U. S. Department of Commerce
Maurice H. Stans
Secretary

National Bureau of Standards
L. M. Branscomb, Director

Certificate of Analysis

STANDARD REFERENCE MATERIAL 1513
for
Determination of Dielectric Constant*
Nitrobenzene**

C. G. Malmberg and M. G. Broadhurst

This Standard Reference Material is intended for use in the calibration of cells and test capacitors for the determination of the dielectric constants of liquids. The nitrobenzene was obtained from Matheson, Coleman, and Bell of Norwood, Ohio, and was modified by treatment with activated aluminas. It is not purported to be a standard for purity and is not free of traces of water.

The dielectric constant*, ϵ, measured on representative bottled samples was:

at 20 °C	35.7037 ± 0.0010
25 °C	34.7416 ± .0010
30 °C	33.8134 ± .0030

*(This quantity is also called relative permittivity. The values given are relative to vacuum, not to air.)

The uncertainties listed represent the maximum deviation of the observed values from the measured mean. The standard deviation of the mean of 14 measurements at 30 °C was ± 0.0012 unit. From a summation of the probable uncertainties due to known sources of error in the measurements, the values of ϵ listed above are estimated to be accurate to ± 0.04 percent or better. From the equation

$$\epsilon^t = 39.9278 - 0.226899\, t + 8.0801 \times 10^{-4} t^2 - 1.267 \times 10^{-6} t^3$$

where t is the temperature in °C, relative values of the dielectric constant, ϵ, in the range 10 ° to 40 °C may be calculated without significant error.

The work leading to the certification of this Standard Reference Material was performed in the Polymers Division, Institute for Materials Research, National Bureau of Standards.

Washington, D. C. 20234
September 17, 1969

J. Paul Cali, Acting Chief
Office of Standard Reference Materials

**This material is very toxic and should be handled accordingly. (N. Irving Sax: Dangerous Properties of Industrial Materials, 3rd Edition, Reinhold Publishing Co., New York, N. Y., 1968)

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METHOD OF MEASUREMENT: Measurements of the dielectric constant were made in the frequency range 0.75 to 12 kHz using a Type 1615-A capacitance bridge, manufactured by General Radio Co., along with two three-terminal cells designed for "absolute" measurements of the dielectric properties of liquids. An oil bath controlled to within 0.01 °C was used to thermostat the cells. A suitable resistance thermometer and "Mueller" bridge were used to determine the temperature of the bath.

Electrode polarization leads to an apparent increase of unpredictable magnitude in the measured dielectric constant. The certified values were obtained by measuring ϵ' (apparent) at three or more frequencies, plotting these against $(\text{frequency})^{-1}$ and extrapolation to $(\text{frequency})^{-1}$ equals zero. The electrolytic conductivity observed at 30 °C on these samples ranged from 0.75 to 1.5×10^{-9} mho cm^{-1}.

DISSOLVED MOISTURE: Gain or loss of dissolved water will shift the dielectric constant of this sample. Test measurements at 25 °C showed an increase in ϵ of 0.17 percent between nitrobenzene dried over "Drierite" and those saturated with water at 21 °C. However, in normal use (with limited exposure to air up to 65 percent relative humidity) the moisture change in this sample can be expected to lead to an uncertainty of less than 0.01 percent.