MERCURY LAMPS

— *operating characteristics and applications*

SUNLAMPS
BLACK LIGHT LAMPS
GENERAL LIGHTING LAMPS
GERMICIDAL LAMPS

The current conducting properties of mercury vapor and the resultant radiation generated makes these lamps the most versatile of all sources. Fundamentally, the principle of all mercury lamps is the same—that of an electron flow between electrodes through ionized mercury vapor. The radiation output is represented primarily by narrow bands or wavelengths throughout the ultraviolet and visible spectrum (neglecting the infrared)—each lamp is like a radio broadcasting station but generating about a dozen principal wavelengths instead of one. These along with other minor lines and some continuous radiation are known as the mercury spectrum. The power or energy emitted is usually different for each wavelength, some quite powerful, others relatively weak. By variation in design of the lamp, regulating the vapor pressure, current, voltage, etc., the distribution of energy in the different wavelengths can be regulated to a great extent; in the 30-watt low-pressure germicidal lamp, for example, nearly 90 per cent of the radiation emitted is at one wavelength of 2537 Angstroms; in the 1000-watt H6 quartz bulb operated at high pressure (110 atmospheres) 52 per cent of the radiation is in the visible spectrum and only 3 per cent emitted at the 2537 line.

This is the reason for the widely different appearance of various mercury lamps—each lamp takes a design best adapted to efficient performance for the particular service intended.

{ Prices and technical data subject to change without notice }

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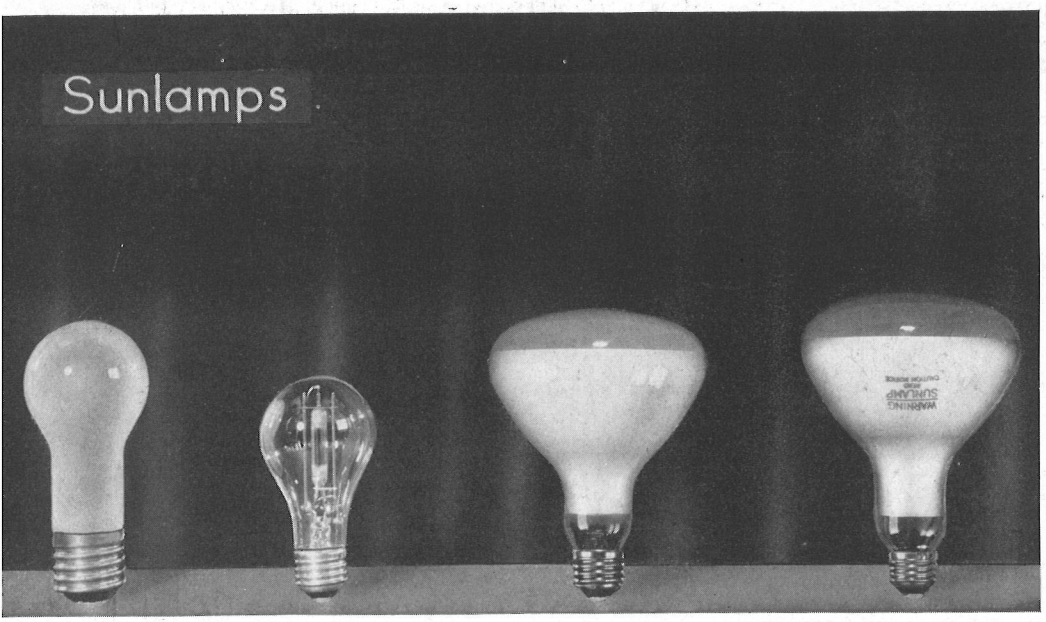
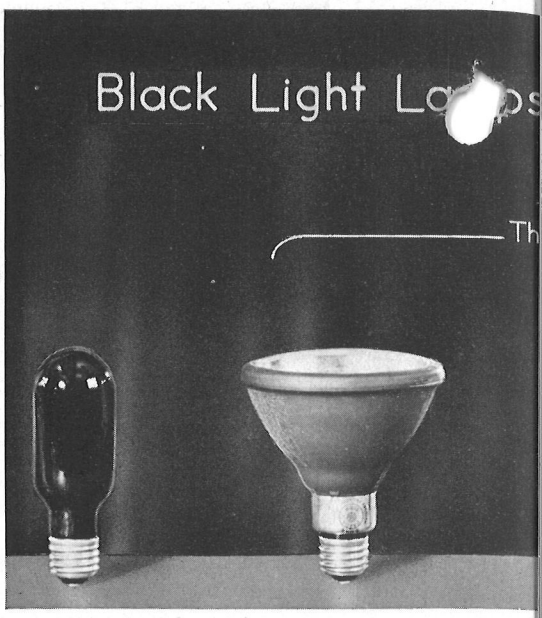
GENERAL ELECTRIC
ENGINEERING DIVISION, LAMP DEPARTMENT
CLEVELAND 12, OHIO

TYPE S and TYPE H LAMPS and THEIR





S-1
400 watts

S-4
100 watts

RS-4
100 watts

RS
275 watts

B-H4
100 watts

C-H4
100 watts (Spotlight)

MERCURY LAMP TYPES

The grouping of lamps shown above illustrates the correlation of lamp design with the spectral requirements of particular applications. In each case the mercury element and outer bulb are selected to give the radiation characteristics known to produce the desired effects—erythema (skin reddening), excitation of fluorescent materials or efficient production of light.

Sunlamps

The S-1 was the earliest form of type S sunlamps and generously provided light, radiant heat and suntan ultraviolet radiation. It incorporates a filament across the mercury arc electrodes. The S-4 and the reflector type RS-4 employ the small arc tube identical in design to that used in Type A-H4—the difference being in the bulb shape and in the ultraviolet transmitting glass used for the bulbs. The RS incorporates in addition, a filament ballast and a bimetallic starting switch within the reflector bulb, so that no auxiliary ballast is required. The filament ballast of the RS, of course, provides additional light and heat. The glass bulbs used for sunlamps transmit practically no radiation shorter than 2800A.

Black Light Lamps

Most mercury lamps generate considerable ultraviolet radiation in the region between 3200 and 4000 Angstroms—the principal line being 3650A, which is high in effectiveness for the usual fluorescent materials. So-called black light lamps differ in that a type of glass is used for the bulbs which transmits this "black light" radiation. For most black light applications the absence of visible light is essential, and this visible light may be absorbed by use of a red-purple filter either as an outer bulb as in the case of the B-H4, or as accessories attached to the unit. Fluorescent type black light lamps are listed on page 5 of this folder.

General Lighting Types

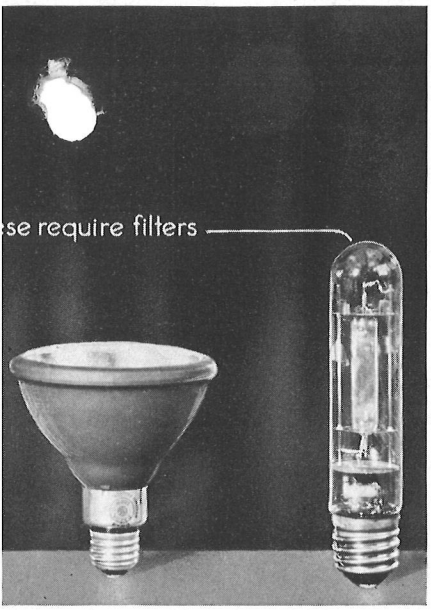
The 400-watt H-1 lamp is by far the most widely used of all mercury lamps, because of its general use in factory lighting and for occasional exterior floodlighting and street lighting. The 3000-watt A-H9 meets the demand for a high wattage lamp for high-bay industrial lighting. The A-H4 and C-H5 fill the need for lower wattage mercury lamps for various uses. The 1000-watt H-6 lamp has been employed for searchlights, television studio lighting and similar specialized applications where water or air cooling is practicable.

Designation	SUNLIGHT	
	S-1	**S-4**
Lamp Watts (Rated)	400	100
Watts, with Single-lamp Transformer	500	123
Watts, with Tulamp Transformer	.....	.....
Lumens at 100 Hours	.....	3000
Lumens (Approx. Initial)	7200	....
Lamp L. P. W. at 100 Hours	.....	30
Initial L. P. W.	18	.....
Over-all Lumens per Watt (Single-lamp Trans.)	14.4	24.4
Rated Life, Hours (See Note)	400	Approx.
Bulb	PS-22	A-21
Finish	I. F.	Clear
Base	Mogul	Admed.
Burning Position	Base Up	Any
Max. Over-all Length, Inches	$6\frac{7}{16}$	$5\frac{1}{4}$
Light Center Length, Inches	5	$3\frac{7}{16}$
Pressure, Atmospheres	0.9	8
Number of Electrodes	2	3
Lamp Operating Volts	14	130
Lamp Starting Current, Amps.	9.5	1.3
Lamp Operating Current, Amps.	30	0.9
Supply Voltage (Primary Volts)†	115	115, 230
Transformer Secondary Open Circuit Voltage	33	245
Power Factor, Per Cent	50	50, 90
Starting Time to Full Output	5 min.	3 min.
Restarting Time	0	3 min.
List Price	$4.75	$8.50
Standard Package Quantity	6	6

† Nominal voltage—lamp design is centered for the range of standard voltage circuits.

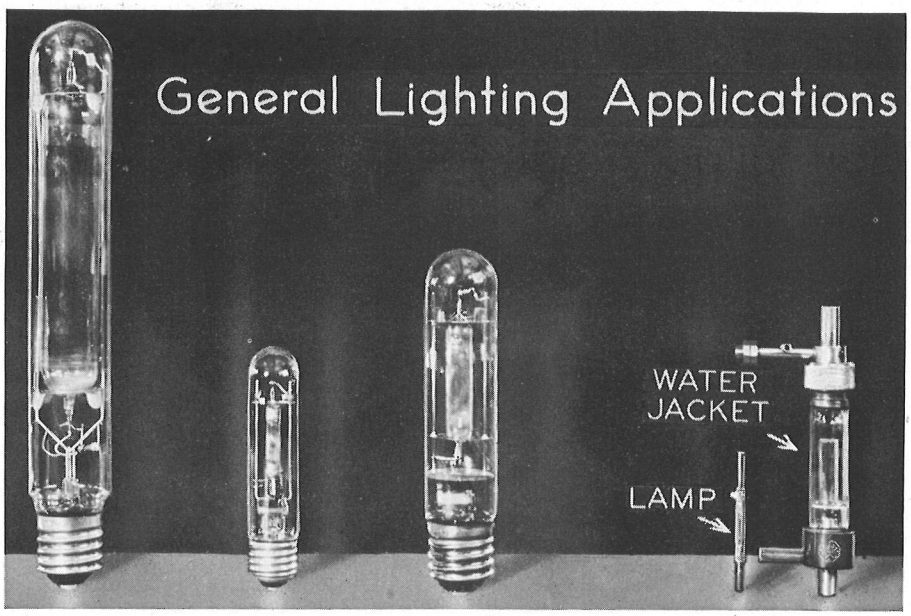
Rated Life. In the case of A-H1, B-H1, A-H4, B-H4, C-H4, E-H4, A-H5, C-H5 and A-H9 lamps, the rated life is based on specified t conditions with the lamps turned off and restarted no oftener than on every 5 burning hours. The life rating of the C-H5 is 3000 hours; of the A-H1, B-H1 and F-H1, 6000 hours for 10 hours per start. Life of S-4, RS-4, and RS sunlamps cannot be adequately expressed in hours for ordinary household service because comparatively short burning periods are employed. The A-H6 life rating is based on tests employing 25-minute burning periods and the life may not be more than one-third as much

OPERATING CHARACTERISTICS



E-H4
100 watts (Floodlight)

A-H5
250 watts

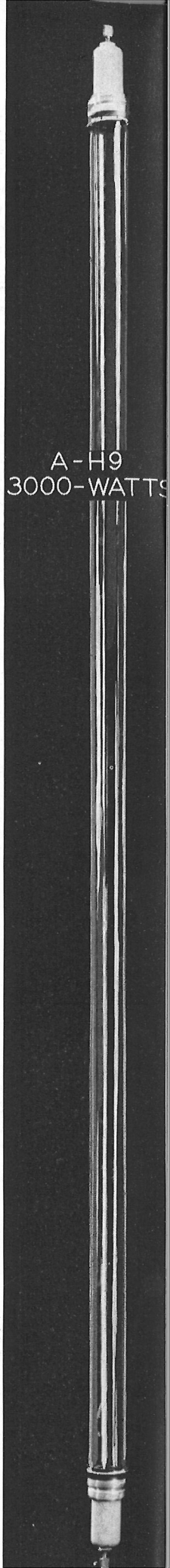


A-H1
400 watts

A-H4
100 watts

C-H5
250 watts

A-H6
1000 watts



LAMPS		"BLACK LIGHT" LAMPS			GENERAL LIGHTING LAMPS				
RS-4	**RS**	**B-H4**	**C-H4** (Spot) **E-H4** (Flood)	**A-H5**	**A-H1 B-H1**	**A-H4**	**C-H5**	**A-H6***	**A-H9**
100	275	100	100	250	400	100	250	1000	3000
123	.....	123	123	290	452	120	290	1095	3220
.....	.....	...	....	286/lamp	440/lamp	.....	286/lamp	.....	.....
Reflector-type Lamps Not Rated in Lumens		..... Black Light Bulb	Not Rated in Lumens	10,000 ..... 40 ..... 34.5	16,000 ..... 40 ..... 35.4	3000 ..... 30 ..... 24.4	10,000 ..... 40 ..... 34.5	..... 65,000 ..... 65 ..... 59.4	120,000 ..... 40 ..... 37.3
400 Applications		1000	1000	1000	4000	1000	2000	75	3000
R-40 I. F. Reflector Type Admed. Any	R-40 I. F. Reflector Type Medium Any	T-16 Natural Red Purple Admed. Any	PAR-38 Alum. Reflector and Clear Lens Admed. Skt. Any	T-14 Clear Mogul Upright	T-16 Clear Mogul ‡ See Note	T-10 Clear Admed. Any	T-14 Clear Mogul Any	T-2 Clear $\frac{3}{16}$" Sleeve Horiz.	T-9½ Clear S. C. Term. Any
6¾	7	5½	5 7/16	8	13	5⅝	8	3¼	54⅞
.....	.....	3 7/16	.....	5	7¾	3 7/16	5	.....	.....
8	2	8	8	4	1.2	8	4	110	0.7
3	3	3	3	3	3	3	3	2	2
130	110–125 (50–60 Cycles AC)	130	130	135	137	130	135	840	535
1.3	3.2	1.3	1.3	2.9	5	1.3	2.9	2.5	9.3
0.9	2.5	0.9	0.9	2.1	3.2	0.9	2.1	1.4	6.1
115, 230	110–125	115, 230	115, 230	115, 230	115, 230	115, 230	115, 230	115, 230	230, 460, 575
245	No Trans.	245	245	250	220	245	250	1200	850
50, 90	90	50, 90	50,90	50, 90, 95	60, 90, 95	50, 90	50, 90, 95	.....	90
3 min.	3 min.	3 min	3 to 8 min.	4 min.	7 min.**	3 min.	4 min.	4 sec.	7 min.
3 min.	5 min.	3 min.	3 to 8 min.	4 min.	7 min.**	3 min.	4 min.	2 sec.	8 min.
$10.00	[redacted]	$11.50	$12.00	$12.00	$10.50	$10.50	$12.00	$7.50	$44.00
6	6 $9.95	6	12	6	6	6	6	6	1

* B-H6 is air-cooled and rated at 900 watts. Characteristics are similar to A-H6. Sales on both are handled through District Sales Offices of the Apparatus Department, G. E. Co.

‡ F-H1 differs from A-H1 only in having a mechanical base.

** On lag circuits.

on very short burning periods such as 3 to 5 minutes. An approved type water cooling jacket must be used with the A-H6 lamp.

Burning Position. While the S-1 lamp can be operated in any position from base up to horizontal, the maximum ultraviolet output is obtained when vertically base up. The life of the A-H5 may be somewhat impaired if the lamp is burned in a horizontal position. A-H1 is for base-up burning; B-H1 for base-down burning. Both types must be operated within 10° of vertical. A special D-H1 lamp (not listed above) has an inner quartz bulb for any burning position, higher efficiency and smaller arc dimensions than the A-H1. List price $17.00.

Power Factor. The higher power factor is obtained with transformers incorporating integral correction Tulamp transformers for A-H1, B-H1, A-H5 and C-H5 have an over-all power factor of 95 per cent.

TRANSFORMERS

Auxiliary equipment for mercury-vapor lamps consists essentially of the proper size and type of transformer to provide the required electrical characteristics for lamp starting and operation. Individual transformers for most mercury lamps are obtainable for both 115- and 230-volt operation and often for either 60 or 50 cycles. Transformers are listed in core-and-coil designs, enclosed units and weatherproof units, depending on the service intended.

Typical transformers for various lamps are illustrated below. Tulamp transformers for mercury lamps use the split-phase principle well known from Tulamp fluorescent ballasts and such transformers are recommended for systems using H-1 and H-5 lamps because they provide high over-all power factor, good stability, line starting current less than the operating current, lower first cost, lower power losses and lower wiring costs. Single-lamp transformers having built-in capacitors for power correction are available in enclosed and weatherproof designs for some lamps. High power factor auxiliary equipment is recommended in all cases to relieve the supply lines of unnecessary burden, giving better voltage conditions at the lamp and greater installation and operation economy.

Sunlamp transformers are designed for installation in fixture housings and for intermittent operation. Special transformers should be obtained when the service requires continuous burning.

AUTOTRANSFORMERS FOR TYPE H MERCURY LAMPS—60 CYCLES

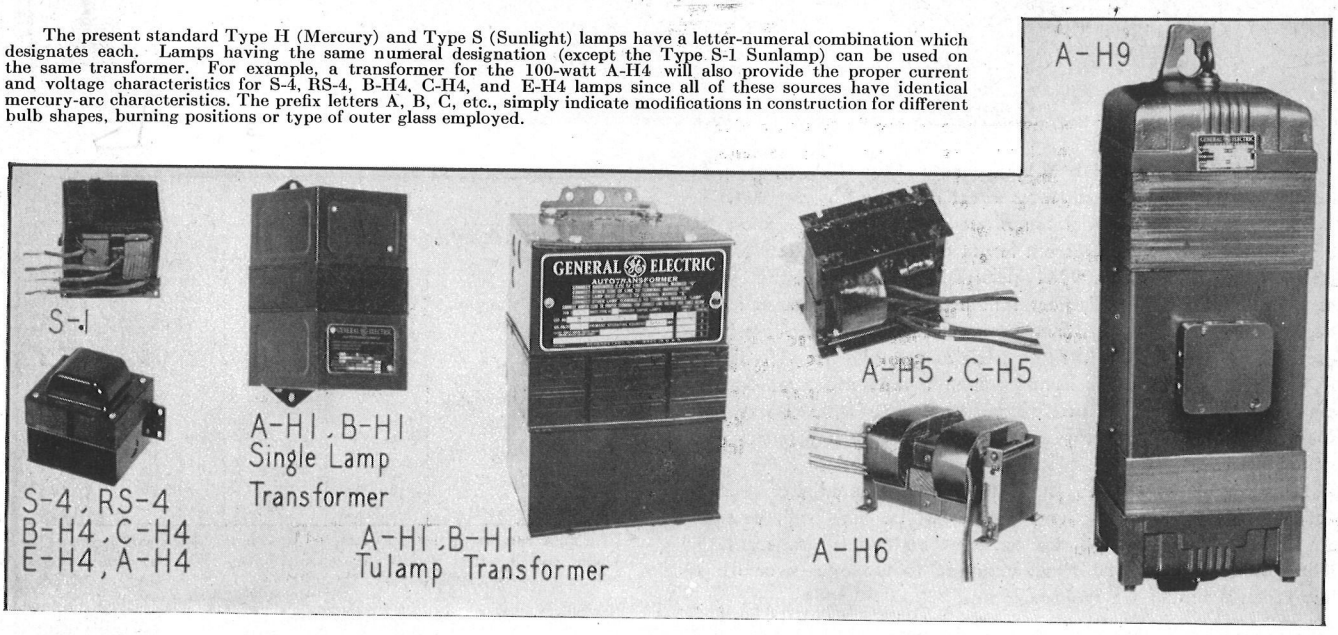
Lamps	Type of Transformer	Line Power-factor Per Cent	G-E Catalog No. 115-V	G-E Catalog No. 230-V	List Price Each†	Weight, Pounds	Watts Loss 115-V	Watts Loss 230-V	Approx. Line Current, Amperes: Starting 115-V	Starting 230-V	Operating 115-V	Operating 230-V	Approx. Over-all Dimensions, Inches: Width	Length	Height
H-1 400 Watts	Enclosed	90	58G2	58G12	$ 20.90	28	48	52	7.0	3.5	4.5	2.25	6 1/16	12 1/8	6 1/4
	Enclosed	60	58G3	58G13	15.35	23	40	48	12.0	6.0	6.0	3.0	6 1/16	11 3/4	6 1/4
	Enclosed Tulamp	95	58G106	58G116	30.45	39	80	70	6.0	3.0	7.3	3.65	7 9/16	13 1/8	6 7/16
	Weatherproof	90	58G10	58G20	22.35	37	48	52	7.0	3.5	4.5	2.25	6 3/8	12 7/8	6 1/2
	Weatherproof	60	58G9	58G19	16.75	32	40	37	12.0	6.0	6.0	3.0	6 3/8	11 5/8	6 1/2
	Core-and-Coil	60	58G1	58G11	11.85	18 1/2	42	50	12.0	6.0	6.0	3.0	5 15/16	5 15/16	6 1/4
H-4 100 Watts (Can also be used for S-4)	Enclosed	90	59G22	59G32	16.75	15	23	23	2.75	1.375	1.0	0.5	6 1/16	11 5/16	6 1/4
	Enclosed	50	59G18	59G28	9.75†	8	22	22	3.1	1.6	2.0	1.0	5	5 5/8	3 31/32
	Weatherproof	50	59G20	59G30	12.60†	9	22	22	3.1	1.6	2.0	1.0	4 5/8	8 13/16	4 13/16
	Core-and-Coil	50	59G16	59G26	7.00†	7	22	22	3.1	1.6	2.0	1.0	3	3 3/4	4 5/8
H-5 250 Watts	Enclosed	90	58G132	58G142	20.90	28	37	40	3.6	1.8	2.5	1.25	6 1/16	12 1/8	6 1/4
	Enclosed	50	58G133	58G143	15.35	23	35	38	7.5	3.75	5.0	2.5	6 1/16	11 3/4	6 1/4
	Enclosed Tulamp	95	58G225	58G235	30.45	36	72	70	2.75	1.375	4.5	2.25	7 9/16	13 1/8	6 7/16
	Weatherproof	90	58G140	58G150	22.35	37	37	40	3.6	1.8	2.5	1.25	6 3/8	12 7/8	6 1/2
	Weatherproof	50	58G139	58G149	16.75	32	35	38	7.5	3.75	5.0	2.5	6 3/8	11 5/8	6 1/2
	Core-and-Coil	50	58G131	58G141	11.85	18 1/2	35	38	7.5	3.75	5.0	2.5	5 5/8	5 15/16	6 1/4
H-6 1000 Watts	Core-and-Coil Transformer	65	59G37	59G38	30.00	45	95	95	30.0	15.0	15.5	8.0	7 1/2	9 1/16	6 1/4
H-9 3000 Watts	Enclosed	90	230V—59G212		167.20	160	220		230V—26.0		15.3		8 3/16	33 23/32	7 23/32
	Enclosed	90	460V—59G213		125.40	135	190		460V—13.0		7.65		7	37 3/16	6 5/32
	Enclosed	90	575V—59G214		125.40	130	185		575V—10.5		6.12		7	36 7/16	6 5/32

AUTOTRANSFORMERS FOR SUNLAMPS—60 CYCLES

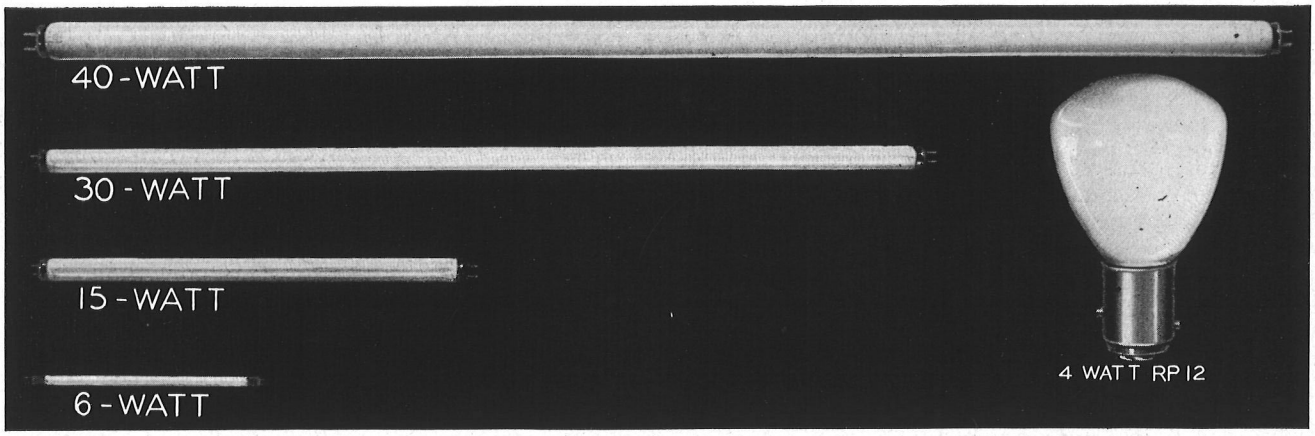
S-1 400 Watts	Core-and-Coil	40	9ADX54C 100–125-V	.....	22	100	3.5	.....	10.0	....	5 1/8	5 1/2	5 1/8
S-4 100 Watts	Core-and-Coil	50	58G720 105–125-V	.....	4 3/4	23	4.0	.....	2.15	....	3 3/4	4 1/2	3 1/16

† Prices given in this column refer to 115-volt ballasts; 230-volt ballasts are 70¢ more for 59G28, and 65¢ more for 59G30, and 59G26.

The present standard Type H (Mercury) and Type S (Sunlight) lamps have a letter-numeral combination which designates each. Lamps having the same numeral designation (except the Type S-1 Sunlamp) can be used on the same transformer. For example, a transformer for the 100-watt A-H4 will also provide the proper current and voltage characteristics for S-4, RS-4, B-H4, C-H4, and E-H4 lamps since all of these sources have identical mercury-arc characteristics. The prefix letters A, B, C, etc., simply indicate modifications in construction for different bulb shapes, burning positions or type of outer glass employed.



"BLACK LIGHT" (360BL) FLUORESCENT LAMPS



Fluorescent lamps containing a special phosphor whose radiation peaks around 3600 A in the near-ultraviolet region of the spectrum are now available. Designated as "360BL" lamps, these sources are similar to comparable sizes of lamps except for the phosphor; they operate from standard auxiliary equipments. They can be used for blueprinting and for activating luminescent materials such as on fluorescent maps, markers, sketches, directional signs, laundry marking, etc. The table at the right indicates the available sizes and technical data.

Some visible light is produced as shown on page 6. Supplementary filters for absorbing the visible light are indicated in the curves at the bottom of page 6.

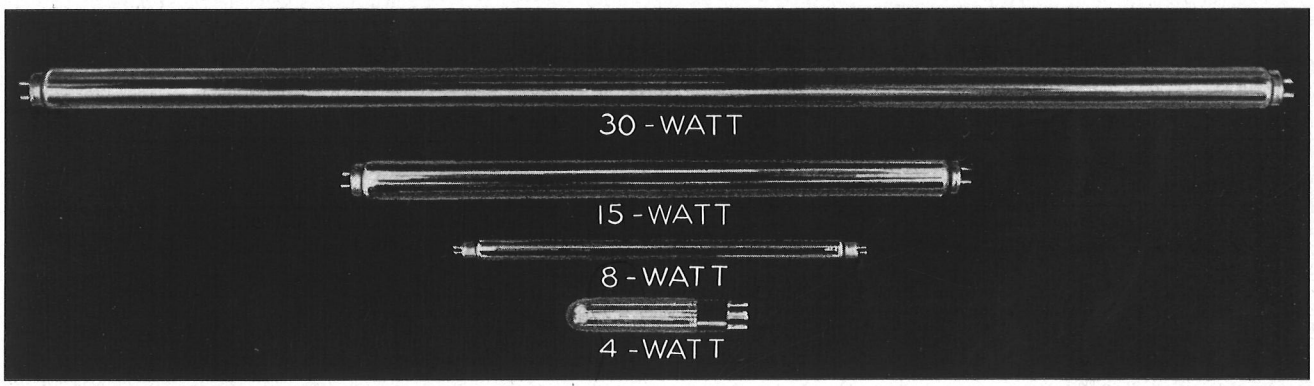
The RP-12 bulb shown is also a "360BL" lamp designed to operate on 12–16 volt and 24–28 volt D.C. circuits for fluorescent instrument dial lighting on airplanes. The wattage ratings are 3 and 4 watts respectively for the two voltage classes.

A 250-watt filament lamp in a red-purple bulb known as the Purple X lamp is also available for black light effects.

Designation	40-watt	30-watt	15-watt	6-watt
Nominal Length, inches	48	36	18	9
Diameter, inches	1½	1	1	⅝
Bulb	T-12	T-8	T-8	T-5
Approx. Lamp Amperes	0.42	0.35	0.31	0.145
Approx. Lamp Volts	106	98	55	48
Circuit Voltages	110–125 199–216 220–250	110–125 199–216 220–250	110–125	110–125
Rated Avg. Life, hours†	1250	1250	1250	750
List Price, each	$1.35	$1.00	$0.87	$1.00
Standard Pkg. Quantity	24	24	24	24

† Useful life—limited by ultraviolet depreciation. Total life is that of the corresponding fluorescent lamp.

GERMICIDAL LAMPS



These lamps radiate most of their energy at the 2537 line which is very near the wavelength most effective in destroying bacteria.

Three of the germicidal lamps are similar in construction to 8-, 15-, and 30-watt fluorescent lamps except for omission of the phosphor and use of No. 9741 glass which transmits the shortwave ultraviolet. Auxiliary equipments for these germicidal lamps are identical with those for standard fluorescent lamps of corresponding size. (See Folder LS-101 published by Nela Park Engineering Division.) A 4-watt germicidal lamp having a bent-U tube and a radio-type base is also available. It uses G-E ballast 58G825 and FS-5 starter. Germicidal lamps are being employed in hospitals, barracks and general interiors, as well as sterile storage cabinets and the like.

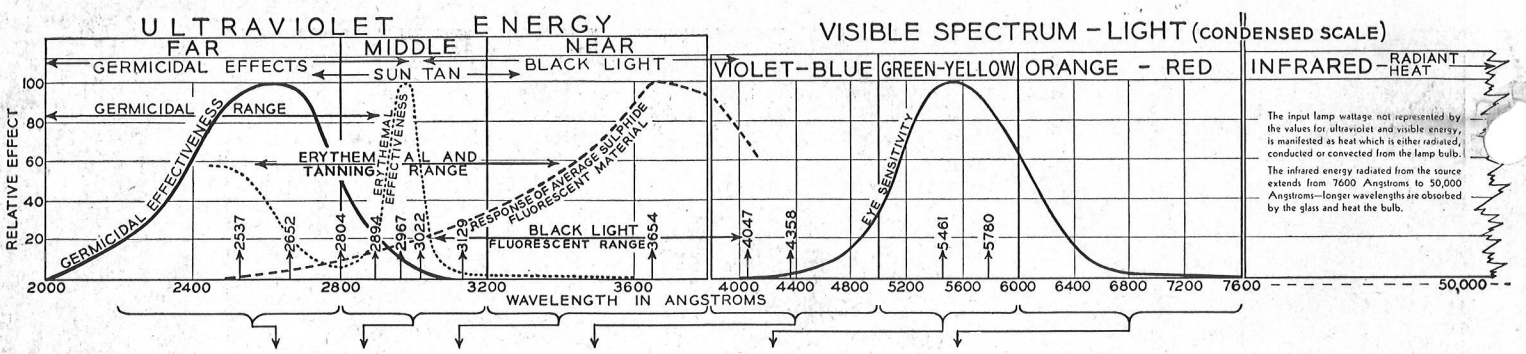
These sources produce shortwave ultraviolet radiation which activates fluorescent phosphors. They must be used with caution and full understanding that the radiation emitted is dangerous to living organisms and that direct exposure to the eyes even for a few seconds should be avoided.

Designation	30-watt	15-watt	8-watt	4-watt
Nominal Length, inches	36	18	12	5¾
Diameter, inches	1	1	⅝	½*
Bulb	T-8	T-8	T-5	T-4
Approx. Lamp Amperes	0.35	0.31	0.16	0.08
Approx. Lamp Volts	98	55	57	58
Circuit Voltages	110–125 199–216 220–250	110–125	110–125	110–125
Rated Avg. Life, hours§	2500	2500	2500	2500
Base	Med. Bipin	Med. Bipin	Min. Bipin	Radio 4-contact
UV Output, watts of 2537A at 100 hours	7.2	2.9	1.5	0.5
List Price, each	$6.75	$4.50	$4.25	$3.40
Standard Pkg. Quantity	24	24	24	12

* Bent tube construction makes lamp approximately one inch in width.

§ Under specified test conditions, when 15- and 30-watt germicidal lamps are burned continuously, the rated life is 4000 hours.

SPECTRAL DATA—UV AND LIGHT OUTPUT



Sources	Bulb	Below 2800A Watts	Below 2800A % of Lamp Watts	2800-3200A Watts	2800-3200A % of Lamp Watts	3200-3800A Watts	3200-3800A % of Lamp Watts	3800-5000A Watts	3800-5000A % of Lamp Watts	3800-5000A Lumens	3800-5000A % of Total Lumens	5000-6000A Watts	5000-6000A % of Lamp Watts	5000-6000A Lumens	5000-6000A % of Lamp Lumens	6000-7600A Watts	6000-7600A % of Lamp Watts	6000-7600A Lumens	6000-7600A % of Total Lumens	Total Ultraviolet Below 3800 A Watts	Total Ultraviolet Below 3800 A % of Lamp Watts	Total Visible 3800-7600 A Watts	Total Visible 3800-7600 A % of Lamp Watts	Germicidal Effectiveness (Equivalent Milliwatts of 2600A)	Units of Erythemal Flux	"Black Light" (Fluorens)	Light (Lumens)
MERCURY LAMPS																											
Germicidal																											
8-watt	#9741	1.5	19	.03	.41	.03	.33	.09	1.1	3/5	2.7	.04	.56	26	96	.002	.03	1/5	1.2	1.6	20	.14	1.7	1470	85,000	28	27
15-watt	#9741	2.9	19	.06	.42	.05	.34	.17	1.15	1½	2.7	.09	.57	51	96	.005	.03	2/5	1.2	3	20	.26	1.75	2840	160,000	54	53
30-watt	#9741	7.2	24	.16	.53	.13	.42	.42	1.4	3½	2.7	.21	.71	125	96	.01	.04	1½	1.2	7.5	25	.65	2.15	7050	400,000	135	132
Sunlamps																											
S-1 (400-watt)	#776	.01	.002	3.2	.8	4.5	1.1	8.2	2.05	280	3.9	9.2	2.3	5200	72	28	6.8	1750	24	7.7	1.95	45	11	66	68,000	4850	7200
S-4 (100-watt)	#721	.01	.01	2.1	2.1	3.6	3.6	6.4	6.4	78	2.6	5.0	5.0	2850	95	.62	.62	60	2.0	5.7	5.7	12	12	71	50,000	3450	3000
RS-4 (100-watt)	#776	.01	.01	1.5	1.5	2.9	2.9	5.0	5.0	57	2.2	4.2	4.2	2450	96	.45	.45	42	1.7	4.4	4.4	9.6	9.6	59	35,000	2950	2550
RS (275-watt)	#776			1.2	.46	2.9	1.1	2.9	1.0	35	1.3	4.6	1.7	2600	96	.71	.26	70	2.6	4.2	1.5	8.1	3.0	32	25,000	2950	2700
Black Light																											
B-H4 (100-watt)	#5872	0	0	.001	.001	.83	.83	.03	.03	. . .	. . .	0	0	0	0	.04	.04	. . .	. . .	.83	.83	.06	.06	0	18	845	. . . . .
E-H4 (100-watt)	#776	. . .	. . .	.05	.05	2.2	2.2	2.8	2.8	35	1.6	3.8	3.8	2150	96	.51	.51	45	2.05	2.2	2.2	7.1	7.1	0	200	2300	2250
A-H5 (250-watt)	#774	0	0	.43	.17	7.6	3.1	11.5	4.7	150	1.5	16.5	6.7	9600	96	2.6	1.05	270	2.7	8.1	3.2	31	12.5	2.1	3850	8350	10,000
6-watt 360BL	. . .	0	0	. . . .	. . . .	.31	5.2	.17	2.85	½	3	.02	.38	13	97	0	0	0	0	.31	5.2	.2	3.25	. . . . .	40	400	14
15-watt 360BL	. . . . .	0	0	. . . .	. . . .	1.2	7.8	.64	4.3	1½	3	.09	.57	51	97	0	0	0	0	1.2	7.8	.73	4.9	. . . . .	150	1500	53
30-watt 360BL	. . .	0	0	. . . .	. . . .	2.6	8.8	1.45	4.9	4	3	.19	.65	115	97	0	0	0	0	2.6	8.8	1.65	5.5	. . . . .	335	3400	120
40-watt 360BL	. . .	0	0	. . . .	. . . .	3.8	9.5	2.1	5.2	5	3	.28	.7	170	97	0	0	0	0	3.8	9.5	2.4	6.0	. . . . .	480	4900	175
Type H																											
A-H1 (400-watt)	#772	0	0	.001	.0003	4.3	1.1	15.5	3.85	155	.96	27	6.8	15,500	98	1.1	.27	160	1.0	4.3	1.1	44	11	0	55	4500	16,000
A-H4 (100-watt)	#772	0	0	.03	.03	2.3	2.3	6.4	6.4	78	2.6	5.0	5.0	2850	95	.62	.62	60	2	2.4	2.4	12	12	.03	180	2450	3000
A-H6 (1000-watt)	#774	0	0	6.8	.68	62	6.2	150	15	3000	4.6	105	10.5	58,500	90	37	3.7	3550	5.5	69	6.9	290	29	68	90,000	78,500	65,000
A-H6 (1000-watt)	Quartz	31	3.1	75	7.5	90	9.0	150	15	3000	4.6	105	10.5	58,500	90	37	3.7	3550	5.5	195	19.5	290	29	32,000	3,500,000	110,000	65,000
A-H9 (3000-watt)	#172	0	0	0	0	22	.72	140	4.7	1350	1.1	215	7.1	120,000	98	12.5	.41	1050	.89	22	.72	370	12.5	0	58	24,500	120,000

SPECTRAL ENERGY MEASUREMENTS

Radiation energy is measured in watts, milliwatts (one thousandth) or microwatts (one millionth). Oftentimes the intensity of radiant energy in any given direction is expressed as milliwatts or microwatts falling on a square inch or square centimeter at a given distance from the source. Such measurements correspond to "candlepower" measurements of light—that is, the intensity in any given direction.

Radiation for Light

The Lumen—For visible radiation or light, the energy is measured quantitatively in lumens, which is the integrated result of all radiation to which the eye responds. The relative amount of energy throughout the range required to produce a lumen is determined by the eye sensitivity curve shown; equal energy throughout will produce white light. Colors and tints are the result of different proportions of energy within the visible range. The light output of most lamps is rated in lumens.

Ultraviolet Energy Measurements

Sunburn, Suntan Radiation, The E-Viton—Being familiar with the energy to produce "lumens" the same process of thinking can be applied to understanding measurements of ultraviolet energy and its relative effects. For example, in sunlamp radiation the skin instead of the eye is the receiver and its response within its range is shown by the erythemal curve, which indicates how effective different wavelengths are in producing temporary reddening of untanned skin. For rating purposes these values have been standardized for the range between 2400 and 3600 Angstroms. The "erythemal flux" column in the above table summarizes the effectiveness of the sources listed; corresponding to the lumen in concept, the unit used is that quantity of radiant energy which produces as much temporary reddening as 10 microwatts of energy at 2967 Angstroms—the wavelength of maximum effectiveness.

The effects of ultraviolet radiation on other biological functions can also be portrayed by response curves, though they differ from the erythemal curve. However, the production of Vitamin D and the antirachitic effectiveness of wavelengths down to 2800A is known to coincide closely with the erythemal effectiveness. The unit "*E-Viton*" has been employed to express the health and erythemal value of radiations above 2800A, which are present in natural sunlight. Antirachitic benefits of shorter wavelengths have also been demonstrated in laboratory experiments. Except for germicidal lamps, sunlamps and the A-H6 mercury lamp (in quartz water jacket), the "Erythemal Flux" column could have been called E-Vitons; for those sources the erythemal flux below and above 2800 Angstroms is given in the table below:

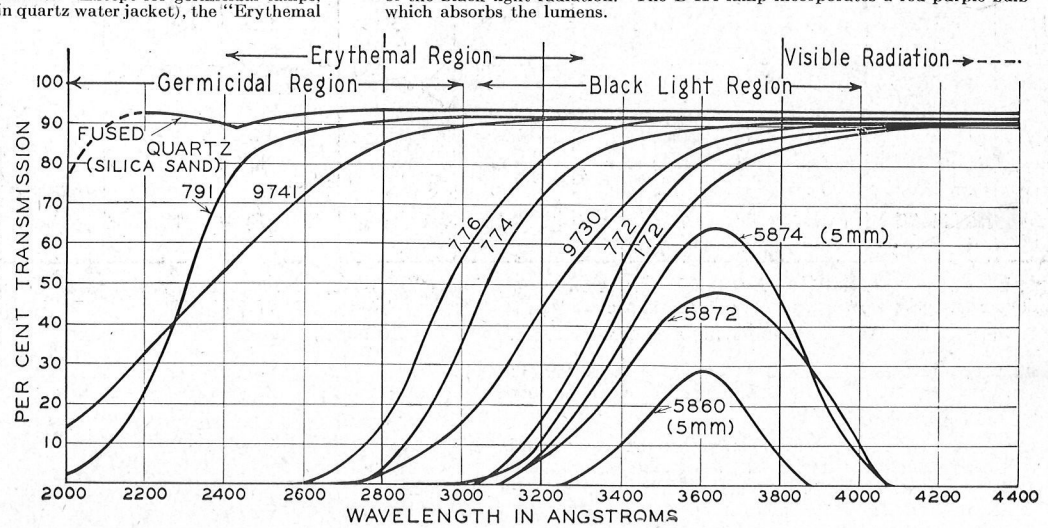
Lamp	Erythemal Flux Above 2800A (E-Vitons)	Erythemal Flux Below 2800A (Equivalent E-Vitons)
8-watt Germicidal	750	84,250
15-watt Germicidal	1,400	158,600
30-watt Germicidal	3,500	396,500
A-H6 Mercury—Quartz Jacket	2,550,000	950,000
S-1 Sunlamps	67,720	280
S-4 Sunlamps	49,925	75
RS Sunlamps	25,000	55

Just as the shorter wavelengths in visible light produce blue light, the longer ones red, the shorter wavelengths under the erythemal curve seem to create quick, temporary reddening or burning of the skin, while the longer wavelengths seem to penetrate deeper to cause a tanning of the skin without burn, unless excessive exposure is made. The use of suntan lotions to prevent sunburn is effective because these create a film which absorbs the shorter, burning rays and allows the longer tanning rays to penetrate to the skin, thus causing the skin to tan without burn.

Germicidal Radiation—The most effective radiation as far as lethal effect on air-borne bacteria is around 2600A and the relative potency of shortwave ultraviolet in this vicinity is indicated by the germicidal curve. Germicidal lamps radiate most of their energy at 2537A and comparative efficiencies of such sources are stated in terms of equivalent milliwatts of 2600A.

Black Light Radiation—The term black light has, by popular usage, come to mean the radiant energy between 3200A and 4000 A, and the term *fluoren* has been proposed to represent 1 milliwatt of energy emitted within this region. The effectiveness of a fluoren in creating fluorescent effects will depend on the product of the incident energy (fluorens) and the response characteristics of the fluorescent material integrated over all the wavelengths in the above range. The fluoren column above shows the relative fluoren content of energy for the various lamps; however, these values are likely to be misleading since most applications require the use of dark glass filters to absorb the visible light, and which at the same time absorbs considerable of the black light radiation. The B-H4 lamp incorporates a red-purple bulb which absorbs the lumens.

The accompanying curves indicate the spectral transmission characteristics of the different glasses used in mercury lamps and of several black light filters. Curves for the former are based on thicknesses of 1 millimeter; the black light filter transmission curves are given for 5 millimeters, the thickness to which such glasses are commonly polished. All the curves were obtained on typical samples and variations due to thickness, glass temperature and other factors can be expected. The ultraviolet transmission is reduced as the thickness is increased.



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