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REPORT**



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**LIGHT SOURCES FOR
REMOTE SENSING SYSTEMS**

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2.4 ZIRCONIUM ARCS

Concentrated arc lamps using zirconium oxide in the cathode were developed during World War II. A detailed discussion of the construction and performance of these lamps has been given by Buckingham and Diebert.⁴³ The unique feature of these lamps is the cathode, which is made by packing zirconium oxide into a small cup at the end of a tungsten, molybdenum or tantalum electrode, metals with high melting points. The anode is also a high melting point material and on account of its large surface area, remains relatively cool. The anode is mounted close to the cathode tip and has a hole through which the cathode may be viewed. During operation molten zirconium metal is formed and it is this which is the direct source of visible radiation. The lamps have an argon fill and spectrograms show lines of ArI, ZrI, ArII, ZrII, ZrIII; lines of ArI and ZrII are the strongest.

The spectral distribution obtained from these arcs is shown in Figure 2.24. The continuum radiation is emitted chiefly

by the molten cathode surface and peaks at around 1000 nm. The lines are emitted by a cloud of excited gas and vapor near the cathode.

The diameter of the cathode spot depends upon the current: it increases with larger currents and the upper limit is set by the cathode spot completely covering the zirconium oxide surface. Further increase in current makes the spot brighter and shortens lamp life. For small currents the lamp becomes unstable and the spot varies in size. The uniformity of the brightness distribution is shown in Figure 2.25 and the spatial distribution in Figure 2.28.

Variations in the position of the arc stream and irregularities in the cathode surface may produce asymmetry in the brightness distribution and also some instability. The spot position may move slowly during operation by an amount equal to a small percentage of its own diameter. These factors produce variations of about 10% in the emitted light. During the first few hours of operation, the intensity of the emitted radiation and the spot diameter decrease and the brightness increases. After about 100 hours of operation these characteristics are nearly stable with a brightness 1.40 times initial brightness, see Figure 2.26.

The above data were obtained from the paper by Buckingham and Deibert.⁴³ Since then improvements may have been made but no such data could be obtained from the manufacturers. In fact, the current Sylvania lamps appear to be very similar to those described

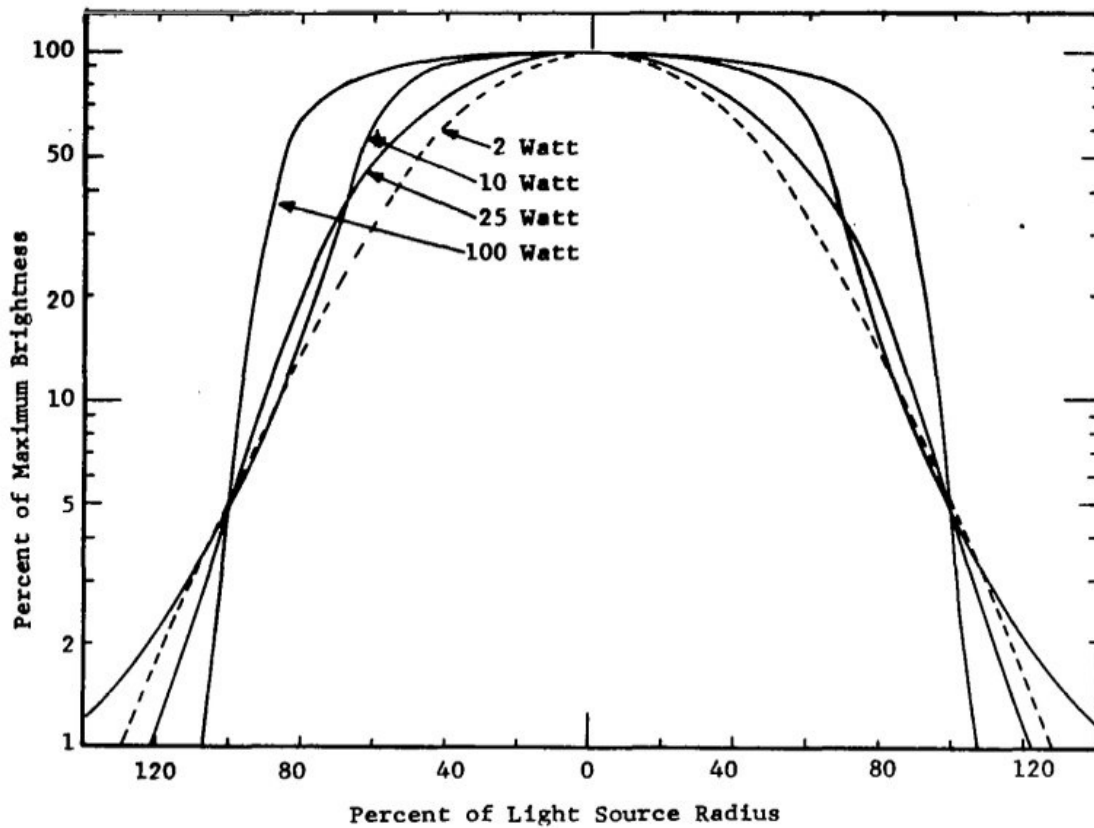


Figure 2.25 Average Cathode Brightness Distribution of Concentrated Arc Lamps⁴³

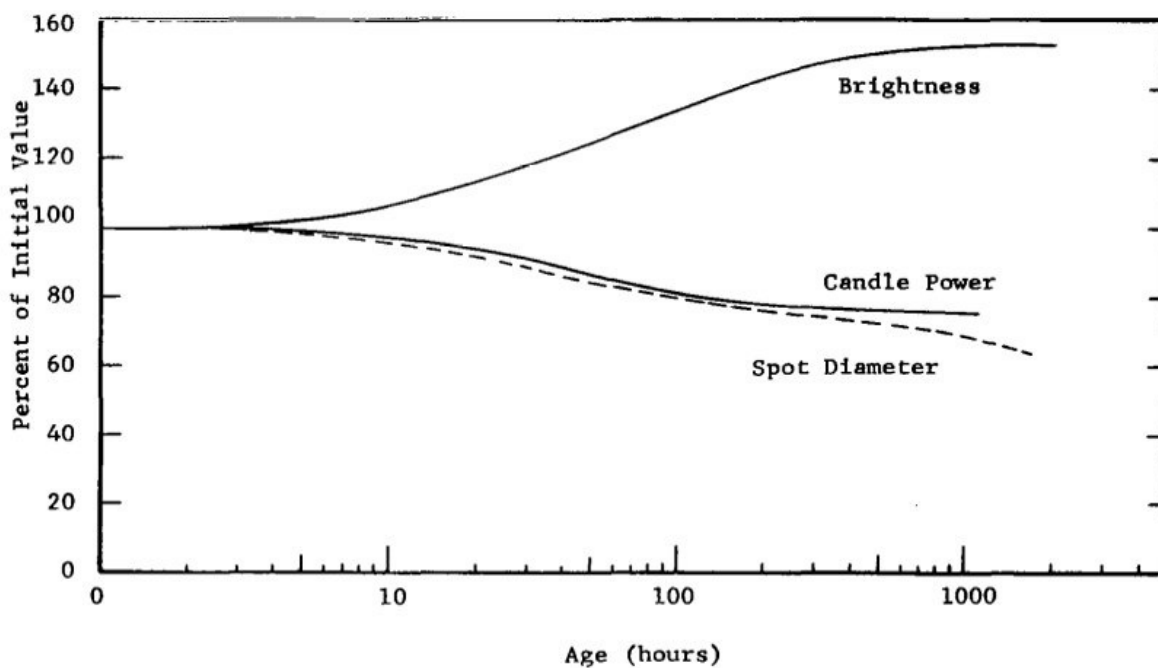


Figure 2.26 Change of Characteristics of Age of 10 Watt Concentrated Arc Lamps⁴³

in this paper and Sylvania literature shows the curves given in Figures 2.24 and 2.28. This suggests that the data of Buckingham and Deibert are still accurate.

Table VI shows the arcs marketed by Sylvania Electric Products Corporation. In this table, the designation A, C, K refer to the envelope type and electrode orientation within the envelope; Figure 2.27 shows the output for their lamp type K100Q. For use in the infrared these arcs require modification to take a suitable window. Turrell⁴⁴ and Hall and Nester⁴⁵ have made such modifications. Turrell modified a Sylvania 300 watt arc and compared the output with a Globar operated at 1175°K. The arc was appreciably stronger as can be seen in Figure 5.3; this figure shows the relative amounts of radiant energy passing the entrance slit of a monochromator, but the zirconium arc did not fill the slit in this experiment due to the small image, so the effect is even greater. The arc operates at a temperature of about 2400°C and so above 10,000 nm scattered light is a more severe problem than for the Globar. Turrell reports that the arc was stable to 2% for periods exceeding an hour; judging from Buckingham's and Deibert's results, this was probably for an aged arc, but still shows an improvement over the earlier results.

TABLE VI SYLVANIA CONCENTRATED ARC LAMPS
(Zirconium Arcs)

	Power (watts)	Mean Light Source Diameter (inch)	Mean Brightness cd mm^{-2}	Average Life (hours)
A2, C2, K2	2	0.005	25	150
C5	5	0.010	37	450
C10, K10	10	0.015	47	450
C25, K25	25	0.030	36	600
C100, K100	100	0.072	39	375
K300	300	0.110	40	250

There is also a K100 Q arc lamp which has a quartz envelope for improved transmission in the ultraviolet.

REFERENCES

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