In papers [1-6] one can find information on radiant energy measurements and the spectral composition of the emission of some pulsed light sources. The fullest survey of time-integrated characteristics of serially discharged, tubular pulsed lamps, is presented in [5]. For many applied problems using powerful pulsed light sources, one needs to know not only the integrated quantities characterizing the radiation, but also the instantaneous power emitted by the lamps over various spectral intervals. Knowing the absolute power of a lamp operated under rating conditions simplifies calculations for many optical systems.

This paper gives the results of absolute energy measurements for the IPKSh-580/20 lamp (an analog of the IFP-20000) in the 430-920 nm region of the spectrum, which approximately corresponds to the absorption bands of Nd\textsuperscript{3+}-activated glass. Brightness temperatures at different wavelengths in a broad region of the emission spectrum of the lamp were measured by means of comparison with a standard source. The brightness over the spectral interval $\lambda_1 - \lambda_2$ (W/cm\textsuperscript{2}·steradian) was then computed graphically.

The radiant power of the lamp, equal to the luminous flux emitted from a flat surface of the cylinder (the lamp envelope), was calculated from [7]

$$ P = \pi^2 B d l,$$

where $B$ is the brightness over the spectral interval $\lambda_1 - \lambda_2$; $d$ is the diameter of the column of radiating plasma; and $l$ is the length of the lamp.

The photoelectric recording method allowed us to perform time resolution and to determine instantaneous values of the power.

Experimental arrangements are shown in Fig. 1. The lamp, A, was projected with a small reducing lens ($y = 0.88$) $L_2$ onto the entrance slit of a DMR-4 double monochromator.

At the monochromator exit we mounted an FEU-28 photomultiplier, from which the signal was fed to an SI-19 oscillograph. The 15 mm high entrance slit admitted a strip of the image of the lamp along its entire diameter, cutting off only the image of the quartz walls of the lamp column. The entire projecting optical system was chosen so that the luminous flux from the lamp and from the image of the reference source capillary would fall on the slit of the monochromator subtending one and the same solid angle.

The entire spectral interval from 430 to 920 nm was divided into 10 sections, corresponding to the completely open exit slit of the DMR-4, i.e., 4 mm. The width of the entrance slit was 0.06 mm. Thus, the brightness was measured averaged over a spectral interval of 40-90 nm (depending on the region of the spectrum), including both continuous emission and lines. The 630-670 nm regions was excluded from the measurements because the standard has a strong absorption line, $H_\alpha$, distorting its spectral distribution. In later calculations, the brightness temperature in this region was taken to be 11,000 K.

In order to measure the brightness of our source, it was necessary to compare signals from the lamp and from the absolute black body coming from the same area and subtending the same solid angle. Since in our experiment it was not the capillary itself, but rather its image which served as a practical reference source, before we started treating the data the brightness of the image had to be calibrated from the source itself.


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Fig. 1. Measuring system for the absolute radiant energy of the IPKSh-580/20 lamp. ABB is the standard source (type EV-45); $L_1$ and $L_2$ are the illuminating lenses, with focal lengths 160 and 140 mm, respectively; $A$ is the lamp under study or an enlarged image of the "bore" of the ABB; $A'$ is the image of the lamp (or of the ABB "bore"); $F$ is the slit of the DMR-4 monochromator; $S$ is a mirror in the DMR-4.

Fig. 2. Light pulse from an IPKSh-580/20 lamp in the 780-850 nm region.

Fig. 3. Energy emitted by the lamp in the 430-920 nm band: 1) power ($P \cdot 10^{-8}$ W); 2) energy.

The standard source was set up according to the EV-45 scheme of Podmoshenskii and Ogurtsova [8]. The parameters of the scheme were verified before we began our work. The magnitude of the current, which was measured by means of the shunt described in [9], was 10,000 A, and the current and light pulses had a square-wave form.

The IPKSh-580/20 lamp was powered from a bank of K41-I7 capacitors having a total capacitance of 1800 $\mu$F. The inductance of the discharge circuit was 190 $\mu$H, and the voltage was 4.5 kV. At its maximum, the discharge current was 5000 A. This system corresponds to an input energy density of $w = 160$ J/cm$^2$. The duration of the light pulse, measured at 0.35 of the peak intensity, was 900 $\mu$sec. Xenon pressure in the lamp was 250 mm Hg.

A sample lamp-flash oscillogram is shown in Fig. 2. From special measurements it is known that in our setup for firing the lamp (the triggering pulse is carried along a metallic wire drawn along the entire lamp), the rise is 220 $\mu$sec. The flash maximum occurs after 400-450 $\mu$sec, and then the signal slowly drops.

The results of brightness temperature measurements corresponding to 400 $\mu$sec are presented in Table 1. The results show that in the visible region of the spectrum, the brightness temperature is about 12,000$^\circ$K. The increase in temperature to 16,000-17,000$^\circ$K, as one goes to the infrared, is probably associated with the presence of intense xenon lines in the infrared region.

A curve of the brightness distribution of the radiation from the IPSKSh-580/20 lamp was constructed using measured brightness values for the lamp and for the absolute black body (ABB) and a Planck curve for $T = 40,000^\circ$K. Values of the radiated power of the lamp corresponding to particular spectral intervals were then determined by graphical integration. The results of these calculations are given in Table 2. Afterwards, a plot of the change in radiated power over the period of the flash was made, and by graphical integration the energy radiated by the lamp in the 430-920 nm band was found (Fig. 3). It amounted to 7.85 kJ. The integration was carried out as far as 1.7 msec.

### Table 1. Brightness Temperatures of Radiation from the IPKSh-580/20 Lamp

<table>
<thead>
<tr>
<th>Spectral Interval $\Delta \lambda$, nm</th>
<th>$\lambda_{av}$, nm</th>
<th>$T_B$, $^\circ$K</th>
<th>Spectral Interval $\Delta \lambda$, nm</th>
<th>$\lambda_{av}$, nm</th>
<th>$T_B$, $^\circ$K</th>
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</thead>
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<tr>
<td>430-470</td>
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<td>11800</td>
<td>670-740</td>
<td>700</td>
<td>11400</td>
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<tr>
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<td>740-790</td>
<td>760</td>
<td>11400</td>
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<tr>
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<td>11900</td>
<td>790-850</td>
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<td>850-920</td>
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<tr>
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<td>10900</td>
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