude aircraft, rocket soundings, ground-based solar telescopes, and modeled spectral irradiance.

5.2 Table 3 presents the solar spectral irradiance in tabular form for the range from 0.1195 to 1000 µm. The first column gives the wavelength (λ) in µm; the second gives the spectral irradiance (E_{λ}) at λ in $W \cdot m^{-2} \cdot \mu m^{-1}$; the third gives the total irradiance for the range from 0 to λ ($E_{0\text{-}\lambda}$) in $W \cdot m^{-2}$; and the fourth gives the percentage of the solar constant associated with wavelengths shorter than λ ($D_{0\text{-}\lambda}$).

5.3 Table 4 presents an abridged version of Table 3. Fig. 1 plots the Standard Solar Spectral Irradiance.

5.4 The Upper Atmosphere Research Satellite (UARS)/ ATLAS-2 spectrum is used between 0.1195 and 0.3795 µm. The values are averages of two different instruments, the Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) and the Solar Stellar Irradiance Comparison Experiment (SOLSTICE), reported by Woods et al (**2**). These data were obtained in April 1993 during a period of moderate solar activity and were scaled by a factor of 0.968 43 to match the Neckel and Labs (**3**) data over the 0.33- to 0.41-µm range.

5.5 In the 0.41- to 0.825-µm range, the values are from the McMath Solar Telescope at Kitt Peak, Arizona, as reported by Neckel and Labs (**3**).

5.6 In the 0.825- to 4.0-µm range, the values are from the high-resolution solar atlas computed by Kurucz (**4**). These data were smoothed to the 2- and 20-nm wavelength resolution of Table 3 and scaled by a factor of 1.000 85 to match the Neckel and Labs (**3**) data at 0.825 µm.

5.7 In the 4.0- to 1000-µm range, the values are from the logarithmic irradiance versus wavelength fits reported by Smith and Gottlieb (**5**). These data were scaled by a factor of 0.994 37 to match the Kurucz (**4**) data at 4.0 µm.

5.8 The composite spectral irradiance data were then scaled by a factor of 0.997 45 to force the integrated total irradiance to equal the solar constant.

6. Keywords

6.1 extraterrestrial; solar constant; solar spectral irradiance; space; zero air mass

TABLE 3 Solar Spectral Irradiance—Standard Curve

NOTE 1—Double lines indicate change in wavelength interval of integration. Each column continues to next page.

NOTE 2—λ = wavelength, µm,
E_λ = solar spectral irradiance averaged over small bandwidth centered at λ, $W \cdot m^{-2} \cdot \mu m^{-1}$,
$E_{0-\lambda}$ = integrated solar irradiance in the wavelength range from 0 to λ, $W \cdot m^{-2}$, and
$D_{0-\lambda}$ = percentage of solar constant (1366.1 $W \cdot m^{-2}$) associated with wavelengths shorter than λ.

λ	E_λ	$E_{0-\lambda}$	$D_{0-\lambda}$	λ	E_λ	$E_{0-\lambda}$	$D_{0-\lambda}$
0.1195	6.185×10^{-2}	0.0	0.0	1.306	413.6	1117.65	81.81
0.1205	0.5614	3.12×10^{-4}	2.28×10^{-5}	1.308	412.3	1118.47	81.87
0.1215	4.901	3.04×10^{-3}	2.23×10^{-4}	1.310	410.6	1119.30	81.93
0.1225	1.184	6.09×10^{-3}	4.45×10^{-4}	1.312	403.3	1120.11	81.99
0.1235	4.770×10^{-2}	6.70×10^{-3}	4.91×10^{-4}	1.314	402.2	1120.92	82.05
0.1245	3.433×10^{-2}	6.74×10^{-3}	4.94×10^{-4}	1.316	397.9	1121.72	82.11
0.1255	2.882×10^{-2}	6.77×10^{-3}	4.96×10^{-4}	1.318	401.7	1122.52	82.17
0.1265	3.523×10^{-2}	6.81×10^{-3}	4.98×10^{-4}	1.320	401.6	1123.32	82.23
0.1275	2.127×10^{-2}	6.83×10^{-3}	5.00×10^{-4}	1.322	398.6	1124.12	82.29
0.1285	1.727×10^{-2}	6.85×10^{-3}	5.02×10^{-4}	1.324	398.1	1124.92	82.35
0.1295	3.994×10^{-2}	6.88×10^{-3}	5.04×10^{-4}	1.326	394.9	1125.71	82.40
0.1305	0.1206	6.96×10^{-3}	5.10×10^{-4}	1.328	390.8	1126.49	82.46
0.1315	3.983×10^{-2}	7.04×10^{-3}	5.16×10^{-4}	1.330	387.8	1127.27	82.52
0.1325	4.126×10^{-2}	7.08×10^{-3}	5.19×10^{-4}	1.332	386.3	1128.05	82.57
0.1335	0.1680	7.19×10^{-3}	5.26×10^{-4}	1.334	389.2	1128.82	82.63
0.1345	4.572×10^{-2}	7.29×10^{-3}	5.34×10^{-4}	1.336	386.6	1129.60	82.69
0.1355	3.802×10^{-2}	7.34×10^{-3}	5.37×10^{-4}	1.338	383.2	1130.37	82.74
0.1365	3.094×10^{-2}	7.37×10^{-3}	5.40×10^{-4}	1.340	379.0	1131.13	82.80
0.1375	2.920×10^{-2}	7.40×10^{-3}	5.42×10^{-4}	1.342	380.5	1131.89	82.86
0.1385	3.968×10^{-2}	7.44×10^{-3}	5.44×10^{-4}	1.344	379.8	1132.65	82.91
0.1395	7.562×10^{-2}	7.49×10^{-3}	5.49×10^{-4}	1.346	377.2	1133.41	82.97
0.1405	6.075×10^{-2}	7.56×10^{-3}	5.54×10^{-4}	1.348	376.6	1134.16	83.02
0.1415	4.207×10^{-2}	7.61×10^{-3}	5.57×10^{-4}	1.350	372.4	1134.91	83.08
0.1425	4.683×10^{-2}	7.66×10^{-3}	5.61×10^{-4}	1.352	374.2	1135.66	83.13
0.1435	5.110×10^{-2}	7.71×10^{-3}	5.64×10^{-4}	1.354	372.2	1136.40	83.19
0.1445	5.093×10^{-2}	7.76×10^{-3}	5.68×10^{-4}	1.356	367.5	1137.14	83.24
0.1455	5.535×10^{-2}	7.81×10^{-3}	5.72×10^{-4}	1.358	368.8	1137.88	83.29
0.1465	7.087×10^{-2}	7.87×10^{-3}	5.76×10^{-4}	1.360	367.3	1138.62	83.35
0.1475	8.485×10^{-2}	7.95×10^{-3}	5.82×10^{-4}	1.362	367.7	1139.35	83.40
0.1485	8.199×10^{-2}	8.03×10^{-3}	5.88×10^{-4}	1.364	365.7	1140.08	83.46
0.1495	7.956×10^{-2}	8.12×10^{-3}	5.94×10^{-4}	1.366	365.7	1140.81	83.51
0.1505	8.697×10^{-2}	8.20×10^{-3}	6.00×10^{-4}	1.368	362.8	1141.54	83.56
0.1515	9.266×10^{-2}	8.29×10^{-3}	6.07×10^{-4}	1.370	359.9	1142.27	83.62
0.1525	0.1163	8.39×10^{-3}	6.14×10^{-4}	1.372	362.1	1142.99	83.67
0.1535	0.1299	8.52×10^{-3}	6.23×10^{-4}	1.374	361.1	1143.71	83.72
0.1545	0.2059	8.68×10^{-3}	6.36×10^{-4}	1.376	356.1	1144.43	83.77
0.1555	0.2144	8.89×10^{-3}	6.51×10^{-4}	1.378	358.0	1145.14	83.83
0.1565	0.1847	9.09×10^{-3}	6.66×10^{-4}	1.380	357.9	1145.86	83.88
0.1575	0.1717	9.27×10^{-3}	6.79×10^{-4}	1.382	354.5	1146.57	83.93
0.1585	0.1675	9.44×10^{-3}	6.91×10^{-4}	1.384	354.7	1147.28	83.98
0.1595	0.1754	9.61×10^{-3}	7.04×10^{-4}	1.386	353.2	1147.99	84.03
0.1605	0.1934	9.80×10^{-3}	7.17×10^{-4}	1.388	353.0	1148.69	84.09
0.1615	0.2228	1.00×10^{-2}	7.32×10^{-4}	1.390	350.6	1149.40	84.14
0.1625	0.2519	1.02×10^{-2}	7.50×10^{-4}	1.392	351.3	1150.10	84.19
0.1635	0.2841	1.05×10^{-2}	7.69×10^{-4}	1.394	348.8	1150.80	84.24
0.1645	0.2973	1.08×10^{-2}	7.91×10^{-4}	1.396	348.7	1151.50	84.29
0.1655	0.4302	1.12×10^{-2}	8.17×10^{-4}	1.398	349.2	1152.19	84.34
0.1665	0.3989	1.16×10^{-2}	8.48×10^{-4}	1.400	342.7	1152.89	84.39
0.1675	0.3875	1.20×10^{-2}	8.76×10^{-4}	1.402	343.9	1153.57	84.44
0.1685	0.4556	1.24×10^{-2}	9.07×10^{-4}	1.404	342.8	1154.26	84.49
0.1695	0.5877	1.29×10^{-2}	9.46×10^{-4}	1.406	343.1	1154.95	84.54
0.1705	0.6616	1.35×10^{-2}	9.91×10^{-4}	1.408	342.7	1155.63	84.59
0.1715	0.6880	1.42×10^{-2}	1.04×10^{-3}	1.410	341.8	1156.32	84.64
0.1725	0.7252	1.49×10^{-2}	1.09×10^{-3}	1.412	334.8	1156.99	84.69
0.1735	0.7645	1.57×10^{-2}	1.15×10^{-3}	1.414	337.7	1157.67	84.74
0.1745	0.9067	1.65×10^{-2}	1.21×10^{-3}	1.416	338.5	1158.34	84.79
0.1755	1.079	1.75×10^{-2}	1.28×10^{-3}	1.418	338.6	1159.02	84.84
0.1765	1.220	1.86×10^{-2}	1.36×10^{-3}	1.420	335.7	1159.69	84.89
0.1775	1.403	2.00×10^{-2}	1.46×10^{-3}	1.422	331.5	1160.36	84.94
0.1785	1.538	2.14×10^{-2}	1.57×10^{-3}	1.424	331.1	1161.02	84.99
0.1795	1.576	2.30×10^{-2}	1.68×10^{-3}	1.426	328.1	1161.68	85.04
0.1805	1.831	2.47×10^{-2}	1.81×10^{-3}	1.428	328.5	1162.34	85.08
0.1815	2.233	2.67×10^{-2}	1.96×10^{-3}	1.430	325.7	1162.99	85.13
0.1825	2.243	2.90×10^{-2}	2.12×10^{-3}	1.432	330.0	1163.65	85.18
0.1835	2.244	312×10^{-2}	2.28×10^{-3}	1.434	328.4	1164.31	85.23
0.1845	2.066	3.34×10^{-2}	2.44×10^{-3}	1.436	328.5	1164.96	85.28
0.1855	2.311	3.55×10^{-2}	2.60×10^{-3}	1.438	328.3	1165.62	85.32
0.1865	2.700	3.81×10^{-2}	2.79×10^{-3}	1.440	318.8	1166.27	85.37

TABLE 3 *Continued*

λ	$E_λ$	$E_{0-λ}$	$D_{0-λ}$	λ	$E_λ$	$E_{0-λ}$	$D_{0-λ}$
0.1875	3.009	4.09×10^{-2}	2.99×10^{-3}	1.442	318.6	1166.91	85.42
0.1885	3.291	4.41×10^{-2}	3.22×10^{-3}	1.444	319.7	1167.54	85.47
0.1895	3.569	4.75×10^{-2}	3.48×10^{-3}	1.446	321.6	1168.19	85.51
0.1905	3.764	5.12×10^{-2}	3.74×10^{-3}	1.448	321.6	1168.83	85.56
0.1915	4.165	5.51×10^{-2}	4.03×10^{-3}	1.450	318.7	1169.47	85.61
0.1925	4.113	5.93×10^{-2}	4.34×10^{-3}	1.452	315.4	1170.10	85.65
0.1935	3.808	6.32×10^{-2}	4.63×10^{-3}	1.454	314.3	1170.73	85.70
0.1945	5.210	6.77×10^{-2}	4.96×10^{-3}	1.456	313.1	1171.36	85.74
0.1955	5.427	7.30×10^{-2}	5.35×10^{-3}	1.458	316.7	1171.99	85.79
0.1965	6.008	7.88×10^{-2}	5.77×10^{-3}	1.460	315.6	1172.62	85.84
0.1975	6.191	8.49×10^{-2}	6.21×10^{-3}	1.462	312.1	1173.25	85.88
0.1985	6.187	9.10×10^{-2}	6.66×10^{-3}	1.464	310.5	1173.87	85.93
0.1995	6.664	9.75×10^{-2}	7.14×10^{-3}	1.466	310.8	1174.49	85.97
0.2005	7.326	0.104	7.65×10^{-3}	1.468	311.4	1175.12	86.02
0.2015	8.023	0.112	8.21×10^{-3}	1.470	310.2	1175.74	86.07
0.2025	8.261	0.120	8.81×10^{-3}	1.472	307.3	1176.35	86.11
0.2035	9.217	0.129	9.44×10^{-3}	1.474	303.4	1176.96	86.16
0.2045	10.25	0.139	1.02×10^{-2}	1.476	304.8	1177.57	86.20
0.2055	10.54	0.149	1.09×10^{-2}	1.478	304.4	1178.18	86.24
0.2065	11.08	0.160	1.17×10^{-2}	1.480	306.8	1178.79	86.29
0.2075	12.65	0.172	1.26×10^{-2}	1.482	304.4	1179.40	86.33
0.2085	15.05	0.186	1.36×10^{-2}	1.484	303.9	1180.01	86.38
0.2095	21.38	0.204	1.49×10^{-2}	1.486	303.3	1180.62	86.42
0.2105	27.92	0.229	1.67×10^{-2}	1.488	285.5	1181.21	86.47
0.2115	33.54	0.259	1.90×10^{-2}	1.490	301.5	1181.80	86.51
0.2125	31.30	0.292	2.14×10^{-2}	1.492	301.8	1182.40	86.55
0.2135	33.15	0.324	2.37×10^{-2}	1.494	303.3	1183.00	86.60
0.2145	40.03	0.360	2.64×10^{-2}	1.496	297.2	1183.60	86.64
0.2155	36.15	0.399	2.92×10^{-2}	1.498	299.4	1184.20	86.68
0.2165	32.27	0.433	3.17×10^{-2}	1.500	301.1	1184.80	86.73
0.2175	35.29	0.467	3.42×10^{-2}	1.502	292.4	1185.40	86.77
0.2185	44.37	0.506	3.71×10^{-2}	1.504	279.9	1185.97	86.81
0.2195	46.92	0.552	4.04×10^{-2}	1.506	284.8	1186.53	86.86
0.2205	47.33	0.599	4.39×10^{-2}	1.508	291.9	1187.11	86.90
0.2215	39.58	0.643	4.70×10^{-2}	1.510	294.7	1187.70	86.94
0.2225	49.65	0.687	5.03×10^{-2}	1.512	291.3	1188.28	86.98
0.2235	63.01	0.744	5.44×10^{-2}	1.514	288.3	1188.86	87.03
0.2245	58.97	0.805	5.89×10^{-2}	1.516	288.2	1189.44	87.07
0.2255	52.29	0.860	6.30×10^{-2}	1.518	288.4	1190.01	87.11
0.2265	39.40	0.906	6.63×10^{-2}	1.520	286.6	1190.59	87.15
0.2275	39.92	0.946	6.92×10^{-2}	1.522	282.4	1191.16	87.19
0.2285	51.95	0.992	7.26×10^{-2}	1.524	283.5	1191.72	87.24
0.2295	47.71	1.04	7.62×10^{-2}	1.526	284.6	1192.29	87.28
0.2305	52.12	1.09	7.99×10^{-2}	1.528	284.6	1192.86	87.32
0.2315	50.97	1.14	8.37×10^{-2}	1.530	276.5	1193.42	87.36
0.2325	53.26	1.20	8.75×10^{-2}	1.532	282.3	1193.98	87.40
0.2335	44.74	1.24	9.11×10^{-2}	1.534	278.4	1194.54	87.44
0.2345	38.97	1.29	9.41×10^{-2}	1.536	280.6	1195.10	87.48
0.2355	51.42	1.33	9.74×10^{-2}	1.538	277.3	1195.66	87.52
0.2365	48.59	1.38	0.101	1.540	273.0	1196.21	87.56
0.2375	48.44	1.43	0.105	1.542	275.3	1196.76	87.60
0.2385	41.96	1.47	0.108	1.544	277.8	1197.31	87.64
0.2395	44.12	1.52	0.111	1.546	277.2	1197.87	87.69
0.2405	39.56	1.56	0.114	1.548	271.1	1198.41	87.73
0.2415	51.48	1.61	0.118	1.550	271.3	1198.96	87.76
0.2425	70.60	1.67	0.122	1.552	273.1	1199.50	87.80
0.2435	66.53	1.73	0.127	1.554	267.6	1200.04	87.84
0.2445	60.97	1.80	0.132	1.556	267.1	1200.58	87.88
0.2455	49.39	1.85	0.136	1.558	268.9	1201.11	87.92
0.2465	50.40	1.90	0.139	1.560	268.3	1201.65	87.96
0.2475	55.50	1.96	0.143	1.562	269.7	1202.19	88.00
0.2485	45.65	2.01	0.147	1.564	266.9	1202.73	88.04
0.2495	56.38	2.06	0.151	1.566	265.4	1203.26	88.08
0.2505	60.10	2.12	0.155	1.568	263.3	1203.79	88.12
0.2515	46.01	2.17	0.159	1.570	264.5	1204.31	88.16
0.2525	41.55	2.21	0.162	1.572	267.3	1204.85	88.20
0.2535	51.55	2.26	0.165	1.575	261.0	1205.37	88.23
0.2545	59.57	2.32	0.169	1.576	253.6	1205.89	88.27
0.2555	79.30	2.38	0.175	1.578	254.7	1206.40	88.31
0.2565	101.8	2.48	0.181	1.580	265.0	1206.92	88.35
0.2575	125.4	2.59	0.190	1.582	259.0	1207.44	88.39
0.2585	125.1	2.71	0.199	1.584	259.1	1207.96	88.42
0.2595	104.0	2.83	0.207	1.586	259.9	1208.48	88.46
0.2605	88.51	2.92	0.214	1.588	249.0	1208.99	88.50
0.2615	89.80	3.01	0.220	1.590	240.5	1209.48	88.53

TABLE 3 *Continued*

λ	$E_λ$	$E_{0-λ}$	$D_{0-λ}$	λ	$E_λ$	$E_{0-λ}$	$D_{0-λ}$
0.2625	103.6	3.11	0.228	1.592	252.6	1209.97	88.57
0.2635	165.8	3.24	0.237	1.594	258.3	1210.48	88.61
0.2645	249.7	3.45	0.253	1.596	250.6	1210.99	88.65
0.2655	252.7	3.70	0.271	1.598	254.5	1211.49	88.68
0.2665	249.4	3.95	0.289	1.600	251.2	1212.00	88.72
0.2675	250.8	4.20	0.308	1.602	248.9	1212.50	88.76
0.2685	243.8	4.45	0.326	1.604	249.7	1213.00	88.79
0.2695	238.9	4.69	0.343	1.606	247.7	1213.50	88.83
0.2705	267.3	4.94	0.362	1.608	249.1	1213.99	88.87
0.2715	224.4	5.19	0.380	1.610	240.0	1214.48	88.90
0.2725	197.4	5.40	0.395	1.612	243.0	1214.96	88.94
0.2735	196.5	5.60	0.410	1.614	244.9	1215.45	88.97
0.2745	132.6	5.76	0.422	1.616	237.4	1215.93	89.01
0.2755	175.1	5.92	0.433	1.618	242.3	1216.41	89.04
0.2765	242.8	6.13	0.448	1.620	236.9	1216.89	89.08
0.2775	233.8	6.36	0.466	1.622	238.3	1217.37	89.11
0.2785	159.3	6.56	0.480	1.624	241.6	1217.85	89.15
0.2795	85.55	6.68	0.489	1.626	240.2	1218.33	89.18
0.2805	94.63	6.77	0.496	1.628	241.8	1218.81	89.22
0.2815	208.3	6.92	0.507	1.630	239.3	1219.29	89.25
0.2825	294.1	7.18	0.525	1.632	238.7	1219.77	89.29
0.2835	313.5	7.48	0.547	1.634	235.9	1220.25	89.32
0.2845	235.3	7.75	0.568	1.636	235.7	1220.72	89.36
0.2855	163.1	7.95	0.582	1.638	227.4	1221.18	89.39
0.2865	322.7	8.20	0.600	1.640	226.2	1221.63	89.42
0.2875	336.3	8.53	0.624	1.642	226.6	1222.09	89.46
0.2885	322.2	8.85	0.648	1.644	227.8	1222.54	89.49
0.2895	472.7	9.25	0.677	1.646	229.4	1223.00	89.52
0.2905	601.3	9.79	0.717	1.648	229.2	1223.46	89.56
0.2915	580.8	10.38	0.760	1.650	227.2	1223.91	89.59
0.2925	521.9	10.93	0.800	1.652	226.8	1224.37	89.63
0.2935	535.5	11.46	0.839	1.654	226.2	1224.82	89.66
0.2945	508.8	11.98	0.877	1.656	226.0	1225.27	89.69
0.2955	553.2	12.51	0.916	1.658	225.2	1225.72	89.72
0.2965	509.6	13.04	0.955	1.660	224.5	1226.17	89.76
0.2975	507.3	13.55	0.992	1.662	224.6	1226.62	89.79
0.2985	465.5	14.04	1.03	1.664	222.7	1227.07	89.82
0.2995	484.0	14.51	1.06	1.666	221.2	1227.51	89.86
0.3005	420.0	14.97	1.10	1.668	219.3	1227.95	89.89
0.3015	455.5	15.40	1.13	1.670	222.5	1228.40	89.92
0.3025	489.0	15.88	1.16	1.672	217.3	1228.84	89.95
0.3035	620.6	16.43	1.20	1.674	219.3	1229.27	89.98
0.3045	602.5	17.04	1.25	1.676	216.1	1229.71	90.02
0.3055	594.8	17.64	1.29	1.678	216.8	1230.14	90.05
0.3065	555.7	18.22	1.33	1.680	208.0	1230.57	90.08
0.3075	615.0	18.80	1.38	1.682	205.4	1230.98	90.11
0.3085	611.4	19.42	1.42	1.684	212.9	1231.40	90.14
0.3095	496.5	19.97	1.46	1.686	213.1	1231.82	90.17
0.3105	622.4	20.53	1.50	1.688	212.0	1232.25	90.20
0.3115	729.2	21.20	1.55	1.690	210.5	1232.67	90.23
0.3125	655.9	21.90	1.60	1.692	212.3	1233.09	90.26
0.3135	699.9	22.58	1.65	1.694	211.2	1233.52	90.29
0.3145	662.9	23.26	1.70	1.696	210.0	1233.94	90.33
0.3155	633.0	23.90	1.75	1.698	208.9	1234.36	90.36
0.3165	633.2	24.54	1.80	1.700	206.3	1234.77	90.39
0.3175	773.9	25.24	1.85	1.702	204.7	1235.18	90.42
0.3185	664.9	25.96	1.90	1.704	205.2	1235.59	90.45
0.3195	710.5	26.65	1.95	1.706	205.0	1236.01	90.48
0.3205	805.1	27.41	2.01	1.708	201.7	1236.41	90.51
0.3215	699.5	28.16	2.06	1.710	201.3	1236.81	90.54
0.3225	688.6	28.85	2.11	1.712	198.2	1237.21	90.57
0.3235	661.3	29.53	2.16	1.714	203.7	1237.62	90.59
0.3245	760.8	30.24	2.21	1.716	202.2	1238.02	90.62
0.3255	875.8	31.06	2.27	1.718	201.0	1238.42	90.65
0.3265	979.5	31.98	2.34	1.720	199.3	1238.82	90.68
0.3275	952.7	32.95	2.41	1.722	197.5	1239.22	90.71
0.3285	917.6	33.89	2.48	1.724	195.4	1239.61	90.74
0.3295	1061	34.87	2.55	1.726	198.2	1240.01	90.77
0.3305	1016	35.91	2.63	1.728	197.1	1240.40	90.80
0.3315	965.7	36.90	2.70	1.730	198.4	1240.80	90.83
0.3325	954.9	37.86	2.77	1.732	193.6	1241.19	90.86
0.3335	921.6	38.80	2.84	1.734	187.4	1241.57	90.88
0.3345	958.9	39.74	2.91	1.736	182.7	1241.94	90.91
0.3355	943.4	40.69	2.98	1.738	186.3	1242.31	90.94
0.3365	809.5	41.57	3.04	1.740	190.5	1242.69	90.97

TABLE 3 *Continued*

λ	E_λ	$E_{0\text{-}\lambda}$	$D_{0\text{-}\lambda}$	λ	E_λ	$E_{0\text{-}\lambda}$	$D_{0\text{-}\lambda}$
0.3375	841.8	42.40	3.10	1.742	190.2	1243.07	90.99
0.3385	921.5	43.28	3.17	1.744	190.7	1243.45	91.02
0.3395	958.1	44.22	3.24	1.746	186.7	1243.83	91.05
0.3405	1007	45.20	3.31	1.748	187.2	1244.20	91.08
0.3415	923.8	46.17	3.38	1.750	185.8	1244.57	91.10
0.3425	993.0	47.12	3.45	1.752	185.0	1244.94	91.13
0.3435	950.6	48.10	3.52	1.754	185.6	1245.31	91.16
0.3445	795.7	48.97	3.58	1.756	184.9	1245.68	91.19
0.3455	939.2	49.84	3.65	1.758	184.3	1246.05	91.21
0.3465	926.4	50.77	3.72	1.760	183.1	1246.42	91.24
0.3475	901.7	51.68	3.78	1.762	179.3	1246.78	91.27
0.3485	897.2	52.58	3.85	1.764	180.7	1247.14	91.29
0.3495	889.8	53.48	3.91	1.766	181.7	1247.51	91.32
0.3505	1050	54.45	3.99	1.768	180.2	1247.87	91.35
0.3515	979.5	55.46	4.06	1.770	179.1	1248.23	91.37
0.3525	907.9	56.40	4.13	1.772	179.4	1248.59	91.40
0.3535	1033	57.37	4.20	1.774	179.2	1248.94	91.42
0.3545	1111	58.45	4.28	1.776	176.3	1249.30	91.45
0.3555	1045	59.52	4.36	1.778	174.7	1249.65	91.48
0.3565	912.3	60.50	4.43	1.780	175.6	1250.00	91.50
0.3575	796.0	61.36	4.49	1.782	174.7	1250.35	91.53
0.3585	693.6	62.10	4.55	1.784	173.5	1250.70	91.55
0.3595	991.1	62.94	4.61	1.786	173.9	1251.05	91.58
0.3605	970.8	63.92	4.68	1.788	174.7	1251.40	91.60
0.3615	878.1	64.85	4.75	1.790	173.3	1251.74	91.63
0.3625	997.8	65.79	4.82	1.792	172.1	1252.09	91.65
0.3635	996.9	66.78	4.89	1.794	170.9	1252.43	91.68
0.3645	1013	67.79	4.96	1.796	170.6	1252.77	91.70
0.3655	1152	68.87	5.04	1.798	170.3	1253.11	91.73
0.3665	1233	70.07	5.13	1.800	169.9	1253.45	91.75
0.3675	1180	71.27	5.22	1.802	167.2	1253.79	91.78
0.3685	1101	72.41	5.30	1.804	168.8	1254.13	91.80
0.3695	1226	73.58	5.39	1.806	168.8	1254.47	91.83
0.3705	1139	74.76	5.47	1.808	168.5	1254.80	91.85
0.3715	1175	75.91	5.56	1.810	168.6	1255.14	91.88
0.3725	1054	77.03	5.64	1.812	167.5	1255.48	91.90
0.3735	920.2	78.02	5.71	1.814	165.8	1255.81	91.93
0.3745	900.4	78.93	5.78	1.816	160.5	1256.14	91.95
0.3755	1062	79.91	5.85	1.818	152.0	1256.45	91.97
0.3765	1085	80.98	5.93	1.820	159.6	1256.76	92.00
0.3775	1282	82.16	6.01	1.822	159.8	1257.08	92.02
0.3785	1327	83.47	6.11	1.824	162.4	1257.40	92.04
0.3795	1066	84.67	6.20	1.826	162.8	1257.73	92.07
0.3805	1202	85.80	6.28	1.828	161.1	1258.05	92.09
0.3815	1082	86.94	6.36	1.830	160.6	1258.37	92.11
0.3825	791.3	87.88	6.43	1.832	159.3	1258.69	92.14
0.3835	684.1	88.62	6.49	1.834	158.5	1259.01	92.16
0.3845	959.7	89.44	6.55	1.836	158.1	1259.33	92.18
0.3855	1008	90.42	6.62	1.838	156.2	1259.64	92.21
0.3865	1007	91.43	6.69	1.840	156.2	1259.95	92.23
0.3875	1004	92.43	6.77	1.842	154.0	1260.26	92.25
0.3885	984.3	93.43	6.84	1.844	154.1	1260.57	92.28
0.3895	1174	94.51	6.92	1.846	153.5	1260.88	92.30
0.3905	1247	95.72	7.01	1.848	151.0	1261.18	92.32
0.3915	1342	97.01	7.10	1.850	154.6	1261.49	92.34
0.3925	1019	98.19	7.19	1.852	153.4	1261.80	92.37
0.3935	582.3	98.99	7.25	1.854	152.5	1262.10	92.39
0.3945	1026	99.80	7.31	1.856	150.9	1262.41	92.41
0.3955	1314	100.97	7.39	1.858	152.5	1262.71	92.43
0.3965	854.5	102.05	7.47	1.860	150.3	1263.01	92.45
0.3975	928.8	102.94	7.54	1.862	150.4	1263.32	92.48
0.3985	1522	104.17	7.63	1.864	150.9	1263.62	92.50
0.3995	1663	105.76	7.74	1.866	149.4	1263.92	92.52
0.4005	1682	107.43	7.86	1.868	149.2	1264.22	92.54
0.4015	1746	109.15	7.99	1.870	150.8	1264.52	92.56
0.4025	1759	110.90	8.12	1.872	147.3	1264.81	92.59
0.4035	1684	112.62	8.24	1.874	140.1	1265.10	92.61
0.4045	1674	114.30	8.37	1.876	129.9	1265.37	92.63
0.4055	1667	115.97	8.49	1.878	144.1	1265.65	92.65
0.4065	1589	117.60	8.61	1.880	146.2	1265.94	92.67
0.4075	1628	119.21	8.73	1.882	147.4	1266.23	92.69
0.4085	1735	120.89	8.85	1.884	146.4	1266.52	92.71
0.4095	1715	122.61	8.98	1.886	143.9	1266.81	92.73
0.4105	1532	124.24	9.09	1.888	145.3	1267.10	92.75
0.4115	1817	125.91	9.22	1.890	142.4	1267.39	92.77