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Standard Guide for Use of Freezing-Point Cells for Reference Temperatures¹

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INTRODUCTION

During freezing, pure material transforms from the liquid state to the solid state at a constant temperature known as the freezing point. The freezing points of highly purified materials can serve as reference temperatures, and in fact, the International Temperature Scale of 1990 (ITS-90)² relies on the freezing points of some highly purified metals as defining fixed points. Freezing points can be realized in commercially available systems incorporating freezing-point cells. When the cells are properly made and used, they establish useful reference temperatures for the calibration of thermometers and for other industrial and laboratory purposes; with care, the freezing points of highly purified materials can be realized with an uncertainty of a few millikelvins³ or less.

1. Scope

1.1 This guide describes the essential features of freezing-point cells and auxiliary apparatus, and the techniques required to realize freezing points in the temperature range from 29 to 1085 °C.³

1.2 Detailed design and construction are not addressed in this guide.

1.3 This guide is intended to describe good practice and establish uniform procedures for the realization of freezing points.

1.4 This guide emphasizes principles. The emphasis on principles is intended to aid the user in evaluating cells, in improving technique for using cells, and in establishing procedures for specific applications.

1.5 For the purposes of this guide, the use of freezing-point cells for the accurate calibration of thermometers is restricted to immersion-type thermometers that, when inserted into the reentrant well of the cell, (1) indicate the temperature only of the isothermal region of the well, and (2) do not significantly alter the temperature of the isothermal region of the well by heat transfer.

1.6 This guide does not address all of the details of thermometer calibration.

1.7 This guide is intended to complement special operating

instructions supplied by manufacturers of freezing-point apparatus.

1.8 The following hazard caveat pertains only to the test method portion, Section 7, of this guide. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 344 Terminology Relating to Thermometry and Hydrometry⁴

E 644 Test Methods for Testing Industrial Resistance Thermometers⁴

3. Terminology

3.1 *Definitions:*

3.1.1 *reference temperature, n* —a fixed, reproducible temperature, to which a value is assigned, that can be used for the calibration of thermometers or other purposes.

3.1.2 Additional terms used in this guide are defined in Terminology E 344.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *first cryoscopic constant, A, n* —a constant of proportionality between the freezing point depression of, and concentration of impurities in, a sample of reference material, given by the ratio of the molar heat of fusion of the pure material, L , to the product of the molar gas constant, R , and the square of the thermodynamic temperature of fusion, T , of the pure material (freezing point):

¹ This guide is under the jurisdiction of ASTM Committee E-20 on Temperature Measurement and is the direct responsibility of Subcommittee E20.07 on Fundamentals in Thermometry.

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² Preston-Thomas, H., "The International Temperature Scale of 1990 (ITS-90)," *Metrologia*, Vol 27, No. 1, 1990, pp. 3-10. For errata see *ibid*, Vol 27, No. 2, 1990, p. 107.

³ In this guide temperature intervals are expressed in kelvins (K) and millikelvins (mK). Values of temperature are expressed in degrees Celsius (°C), ITS-90.

⁴ *Annual Book of ASTM Standards*, Vol 14.03.