

# Chapter 1—Introduction

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## **First Edition, 1970**

This manual was prepared by Subcommittee IV of ASTM Committee E-20 on Temperature Measurement. The responsibilities of ASTM Committee E-20 include “Assembling a consolidated source book covering all aspects relating to accuracy, application, and usefulness of thermometric methods.” This manual was addressed to the thermocouple portion of this responsibility.

The contents include principles, circuits, standard electromotive force (emf) tables, stability and compatibility data, installation techniques, and other information required to aid both the beginner and the experienced user of thermocouples. While the manual is intended to be comprehensive, the material, however, will not be adequate to solve all the individual problems associated with many applications. To further aid the user in such instances, there are numerous references and an extensive bibliography. In addition to presenting technical information, an attempt is made to properly *orient* a potential user of thermocouples. Thus, it is hoped that the reader of this manual will make fewer mistakes than the nonreader.

Regardless of how many facts are presented herein and regardless of the percentage retained, all will be for naught unless one simple important fact is kept firmly in mind. The thermocouple reports only what it “feels.” This may or may not be the temperature of interest. The thermocouple is influenced by its entire environment, and it will tend to attain thermal equilibrium with this environment, not merely part of it. Thus, the environment of each thermocouple installation should be considered unique until proven otherwise. Unless this is done, the designer will likely overlook some unusual, unexpected, influence.

Of all the available temperature transducers, why use a thermocouple in a particular application? There are numerous advantages to consider. Physically, the thermocouple is inherently simple, being only two wires joined together at the measuring end. The thermocouple can be made large or small depending on the life expectancy, drift, and response-time requirements. It may be flexible, rugged, and generally is easy to handle and install. A thermocouple normally covers a wide range of temperatures, and its output is reasonably linear over portions of that range. Unlike many temperature transducers, the thermocouple is not subject to selfheating problems. In

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practice, thermocouples of the same type are interchangeable within specified limits of error. Also, thermocouple materials are readily available at reasonable cost, the expense in most cases being nominal.

The bulk of the manual is devoted to identifying material characteristics and discussing application techniques. Every section of the manual is essential to an understanding of thermocouple applications. Each section should be studied carefully. Information should not be used out of context. The general philosophy should be—let the user beware.

### **Second Edition, 1974**

In preparing this edition of the manual, the committee endeavored to include four major changes which greatly affect temperature measurement by means of thermocouples. In 1968, at the same time the First Edition was being prepared, the International Practical Temperature Scale was changed. This new scale (IPTS-68) is now the law of the land, and Chapter 8 has been completely rewritten to so reflect this. In 1972–1973, new Thermocouple Reference Tables were issued by the National Bureau of Standards. Accordingly, Chapter 10 has been revised to include the latest tables of temperature versus electromotive force for the thermocouple types most commonly used in industry. Also, along these same lines, the National Bureau of Standards has issued new methods for generating the new Reference Table values for computer applications. These power series relationships, giving emf as a function of a temperature, are now included in Chapter 10.3. Finally, there have been several important changes in thermocouple material compositions, and such changes have been noted in the appropriate places throughout the text. The committee has further attempted to correct any gross errors in the First Edition and has provided a more complete bibliography in Chapter 12.

### **Third Edition, 1980**

This edition of the manual has been prepared by ASTM E-20.10, the publications subcommittee. The main impetus for this edition was the need for a reprinting. Taking advantage of this opportunity, the editors have carefully reviewed each chapter as to additions and corrections called for by developments in the field of temperature measurement by thermocouples since 1974. Chapters 3, 4, 5, 6, 7, and 8 have been completely revised and strengthened by the appropriate experts. An important addition is Chapter 12 on Measurement Uncertainty. This reflects the trend toward a more statistical approach to all measurements. A selected bibliography is still included at the end of each chapter. A final innovation of this edition is the index to help the users of this manual.