Title

ELECTRICAL AND PHOTOMETRIC TESTS OK GENERAL ELECTRIC HALARC LAMPS AT 350 HOURS

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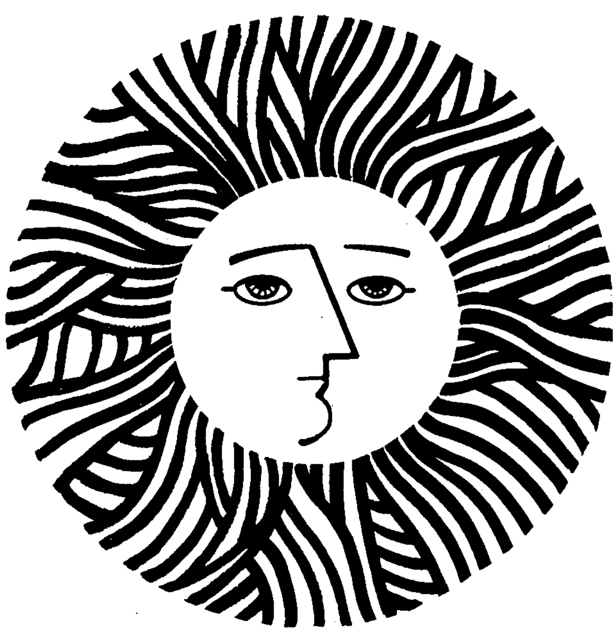
Francis Rubinstein

January 1982



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MEMORANDUM

DATE: January 18, 1982

TO: Lighting Systems Research Group

FROM: Francis Rubinstein

RE: Electrical and Photometric Tests on General Electric Halarc Lamps at 350 Hours

Introduction

This memorandum describes the electrical, photometric and chromatic performance of the General Electric Halarc lamps after 350 hours of burning time. Initial performance of these lamps was described in a previous memorandum dated August 12, 1981.

Test Procedure

All performance characteristics were measured in the integrating sphere. Before any data was taken, each lamp was burned in the open sphere for 20 minutes to allow the lamp to reach thermal equilibrium. The sphere was then closed and electrical and photometric data taken. Immediately thereafter, spectral power distribution data was measured with the spectroradiometer. Equipment used for the measurements is listed below.

Equipment	Parameter Measured
Clarke-Hess 255 watt-meter	Power, Input Voltage, Current
Tektronix J-16 photometer	Luminous Flux
E.G.&G. Electro-Optics 555 Spectroradiometer	Spectral Power Distribution

Absolute luminous flux values were calculated using an NBS luminous flux transfer standard. Correlated color temperature and color-rendering indices were calculated from the spectral power distribution data.

Test Results

Major test results are shown in Table 1. Initial lamp performance data (from previous memorandum) is included in this table to show the relative change in lamp performance over time. Columns 2 and 3 give the measured input power to the lamps at 0 and 350 burning hours, respectively. Similarly, current, power factor and luminous flux values are shown in columns 4 through 9. Relative change in light output over 350 burning hours is shown in column 10. Measured lamp efficacies at 0 and 350 hours are tabulated in columns 11 and 12, respectively and the relative change in lamp efficacy during this period of time is shown in column 12. Correlated color temperature values and color-rendering indices at 0 and 350 hours are given in columns 13 through 16.

In addition to the individual lamp data, I have shown average values for all the lamps except for lamps 1, 16 and 17. (The latter lamps were excluded from the calculation since they were not burned on the life test rack with the others. Lamp #1 is frequently used for demonstration purposes and lamps 16 and 17 were replacements for lamps 3 and 7 which failed to operate initially). Sample standard deviation values are shown in the table below the averages. The standard deviations are a measure of the spread of measured values about the average. For example, the average luminous flux for the lamps at 350 hours is 2256 lumens with a sample standard deviation of ±142 lumens. That is, two-thirds of the lamps were within 142 lumens of the average value. This is not the same as the instrumental uncertainties which arises from a lack of precision in the instrumentation. Instrumental uncertainties are estimated below.

Parameter	Estimated Instrumental Uncertainty
Input Voltage	±0.8 volts
Current	±20 milliamps
Power	±1 watt
Relative Luminous Flux	±45 lumens
Absolute Luminous Flux	±100 lumens
Color Temperature	±50 degrees Kelvin
Color-Rendering Index	±1.0%

Discussion

Initial luminous flux values given in column 8 of Table 1 are not identical to those values previously reported in the August memorandum. The difference is a consequence of the method used to calculate luminous flux. Previously, I did not incorporate a factor which compensated for the absorption of the lampholder. Since I now include this factor, it was necessary to pro-rate the August results so that comparisons between 0 hour results (column 8) and 350 hour results (column 9) would be meaningful.

As indicated in Table 1, the average luminous flux of these lamps has decreased by about 8.5% in 350 hours. Average input power (at rated input voltage) also increased slightly (about a watt) during this time. As a result, the average efficacy of these lamps decreased from 43.6 lumens per watt initially to 39.3 lumens per watt after 350 burning hours: a decrease in efficacy of about 10%. Given that 350 hours is only about 7% of the average rated life of these lamps (5000 hours), the measured decrease in light output seems fairly large relative to conventional metal halide lamps. The reader should be aware, however, that the burning cycle we use (3 hours on, 20 minutes off) is a fairly severe test of the lumen maintenance characteristics of these lamps. Moreover, the first few hundred hours usually show the largest change in light output and we expect that the next data point (to be done at 750 hours) will not show as large a change.

The changes in correlated color temperature and color-rendering index were not remarkable over 350 hours of burning time. In fact, the measured average values of these two parameters do not show statistically significant changes over 350 hours.

Acknowledgement

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TABLE 1

HALARC LAMP PERFORMANCE CHARACTERISTICS

Lamp #	Input Power (watts) Initial	Input Power (watts) 350 Hr	Current (milliamps) Initial	Current (milliamps) 350 Hr	Power Factor (%) Initial	Power Factor (%) 350 HR	Luminous Flux (lumens) Initial	Luminous Flux (lumens) 350 Hr	Change in Light Output (%)	Efficacy (lumens/watt) Initial	Efficacy (lumens/watt) 350 Hr	Change in Efficacy (%)	Correlated Color Temperature (°K) Initial	Correlated Color Temperature (°K) 350 Hr	Color Rendition Index (%) Initial	Color Rendition Index (%) 350 Hr
2	56	57	774	803	60.3	59.2	2186	2024	-7.4	39.0	35.5	-9.0	3046	3033	64.4	64.6
4	54	56	768	801	58.6	58.3	2312	2137	-7.6	42.8	38.2	-10.7	2931	3083	62.7	66.5
5	58	59	812	840	59.5	58.5	2622	2407	-8.2	45.2	40.8	-9.7	2892	2968	66.0	66.2
6	60	60	840	870	59.5	57.5	2552	2352	-7.8	42.5	39.2	-7.8	3068	2948	66.4	66.2
8	55	56	780	816	58.8	57.2	2350	2119	-9.8	42.7	37.8	-11.5	3465	3502	60.8	65.5
9	58	59	819	843	59.0	58.3	2721	2456	-9.7	46.9	41.6	-11.3	2912	2927	66.9	66.9
10	59	59	825	842	59.6	58.4	2645	2390	-9.6	44.8	40.5	-9.6	2930	2910	69.0	66.9
11	55	56	775	801	59.1	58.3	2404	2248	-6.5	43.7	40.1	-8.2	2952	2867	64.3	64.3
12	58	59	802	840	60.3	58.5	2601	2396	-7.9	44.8	40.6	-9.4	2974	2994	68.0	66.9
13	53	55	746	784	59.2	58.5	2328	2121	-8.9	43.9	38.6	-12.1	3112	3105	64.3	64.4
14	56	57	785	820	59.4	57.9	2361	2180	-7.7	42.2	38.2	-9.5	2996	2966	63.4	63.6
15	56	56	799	822	58.4	56.8	2487	2237	-10.1	44.4	39.9	-10.1	2961	2992	63.7	63.1
Average	56.5	57.4	793.8	823.5	59.3	58.1	2464	2256	-8.4	43.6	39.3	-9.9	3020	3026	65	65.4
Sample Standard Deviation	2.1	1.7	27.2	24.3	.59	.66	164	142	1.6	2.0	1.7	1.3	155	165	2.3	1.4

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