XENON LAMPS

ASSOCIATED ELECTRICAL INDUSTRIES RESEARCH LABORATORIES

1960

ASSOCIATED ELECTRICAL INDUSTRIES LIMITED RESEARCH LABORATORIES

XENON ARC DISCHARGE LAMPS

1. *General*

The xenon arc lamp is unique in that:-

(a) It is a source of continuous radiation of sunlight quality at reasonably high luminance and efficiencies.*

(b) The light output may be modified over a wide range by adjusting the lamp ballast without appreciably altering the colour of the light.

In addition the lamp may be switched in and out at any time and full light output is available instantaneously.

The lamps may be designed to run from A.C. or D.C. mains but in general the A.C. type is preferred, since with a D.C. circuit there is generally a large power dissipation in the resistance ballast. This power is not only wasted but removal of the large amount of heat generated can be a problem.

The average objective life of A.C. lamps is 500 hours (longer with some D.C. types). This figure must be considered jointly with the luminous efficiency figure of 22 - 25 L/W. and may be compared with a filament lamp having a life of 1,000 hours at an efficiency of 10 - 15 L/W. and a life of 25 - 50 hours at an efficiency of 20 - 25 L/W.

The spectrum of the radiation shows a continuum extending from about 2,000 A through the visible up to 9,000 A where there is a pronounced peak. For this reason the lamp can also be used as a powerful source of ultra-violet and infra-red radiation. It has the advantage over alternative sources of the U.V. continuum such as the hydrogen lamp in that the intensity is much higher.

2. *Characteristics*

The xenon arc lamps which are at present available are:-

(a) The 1Kw. type XB, a Linear source lamp.
(b) The 375w. type XC, a Compact source lamp.
(c) The 500w. type XC, a Compact source lamp.
(d) The GAE6, a 250w. Compact source lamp.) Prototype
(e) The GAE7, a 1,750w. Compact source lamp.(D.C.only)) Lamps.

Other ratings including higher power lamps than the above are technically possible and have been made on an experimental scale. Enquiries for non-standard ratings of lamps will receive our consideration.

* *Radiation of sunlight quality may be obtained, for example, by using a filament lamp in conjunction with a suitable filter, but the overall efficiency of the arrangement is very low; the luminance is also appreciably less than with the xenon arc. Again a similar quality of radiation can be obtained from fluorescent lamps, but here the source is large and of comparatively low luminance.*

3. *Spectral Energy Data*

3.1 *Spectrographic Plates.*

The spectrogram on page 13 shows comparisons of the spectra of a xenon compact source lamp and a hydrogen lamp taken on an Ilford ordinary plate followed by recommended development. The exposure times for the first, third, fifth and seventh exposures (starting from top of the plate) are 100, 50, 20 and 10 seconds and show the hydrogen spectrum. The second, fourth and sixth exposures with a xenon lamp at 20 amperes are 5, 2 and 1 second respectively.

The xenon continuum begins to break-up and show line structure below about 2300 A and the intensity of line to continuum depends upon the current in the arc, being greater at lower currents; at 20 amps the most intense line is about 4 times that of the continuum. The lower wave-lengths cannot be shown too clearly because of 'fall-off' in the response of the plate.

These plates have been obtained by focusing the bright spot close to one electrode on the spectroscope slit and are not obtained with the whole of the arc. Having focused the xenon lamp on the slit, the hydrogen lamp was substituted, the position of the lens, the distance of the source, the slit width, etc., remaining the same.

3.2 *Typical Spectral Distribution of Energy & Luminance*

Spectral energy distribution values for a 1Kw. type XB lamp are shown in the graph on page 14. The same information is given in the Table on page 8, together with values for spectral luminance expressed as a percentage of total lumen output. To a first approximation it may be assumed that the radiation from all types of xenon arc discharge lamps has a similar distribution, although the energy figures in the ultra-violet may be subject to some variation.

4. *Method of Operation.*

The Xenon lamp will normally operate on A.C. or D.C. mains of 200/250 volts, although by employing special equipment lower line voltages can be tolerated. The operational radiation is produced instantaneously and the arc can be switched in or out under all conditions. The lamp voltage is virtually independent of lamp current and hence lamps should always be operated from a constant current supply. A.C. current control can be brought about most conveniently by the use of chokes placed in series with the arc. On D.C. resistances may be used, or if the supply is is rectified A.C. it may be preferable to use chokes in the A.C. side.

A special high frequency starter device Type HFS.7. has been designed for initiating the arc. It can be used with both A.C. and D.C. lamps provided a 1-2 amp. 250v. A.C. supply is available to energise the starter. The basic lamp circuit is given in Diag.1. A circuit of the starter is also given in Diag.2.

The following points should also be noted carefully before a new lamp and equipment is put into operation:-

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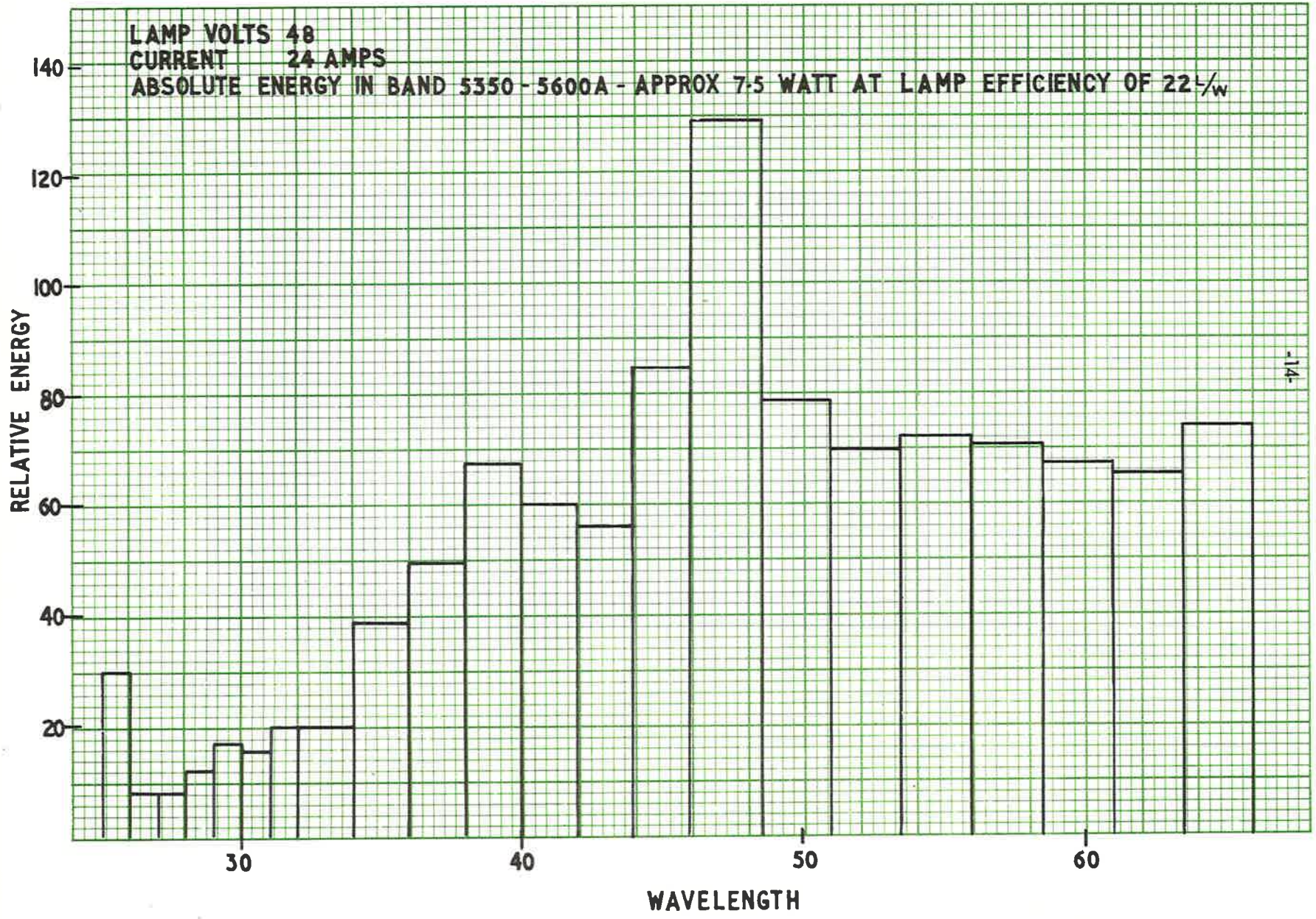
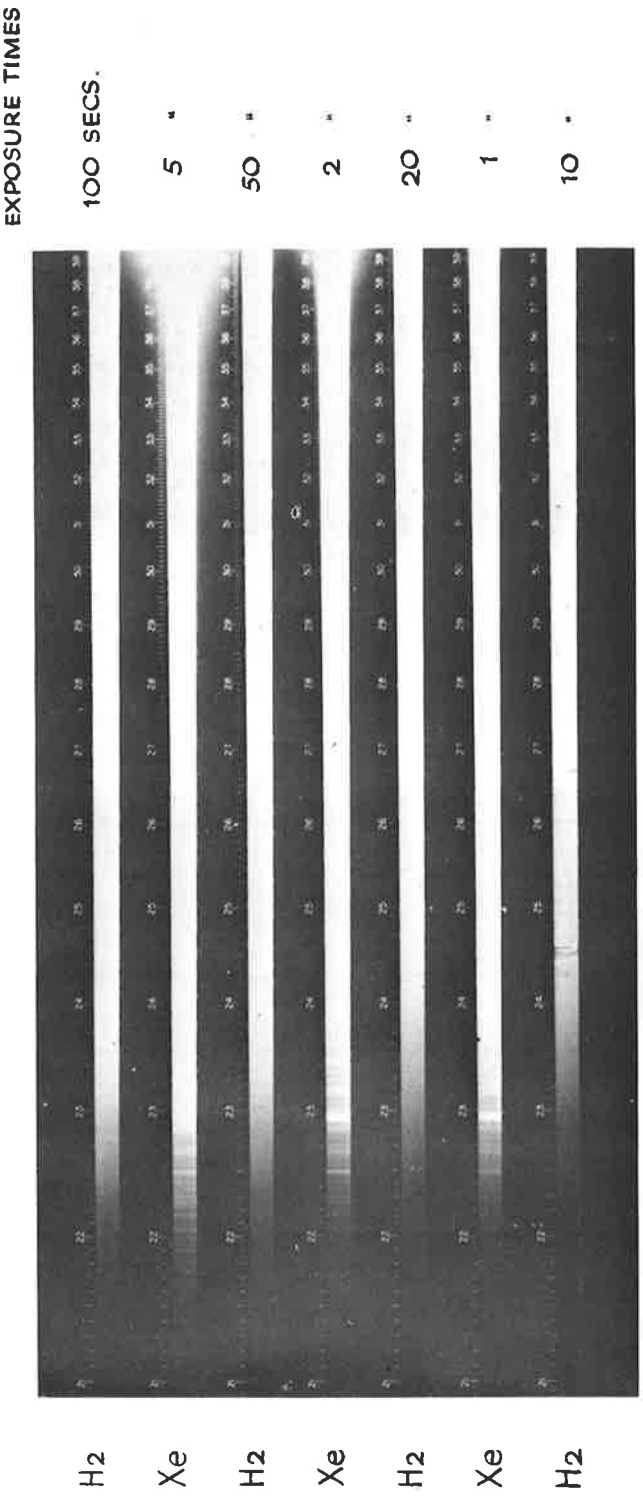
TYPICAL SPECTRAL ENERGY DISTRIBUTION XB/U GAS ARC 1000 WATT



RGB.5063B/G/11


EXPOSURE TIMES
100 SECS.
5 "
50 "
2 "
20 "
1 "
10 "
H2
Xe
H2
Xe
H2
Xe
H2

5.4 *Position of Leads.*

Magnetic fields may affect the stability of the arc and care should be taken therefore to keep the current carrying leads away from the arc.

5.5 *Ultra-Violet Protection.*

Because of the output of short wavelength radiations the lamp should not be observed directly during operation. A layer of ordinary glass or perspex is normally sufficient to provide adequate protection.

NOTE:

Compact source lamps are filled to considerable internal pressures and under certain circumstances may explode. Adequate precautions should therefore be taken when handling and operating lamps.

6. *Special Operation.*

The following notes concern special applications of Xenon lamps. So many variable conditions are possible that it is impossible to give general performance or life figures. We will be glad to advise on particular problems.

6.1 *Pulse Operation.*

It is possible to increase the power into the lamp for short periods of the order of ½ second. The average power should not exceed the rated figure and the peak loading should not exceed 10 times the rated value.

6.2 *Flash Operation of 500-watt XC Lamp.*

The lamp may be used as a conventional flash tube using the starter unit in series as a trigger. The peak current must not exceed 1,000 amperes, a series inductance or resistance being employed to restrict the current to this value if necessary. For stroboscopic applications the wattage dissipated should not exceed 500 watts.

6.3 *Horizontal Operation.*

Lamps may be operated within 15° of the horizontal position with a reduction in life. In the case of the XB lamp convection currents in the lamp will cause the arc to rise and overheat the top surface of the quartz envelope. To maintain the arc in an axial position, one of the leads to the lamp in the form of a bare rod in a quartz sleeve should be mounted along the top of the lamp.

IMPORTANT.

Lamps must not be operated between 15° from the vertical and 15° from the horizontal.

References.

For further information the following references may be consulted.

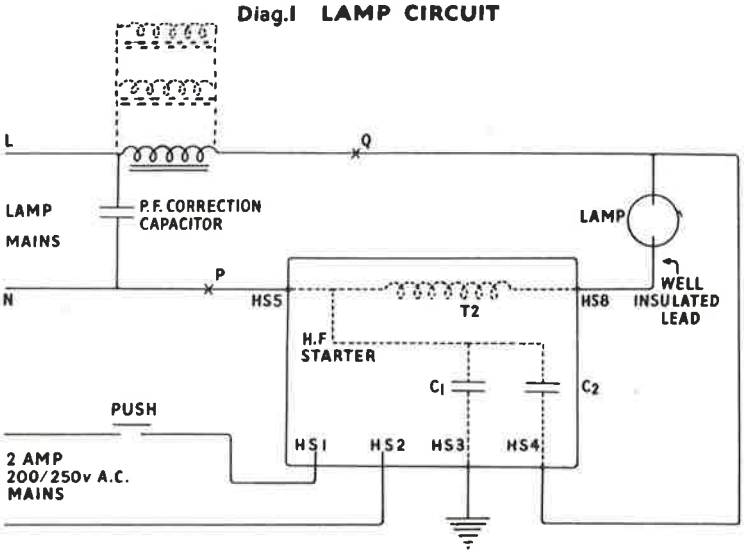
(1) J.N. Aldington, "The Gas Arc - a new Light Source". Trans.Illum.Eng.Soc. (London) 14, 19 (1949)

(2) H.W. Cumming, "The Extension of the Gas Arc Condition" Trans.Illum.Eng.Soc. (London) 16, 6 (1951)

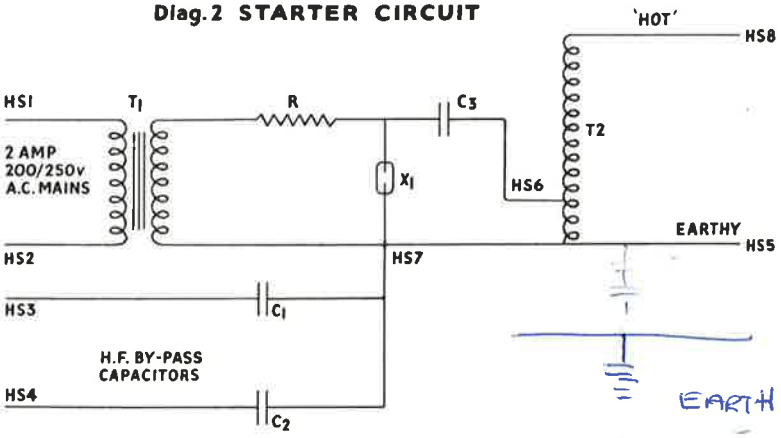
(3) H.W. Cumming, "Xenon Arc Discharge Lamps for Film and Television Industries". The Journal of the British Kinematograph Society 28, 5 (1956)

RGB.5063E/11

Diag.1 LAMP CIRCUIT

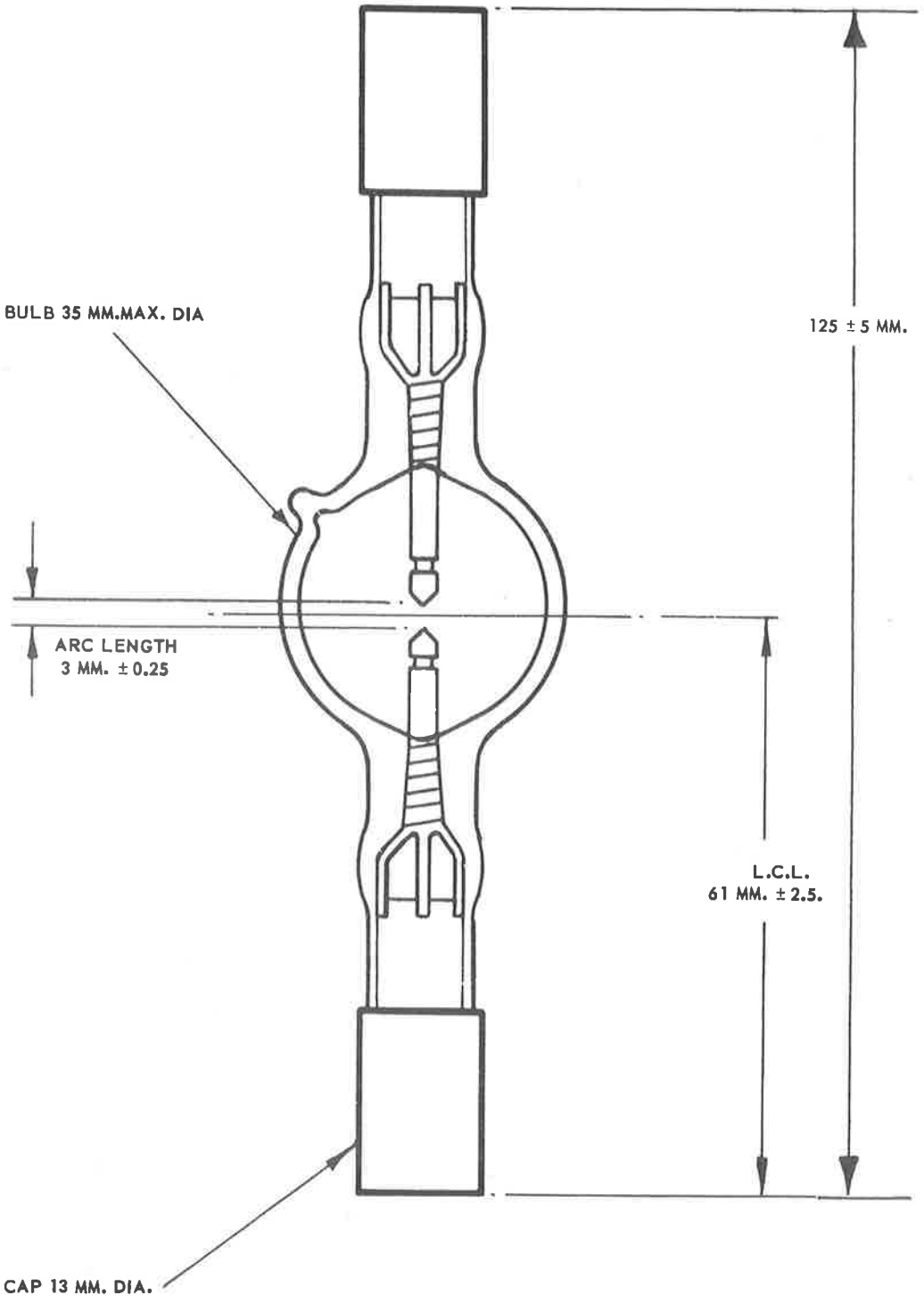


Diag.2 STARTER CIRCUIT



Spectral Band (A.U.)	Spectral Luminance Expressed as a Percentage of Total Lumen Output.	Spectral Energy Expressed as a Percentage of Total Input to arc.
2500 - 2800		0.18
2800 - 3000		0.11
3000 - 3200		0.14
3200 - 3400		0.16
3400 - 3600		0.30
3600 - 3800		0.38
3800 - 4000		0.52
4000 - 4200	0.01	0.46
4200 - 4400	0.27	0.44
4400 - 4600	0.69	0.54
4600 - 4850	3.9	1.01
4850 - 5100	7.3	0.72
5100 - 5350	16.8	0.66
5350 - 5600	22.6	0.67
5600 - 5850	21.8	0.72
5850 - 6100	14.1	0.64
6100 - 6350	8.8	0.74
6350 - 6600	2.9	0.65
6600 - 7100	0.87	1.43
7100 - 7600	0.03	1.7
7600 - 10000	0.00	27.7

TYPE GAE6, 250w. COMPACT SOURCE LAMP



PROVISIONAL

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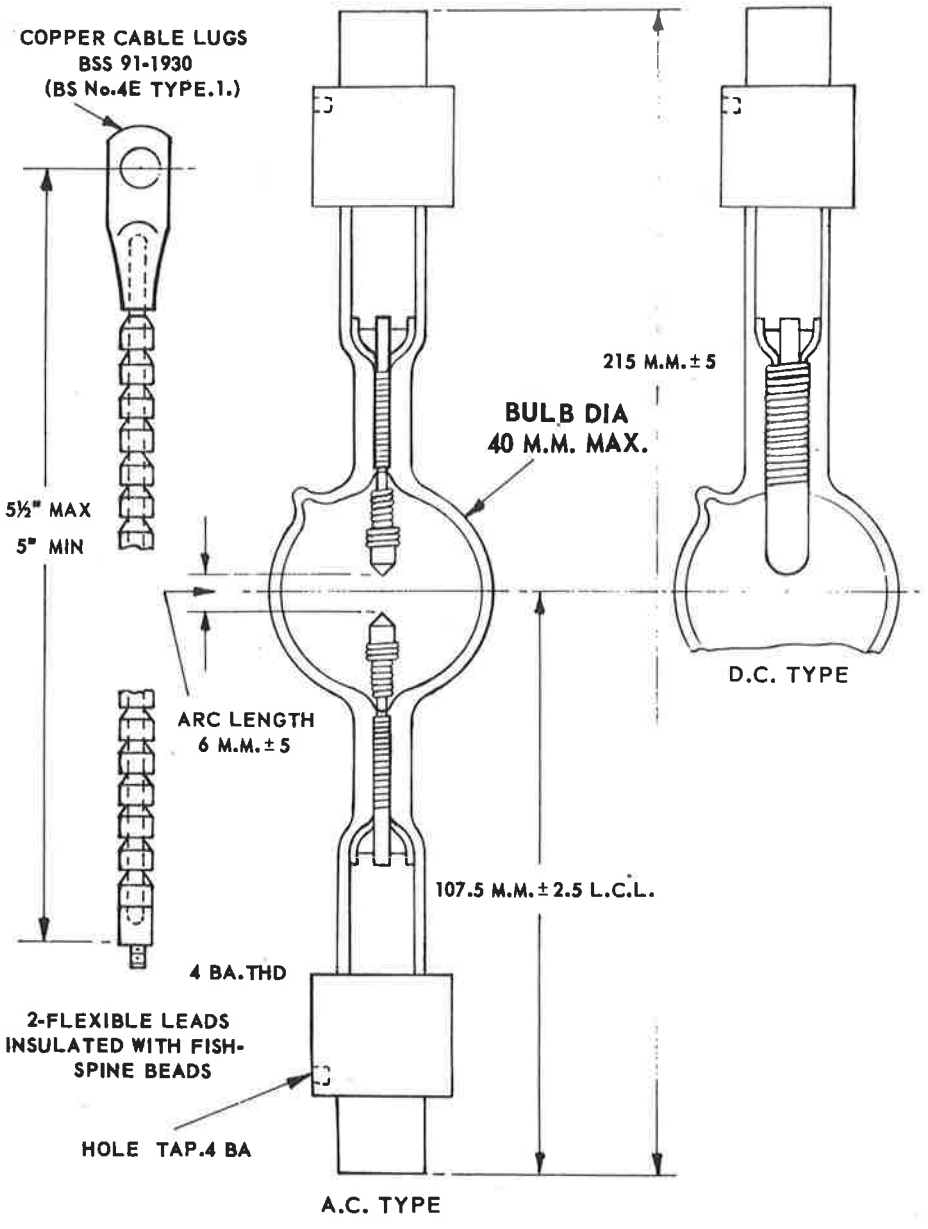
- 375w

500w

TYPE XC. COMPACT SOURCE XENON LAMPS



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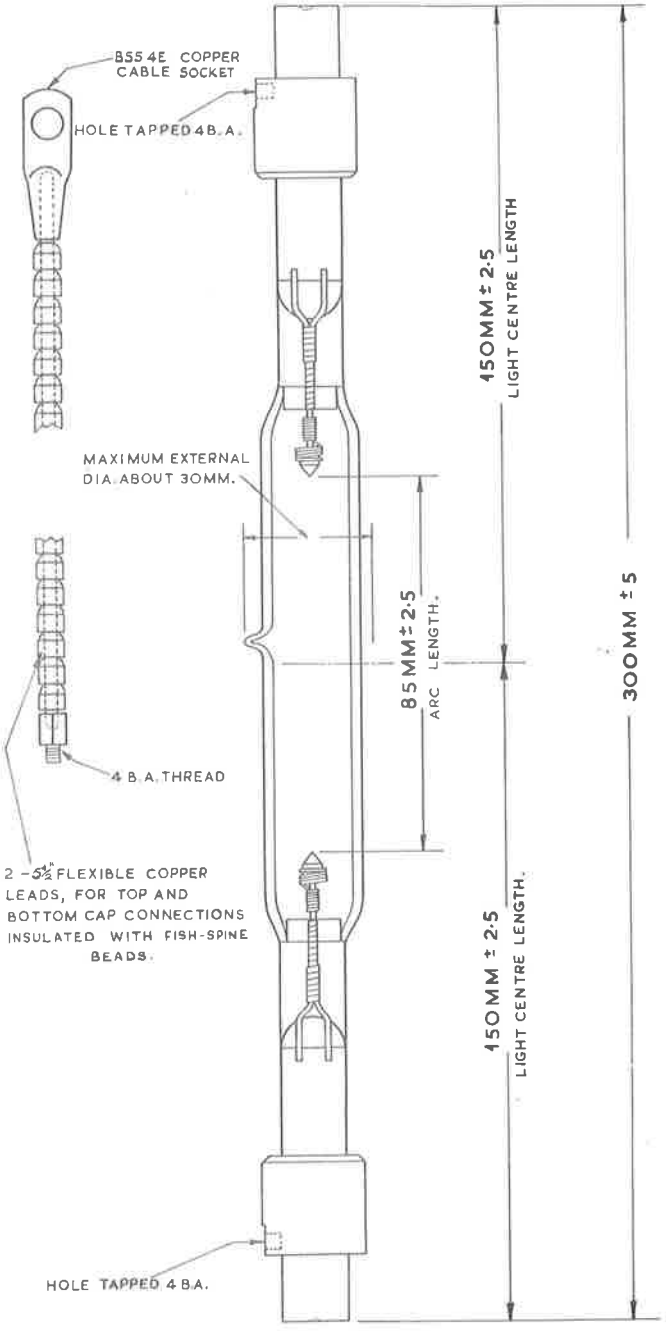
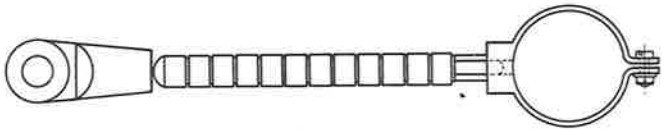
1 KW TYPE XB

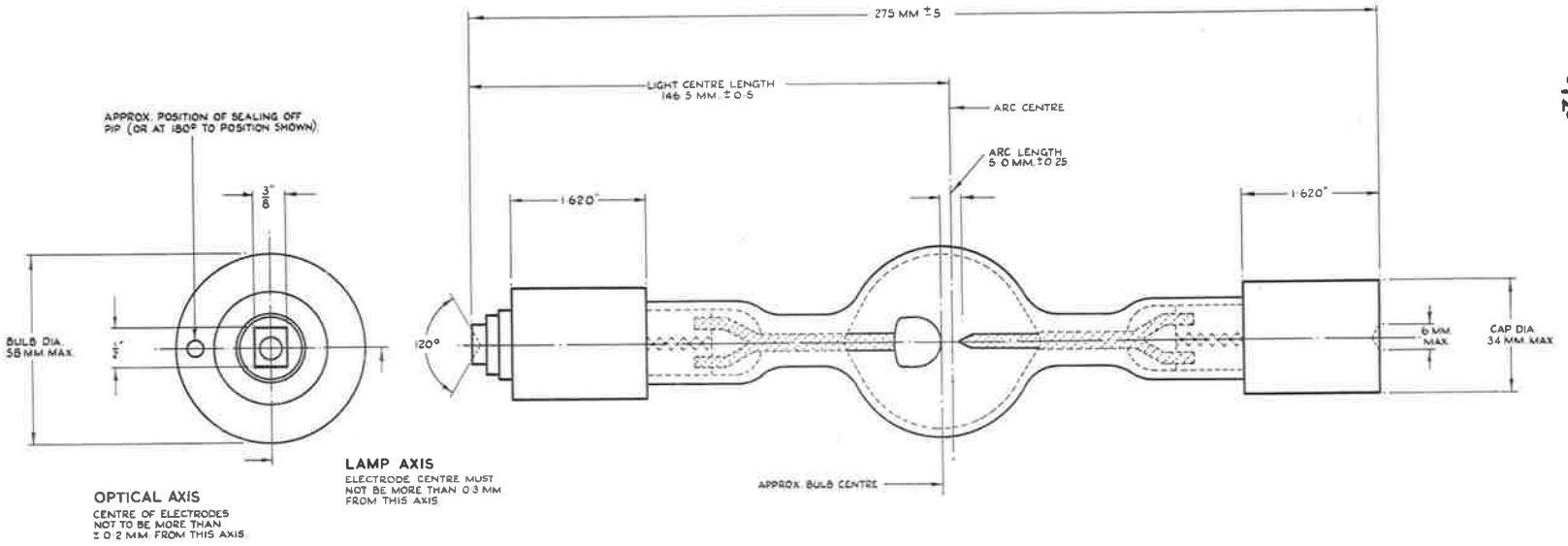
LINEAR SOURCE XENON LAMP



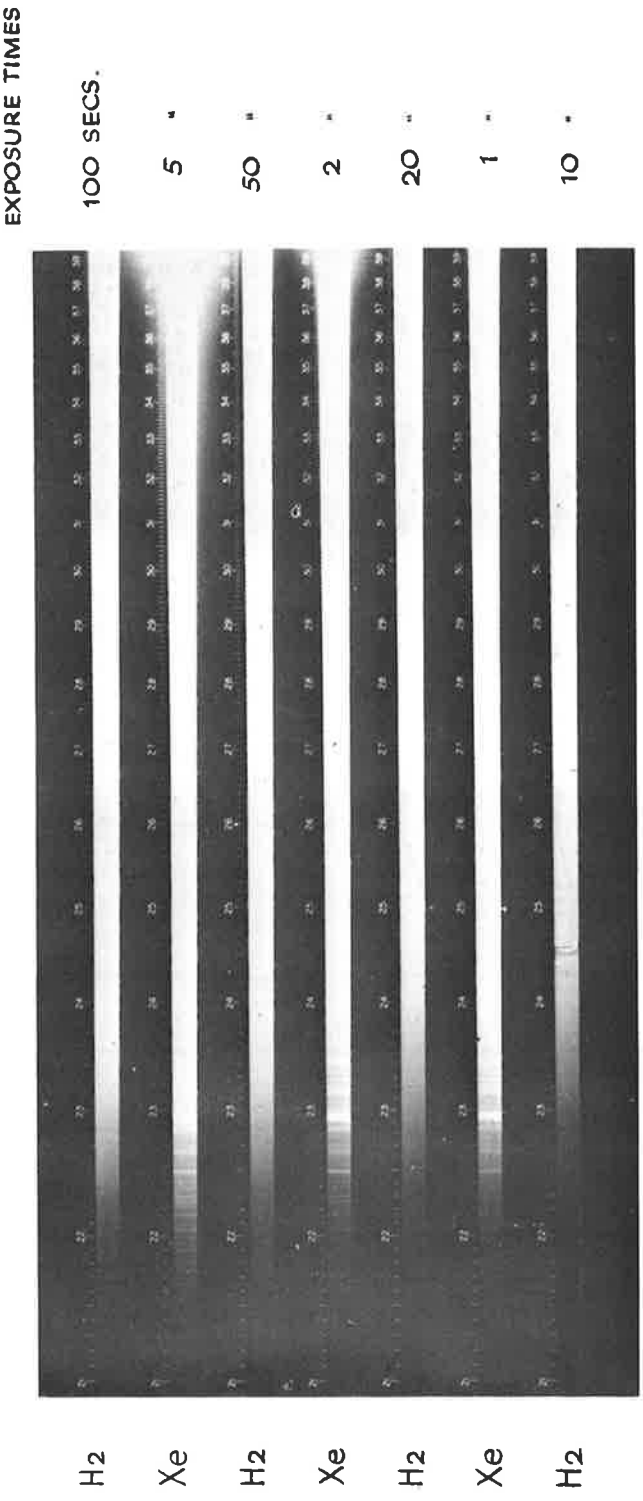


1.75KW TYPE GAE7 COMPACT SOURCE LAMP

CLIP & LEAD ASSEMBLY



PROVISIONAL


EXPOSURE TIMES
100 SECS.
5 "
50 "
2 "
20 "
1 "
10 "
H2
Xe
H2
Xe
H2
Xe
H2

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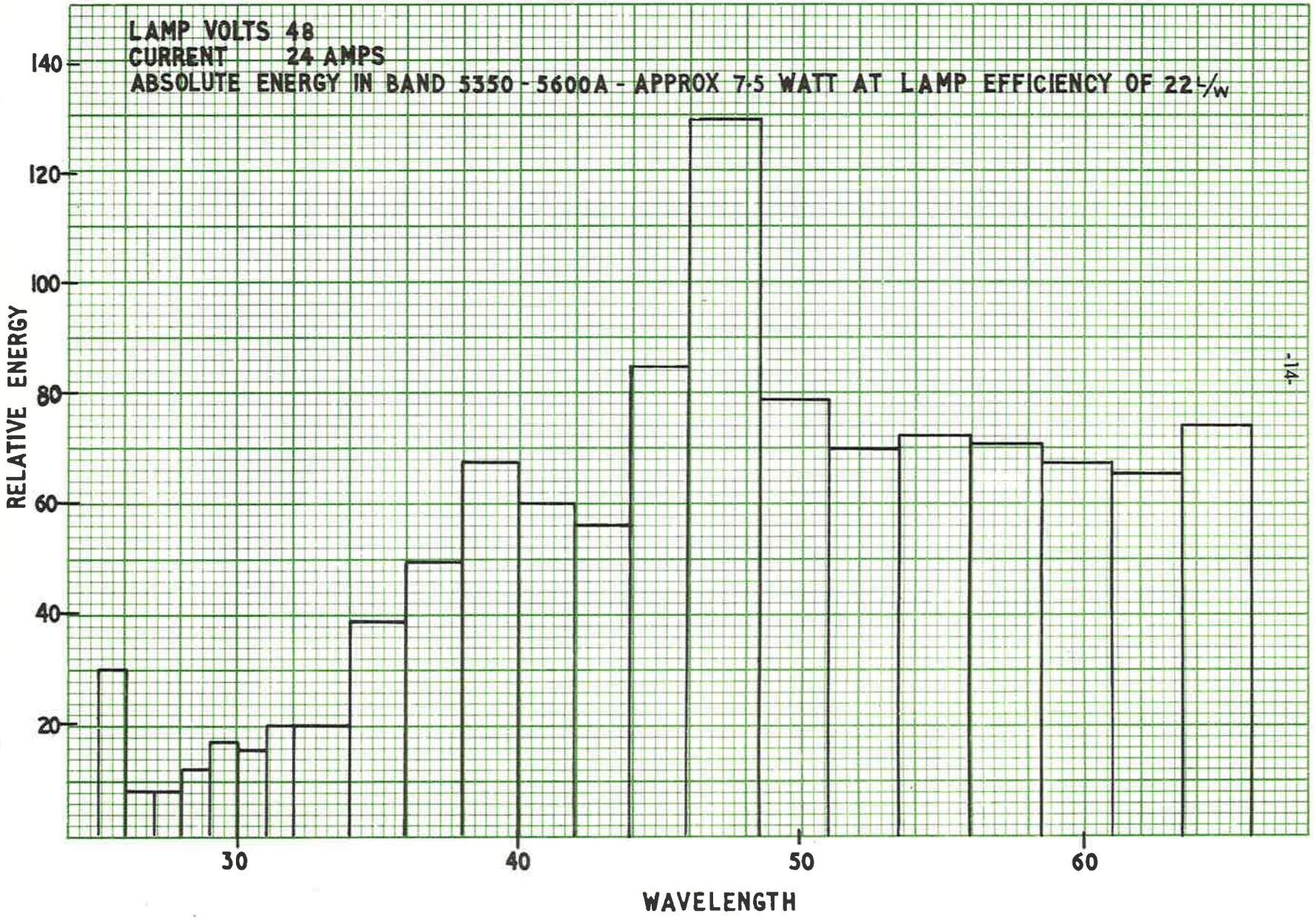
TYPICAL SPECTRAL ENERGY DISTRIBUTION XB/U GAS ARC 1000 WATT



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CHARACTERISTICS OF XENON LAMPS.

	1Kw. XB	375w. XC	500w. XC	250w. GAE 6	1750w. GAE 7
Electrical Supply*	200/250 Volts A.C.	200/250 Volts A.C.	200/250 Volts A.C.	200/250 Volts A.C.	65v D.C. Minimum
Maximum Rating (watts)	1000	375	500	250	1750
Lamp Current (amps)	25	25	25	15	70
Luminous Efficiency (lumens per watt)	25	22	25	25	34
Centre Arc Luminance (stilbs)	150	5,000	9,000	12,000	70,000
Life (hours)	500	500	500	500	1,000
Operating Position	Vertical (±15°)	Vertical (±15°)	Vertical (±15°)	Vertical (±15°)	Vertical (±15°)
Approx. Arc Size (m.m.)	85 x 10	6 x 4	6 x 3	3 x 2	5 x 4
Approx. Capacity to give .85 P.F. (microfarads)	300	300	300	200	-
Mains Current with above capacity (amps)	5	2	3	1.5	-
Starter Type	HFS 7	HFS 7	HFS 7	HFS 7	HFS 7 with Shorting switch
Chokes	1 - GME 1000 & 2 - GME 250	1 - GME 1000 & 2 - GME 250	1 - GME 1000 & 2 - GME 250	1 - GME 1000	-

* The power factor correction capacitor and choke sizes are suitable for 200/250 volts A.C. mains. In all cases the above lamps can be supplied in D.C. forms. With the type XC lamps lower D.C. line voltages may be tolerated.