Questions of the unity, regularity, and accuracy of pH measurements have great significance for controlling technological processes and production in a number of branches of industry and agricultural economy. These processes can be satisfactorily classified as water purification, extraction of milk-acid products, supervision over thermal energy equipment systems, and determination of soil acidity. pH-Meters were found to be extremely popular analytical instruments. A special survey showed, for example, that, in the Ukrainian SSR, pH-meters comprise close to 83% of all the analyzers of the properties and content of liquids. Thus, standardizing pH measurements should be considered as one of the most important problems of physicochemical measurements.

The concept of standardizing pH measurements had its inception in our country with the development of an operating version of a checking circuit for pH-meters, which included an upper standard unit intended for reproducing original measures, the transmission of the meanings and magnitudes of pH units from the original measures to sample means and apparatus for checking operational measurement means. This checking circuit design was proposed as the basis of our metrological projects and standardization of pH measurements. As a result, the checking circuit was adopted with some refinements and simplifications which did not alter the basic design [1]. All the elements comprising the circuit for reproducing the original measures and the transmission of measurement units to the operating instruments remained unchanged. A description of these elements is detailed below.

Reproducing Original Measures. The carriers of the pH unit—buffer solutions with a known pH value—form the basis of standardizing pH measurements [2].

In order to establish the pH values of these buffer solutions, the most accurate measurement methods are used. The electrometrical method of measuring pH in circuits without transfer, by using a hydrogen-chlor silver element, was recognized as such a method.

The method has a well-established theoretical basis and, therefore, was adopted for certifying standard buffer solutions (original measures) and also for developing new original measures pertaining to the interesting limits of pH values at various temperatures. This method and other questions associated with deriving pH standards were developed and described in Soviet and foreign works [3, 4]. On the basis of this method an evaluation was made of the meaning of the pH value of original measures with an error of ± 0.01 pH unit [4], whereas at one time basic practical measurements, using pH-meters, were made with an error of 0.05-0.1 pH units. By using five buffer solutions [4], the pH scale from 1.68 to 9.18 pH at 25°C in the 0 to 95°C range was reproduced, and this was reflected in the All-Union State Standard 10170-62 for the pH scale and in the All-Union State Standard 10171-62 for buffer solutions which reproduce this pH scale.

Later, the need for pH measurements in medicine and biology, and also the development of pH-meters with increased accuracy by domestic industry, posed the problem of producing pH measurement means with an error of thousands of parts of a pH unit. This appeared possible to achieve in the case where, as the basis of the method of calculating the activity factors of the chlor-ion, the Beits-Guggenheim condition was stipulated, by virtue of which the value of the Debye-Hückel equation is assumed equal to $1.5 \text{kg}^{-1/2} \text{mole}^{1/2}$ with an ion strength $I \leq 0.1$. Although the acceptance of this condition permitted increasing pH measurement accuracy, nevertheless it made an accurate pH scale conditional. This fact did not lessen the practical significance of introducing a more accurate pH scale.

In order to carry out all the projects enumerated above, and to maintain henceforth the required level of accuracy of practical pH measurements, a standard unit was produced, whose general appearance is shown in Fig. 1 and Fig. 2.

The arrangement includes a measurement unit, a unit for purifying hydrogen, and a thermostating unit for preliminarily impregnating the solution with hydrogen. A P-37 high-resistance potentiometer, a standard 0.005 class element, and an M-195/2 galvanometer are used in the arrangement's compensating circuit. The unit permits making emf measurements with an error up to 0.02 mV, which corresponds approximately to 0.0003 pH units.

The independent part of the unit is a specially developed TB-3 thermostat, which is a three-cell system with a thermostating liquid capacity close to 140 liters. The thermostat has a cooling chamber (from +4 to 20°C) with an FAK-07 cooling plant evaporator mounted in it, a heating chamber (from 20 to 95°C) where two heaters are located—the basic one and a general one with a power of ~3 kW for forced heating, and an operating chamber with three screens which provide thermostating reliability. All the chambers have heat insulation [6].

Three electrolytic elements are immersed simultaneously in the thermostat's operating chamber. The glass electrolytic element consists of two communicating vessels, connected in the lower part by a glass tube. A hydrogen electrode is immersed in one of the vessels, and two chlorisilver electrodes are immersed in the other. The element's structure permits it to be placed in the thermostat at a depth up to 35 cm, which provides the necessary constant temperature of the solution being examined. The solution's temperature is measured directly in the element by equiscaled mercury thermometers having a scale value of 0.01°C in the 0-60°C range and 0.02°C in the 60-95°C range. The construction of the thermostat and of the electrolytic elements ensures the solution's constant temperatures in the elements up to 0.02°C in the 10-60°C range and 0.03-0.04°C in the 0-10°C and 60-95°C ranges. A temperature change of 0.02°C corresponds to a change in the pH value of ~0.0002 pH units.

In the precision arrangement described above, pH values of buffer solutions were obtained with an error up to ±0.002 pH units in the 6-8 pH region, which is important for medical-biological research. In this region, pH values