U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Selected Blue Light Characteristics of Various Outdoor Lighting Sources at Equivalent Lumen Output

Table 1 below[1] lists various sources used in street and area lighting (among other applications) along with selected characteristics related to their spectral content, normalized for equivalent lumen output. Data for each source includes a measured correlated color temperature (CCT), the calculated percentage of radiant power contained in "blue wavelengths" (defined here from the literature related to sky glow as wavelengths between 405 and 530 nanometers [nm]), and the corresponding scotopic and melanopic multipliers that are shown relative to a high-pressure sodium (HPS) baseline due to its predominance in the existing outdoor lighting market.

Row	Light source	Luminous Flux (lm)	CCT (K)	% Blue*	Relative Scotopic Potential	Relative Melanopic Potential**
A	PC White LED	1000	2700	15% - 21%	1.74 - 2.33	1.90 - 2.82
B	PC White LED	1000	3000	18% - 25%	1.88 - 2.46	2.09 - 3.06
C	PC White LED	1000	3500	22% - 28%	2.04 - 2.54	2.34 - 3.25
D	PC White LED	1000	4000	26% - 33%	2.11 - 2.77	2.36 - 3.64
E	PC White LED	1000	4500	32% - 35%	2.39 - 2.94	2.83 - 3.95
F	PC White LED	1000	5000	35% - 40%	2.61 - 3.43	3.22 - 4.69
G	PC White LED	1000	5700	39% - 45%	2.75 - 3.39	3.42 - 4.62
H	PC White LED	1000	6500	43% - 48%	3.12 - 3.97	4.10 - 5.87
I	Narrowband Amber LED	1000	1606	0%	0.36	0.12
J	Low Pressure Sodium	1000	1718	0%	0.34	0.10
K	PC Amber LED	1000	1872	1%	0.70	0.42
L	High Pressure Sodium	1000	1959	9%	0.89	0.86
M	**High Pressure Sodium**	**1000**	**2041**	**10%**	**1.00**	**1.00**
N	Mercury Vapor	1000	6924	36%	2.33	2.47
O	Mercury Vapor	1000	4037	35%	2.13	2.51
P	Metal Halide	1000	3145	24%	2.16	2.56
Q	Metal Halide	1000	4002	33%	2.53	3.16
R	Metal Halide	1000	4041	35%	2.84	3.75
S	Moonlight†	1000	4681	29%	3.33	4.56
T	Incandescent	1000	2812	11%	2.21	2.72
U	Halogen	1000	2934	13%	2.28	2.81
V	F32T8/830 Fluorescent	1000	2940	20%	2.02	2.29
W	F32T8/835 Fluorescent	1000	3480	26%	2.37	2.87
X	F32T8/841 Fluorescent	1000	3969	30%	2.58	3.18

* Percent blue calculated according to LSPDD: Light Spectral Power Distribution Database, http://galileo.graphycs.cegepsherbrooke.qc.CA/app/en/home.

** Melanopic content calculated according to CIE Irradiance Toolbox, http://files.cie.co.at/784_TN003_Toolbox.xls, 2015.

† Moonlight CCT provided by Telelumen, LLC.

Table 1: Selected blue light characteristics of various outdoor lighting sources at equivalent lumen output.

[1] Updated June 2017 to increase the number of LED samples on which the corresponding data ranges are based; see Table 2.

The ranges listed for the LED properties reflect the fact that various products often differ from one another in terms of their precise spectral content, even when binned together in the same nominal CCT, and each CCT bin listed in the table contains numerous product samples. The exact number of samples in each bin ranges from 20 (for 5700 K) to 162 (for 3000 K), with others falling in between (457 samples in all; see Table 2). Conventional light sources are all represented by single values though they would likewise be more accurately characterized by a range (albeit much narrower than LED).

Count	Row	Light source	Luminous Flux (lm)	CCT (K)
59	A	PC White LED	1000	2700
162	B	PC White LED	1000	3000
53	C	PC White LED	1000	3500
51	D	PC White LED	1000	4000
36	E	PC White LED	1000	4500
44	F	PC White LED	1000	5000
20	G	PC White LED	1000	5700
32	H	PC White LED	1000	6500

Table 2: Number of LED products underlying the data ranges shown for each CCT bin in Table 1.

Most importantly, performing a calculation with these values only provides an idea of the relative *potential* to cause health or other impacts, rather than detailing any actual impacts likely to occur. Impacts are critically related to additional factors such as intensity, length of exposure, and other exogenous variables that are not represented in the table.

Nevertheless, the potential influence of blue wavelengths is immediately evident in all "white light" sources containing them. In addition, as demonstrated by the relative properties displayed by conventional lighting sources in the table, the blue light issues that have been raised in recent debate are clearly nothing new to our lighted environment. What *is* new is our increased understanding of their *potential* influence regarding human and environmental health issues, as the related research has evolved. Much work remains to put any associated potential risk into a realistic context, however.