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GUIDELINES FOR DECISION RULES: CONSIDERING MEASUREMENT UNCERTAINTY IN DETERMINING CONFORMANCE TO SPECIFICATIONS

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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FOREWORD

The intent of these guidelines is to facilitate the development of understanding between suppliers and customers regarding measurement uncertainty in the decision to accept or to reject a product. Metrologists are continuously faced with the task of making decisions in the presence of measurement uncertainty. To formalize this task, procedures known as decision rules have been developed. A decision rule is a prescription for the acceptance or rejection of products based on the measurement result of a characteristic of the product, the permissible variation associated with that characteristic, and the uncertainty of the measurement result. For workpieces, the permissible variation is commonly called the tolerance; for instruments it is often given by the specification limits or maximum permissible error (MPE). The terminology of ISO 14253-1 has been adopted and the permitted variation of a product's characteristic is referred to as the specification zone. This document is intended to provide guidance on decision rules and their implementation.

A related document, ASME B89.7.2-1999, Dimensional Measurement Planning, specifies requirements for preparation and approval of dimensional measurement plans and for the use of approved plans in making dimensional measurements. The dimensional measurement plan must contain or reference all information for making measurements, including specification of a decision rule. ASME B89.7.3.1 serves as a resource to the dimensional measurement planner by providing terminology and specifying the requirements for decision rules for use in dimensional measurement plans.

The Guide to the Expression of Uncertainty in Measurement, (GUM), NCSL Z540-2-1997 provides a unified means of evaluating and expressing the uncertainty of a measurement result; consequently the calculational details of evaluating the uncertainty of a measurement result will not be discussed. Unless otherwise stated, the term "measurement uncertainty" will be used to mean the expanded uncertainty, U, with a coverage factor of two, which is the most common coverage factor used nationally and internationally.

Although all traceable measurement results include an uncertainty statement not all measurement results involve decision rules. (See ISO International Vocabulary of Basic and General Terms in Metrology.) Many calibrations, particularly at National Measurement Institutes (NMIs), typically state a description of the measurement, its result, and its uncertainty; decision rules are not involved since there are no specifications. Most products, however, have stated specifications and a decision must be reached regarding the product's characteristic relative to its stated specifications.

The decision rule in use should be well documented to prevent ambiguity in the acceptance or rejection of product. The selection of a particular decision rule is ultimately a business decision; some of the factors to be considered are outlined in nonmandatory Appendices A and D.

The concept of a decision rule has a long history and over the years has developed many variations including "gauge maker's rule," "test accuracy ratio (TAR)," "test uncertainty ratio (TUR)," "four-to-one rule," "gauging ratio," "guard bands," "gauging limit," and many more. Most of these terms were defined before the development of the GUM and hence concepts such as "accuracy" or "uncertainty" were nebulously defined. One of the motivations of these guidelines is to explicitly define the decision rule concept and have some well-documented decision rules that can be referenced. Consequently, these guidelines have encapsulated some of the commonly used procedures and their specifically-named decision rules.

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