The object of light and optical measurements should be considered to consist of determining the basic quantities which characterize luminous radiations, the properties of the medium when it is affected by light, and the parameters of the luminous radiations' detectors.

The basic characteristics of the sources of light consist of the radiated power, wavelength, directivity of radiations, and the degree of polarization. The interaction of the medium with luminous radiations is determined by the optical properties of the medium such as refraction, capacity to change the direction of plane polarization, double refraction, and the capacity to absorb or reflect light. The parameters of detectors consist of their integral and spectral sensitivity. It is only the knowledge of these precise metrological characteristics of the system of source-medium-detector that enable one to evaluate correctly the operation of any given measuring instrument, equipment, or device.

The problems of measuring the above characteristics and parameters of such a system, and the creation of reference and standard equipment for reproducing various quantities in photometry and optical measurements are dealt with in the work carried out by the photometric and optical laboratory of the VNIIM (All-Union Scientific Research Institute of Metrology). Moreover, the measurements related to the power and directivity of radiations, the reflecting and absorbing capacity of the medium, and the parameters of thermoelectric and photoelectric detectors are dealt with in photometry. The measurements of wavelengths, the refractive indexes, the rotation angle of the polarization plane, double refraction, and the characteristics of certain optical systems, as well as the study of the properties of photographic materials, detectors of radiation, and of its distribution in space, belong to the sphere of optics.

Work in the Sphere of Photometry. Present-day light technology is characterized by a rapid development of new sources of light, physical radiation detectors, and physical measuring methods. Sources are distinguished by the particular features of their light and electrical characteristics. Radiation detectors differ in their characteristics and principles of operation. The application of physical detectors in combination with complicated electronic circuits provides a high relative precision in measuring radiation power, and extends measurements to ranges adjacent to the visual part of the spectrum.

The maintenance of uniform luminous measurements in our country and agreement between our measurements and those made abroad require the raising of the precision in reproducing and transferring light units, establishing in certain cases new methods for their transmission, as well as developing and investigating special measuring methods and equipment.

In view of the complicated spectral composition of the new light sources and the wide application of different detectors, spectral measurements of the light source and radiation detector characteristics are becoming important. The extension of the spectral range, the picking out of more or less narrow or, on the contrary, wide sections of the spectrum for evaluating radiations, the necessity of such evaluations either independently of the radiations detector spectral sensitivity, or according to the sensitivity of detectors of various types—all these problems determine the establishment of a base for measuring radiation power, establishing reference standards for reproducing energy units, and for an appropriate transfer of their values.

The basic work of the VNIIM in the field of light measurements developed in the last ten years along these lines. This work includes above all the development of reference standards, of precise physical methods for light measurements (including the testing of the detectors' measuring properties), of methods for measuring various characteristics of light sources, etc. The principal attention was paid to work with reference standards, which is of outstanding importance.

It is known that light measurements are based on a primary luminous reference standard consisting of a complete radiator at the freezing temperature of platinum as specified by the adopted international recommendation [1]. However, the transfer to this standard which in principle is far superior to the previous one (consisting of a group of incandescent lamps) did not at first raise appreciably the precision in reproducing light units. A prolonged study of this standard's errors was required before any stable and reproducible results could be obtained from it. The very first experiments indicated a substantial effect of the unequal distribution of high-frequency heating (which led to a dispersion of ±2% or more in the measured values of the light standard's luminance), and the ambiguity of the transmission factor values, which is produced in the optical system of the standard by the depositing of dust during measurements.

The most substantial lowering of these errors was attained by the following measures. In order to obtain a more uniform temperature in the metal mass and inside the cavity and, hence, in order to ensure more stable and definite values in reproducing the standard luminance, the lagging of the container was increased considerably, the melting conditions were slowed down, especially the initial heating up of the container, and (which is most important) the high-frequency furnace helix was continuously displaced along the axis of the platinum ingot.

In order to eliminate the above-mentioned ambiguity in the optical system's transmission factor, a new photoelectric equipment was made suitable for evaluating the final changes in the transmission factor of the optical equipment during melting. Moreover, the improved schematic was fitted, in addition to the eyepiece photometer, also with a photoelectric equipment whose vacuum photocell is highly sensitive and stable, thus raising the precision in measuring the luminance of the complete radiator [2].

As a result of this work the laboratory precision of reproducing the complete radiator's luminance was substantially raised and, in particular, the deviations from the mean value of luminance, which previously amounted to ±2-3%, were now reduced to a value below ±1%. The values of the melting and freezing plateaus coincided within ±0.05-0.1%, which indicates the accuracy of the measured values.

However, despite such a substantial improvement in precision, the agreement among the measured data on an international scale is as yet far from the above level. The discrepancy among the data of eight national laboratories (which estimate their measurement errors to be of the same order as that of VNIIM) lies in the range of approximately 1.5%. An attempt to account for the specific features of the measuring equipment and methods of various laboratories made in 1962-63 has not so far led to any substantial improvement. Therefore, further research in this respect is still necessary. The latest decision of the Consultative Committee on Photometry proposes a stricter coordination of the containers with platinum and of the complete radiator's cavity.

Owing to the difficulties in the work with the primary light standard, it has become necessary to look for parallel methods of reproducing light units [3, 4].

It has been established theoretically for a long time that it is possible to reproduce light units by means of a reference standard radiations detector, instead of a standard source, on the basis of the well-known expressions which relate luminous quantities \( F \) with energy quantities \( P \) by the relative visibility factor \( v_\lambda \) and the light equivalent \( K_m \) of radiant power:

\[
F = K_m \int P_\lambda v_\lambda d_\lambda .
\]

This condition can be met by a nonselective absolute detector provided with a noncorrecting filter whose transparency is similar to the relative visibility curve. The advantage of this method as compared with other possible methods consists of the relative low precision in energy measurements and the small values of the radiation fluxes subject to measurement.

The light equivalent of radiant energy was determined at the VNIIM in 1957 [5]. The latter quantity was found from the readings of a thermopile which had a correcting absorber with a transparency similar to the relative