ASME B89.7.4.1-2005
(Technical Report)

Measurement Uncertainty and Conformance Testing: Risk Analysis

AN ASME TECHNICAL REPORT

The American Society of Mechanical Engineers

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CONTENTS

FOREWORD

The ISO Guide to the Expression of Uncertainty in Measurement (GUM) is now the internationally accepted method of expressing measurement uncertainty [1]. The U.S. has adopted the GUM as a national standard [2]. The evaluation of measurement uncertainty has been applied for some time at national measurement institutes; more recently, increasingly stringent laboratory accreditation requirements have increased the use of measurement uncertainty analysis in industrial calibration laboratories. In some cases, measurement uncertainty calculations have even been applied to factory floor measurements.

Given the potential impact to business practices, national and international standards committees are working to publish new standards and technical reports that will facilitate the integration of the GUM approach and the consideration of measurement uncertainty in product conformance decisions. In support of this effort, the ASME B89 Committee for Dimensional Metrology has formed Subcommittee 7 — Measurement Uncertainty.

Measurement uncertainty has important economic consequences for calibration and inspection activities. In calibration reports, the magnitude of the uncertainty is often taken as an indication of the quality of the laboratory, and smaller uncertainty values generally are of higher value and cost. In industrial measurements, uncertainty has an economic impact through the decision rule employed in accepting and rejecting products. ASME B89.7.3.1, Guidelines for Decision Rules: Considering Measurement Uncertainty in Determining Conformance to Specifications, addresses the role of measurement uncertainty when accepting or rejecting products based on a measurement result and a product specification.

With significant economic interests at stake, it is advisable that manufacturers guard against accepting bad products and rejecting good ones. Even with a very good measurement system, there will be some risk of decision errors, with cost impacts that vary depending upon the nature of the product and its intended end use. While the evaluation of measurement uncertainty is a technical activity well-described in the GUM, the selection of a decision rule is a business decision that involves cost considerations.

ASME B89.7.3.1 provides uniform, unambiguous terminology for documenting a decision rule. It describes the relationship between the conformance zone (locating conforming characteristics) and the acceptance zone (locating acceptable measurement results). This Technical Report addresses the problem of determining the gauging limits (or test limits) that define the boundaries of the acceptance zone. The limits are chosen to balance the risks of the two types of decision errors, whose relative magnitudes depend upon product-specific economic factors that are outside the scope of this Report.