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# Methods for Performance Evaluation of Articulated Arm Coordinate Measuring Machines

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda issued to this edition.

ASME will issue written replies to inquiries concerning interpretation of technical aspects of this Standard.



The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

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# FOREWORD

The ambiguity of articulated arm coordinate measuring machines (AACMM) specifications makes comparative evaluations of performance characteristics very difficult. Because of this and the increasing use of this class of measurement equipment, the ASME Standards Committee B89 elected to establish a USA industry standard applicable to these machines. At the October 1994 meeting, Project Team B89.4.22 was established to develop the Standard.

As far as possible, this Standard parallels ASME B89.4.1b-2001 for "conventional" coordinate measuring machines. An attempt has also been made to make the Standard compatible with existing and emerging international standards.

This Standard addresses the performance evaluation of AACMM by supplying definitions and test procedures. These procedures should enable users to determine if an AACMM is appropriate for their specific requirements. It should also provide accurate comparison of machines from different suppliers and provide a determination of whether an AACMM meets contractual requirements without negotiations after the machine has been purchased.

The intent of this Standard is to specify the simplest methods that can be used for reasonable performance evaluation. It is recognized that a more complex evaluation may be appropriate for special applications. These methods, however, must be specified in adequate detail in the AACMM specification.

This Standard was approved by the American National Standards Institute on August 9, 2004.

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## SPECIAL ACKNOWLEDGEMENT

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# CORRESPONDENCE WITH THE B89 COMMITTEE

**General.** ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions, and attending Committee meetings. Correspondence should be addressed to:

Secretary, B89 Standards Committee
The American Society of Mechanical Engineers
Three Park Avenue
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**Proposing Revisions.** Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

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The request for interpretation should be clear and unambiguous. It is further recommended that the inquirer submit his/her request in the following format:

| | |
|---|---|
| Subject: | Cite the applicable paragraph number(s) and provide a concise description. |
| Edition: | Cite the applicable edition of the Standard for which the interpretation is being requested. |
| Question: | Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. |

Requests that are not in this format may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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# METHODS FOR PERFORMANCE EVALUATION OF ARTICULATED ARM COORDINATE MEASURING MACHINES

## INTRODUCTION

The primary purpose of this Standard is to clarify the performance evaluation of articulated arm coordinate measuring machines (AACMMs). A secondary purpose is to facilitate performance comparisons between machines. Definitions, environmental requirements, and test methods are specified. This Standard defines the test methods capable of yielding adequate results for the majority of articulated arm coordinate measuring machines and is not intended to replace more complete tests that may be required for special applications.

## 1 SCOPE

The scope of this Standard pertains to the performance evaluation of articulated arm coordinate measuring machines. While any number of rotational joints can be evaluated, the Standard focuses on the more common configurations commercially available today and is limited to seven joints. The Standard addresses purely manual machines, so no motorized axes are addressed in the current document. While the application of this class of measuring machine continues to grow, at this point in time only contact probes are considered and optical noncontact probes are specifically excluded.

This Standard establishes requirements and methods for specifying and testing the performance of AACMMs. In addition to clarifying the performance evaluation of AACMMs, this Standard seeks to facilitate performance comparisons among machines by unifying terminology, general machine classification, the treatment of environmental effects, and data analysis. This Standard attempts to define the simplest testing methods capable of yielding adequate results for most AACMMs and it is not intended to replace more complete tests that may be suitable for special applications.

This Standard provides definitions of terms applicable to AACMMs. These definitions are separated into two parts. The first part is a glossary covering technical terms used throughout this and other ASME Standards. The second part defines a number of common machine classifications.

The actual specification is subdivided into three sections: general machine classification, machine environmental requirements, and machine performance. Machine classification includes machine type, measurement ranges, and rotary axis encoder resolution. Environmental specification includes thermal response, electrical requirements, and vibration sensitivity. Machine performance specification includes effective diameter test, single-point articulation performance, and volumetric performance tests.

Within this Standard, performance values are reported as the maximum deviation, the range, and the standard deviation. This is done to bring the Standard more into line with existing national and international standards.

In order to clarify the use of this Standard, a short guide on how to use it is included as Appendix A.

Productivity is an important consideration in the selection of an articulated arm coordinate measuring machine. There are numerous factors that affect the relative productivity of measuring systems, which include variables attributable to both the measurement system and the workpiece. This Standard does not address methods to specify and evaluate productivity. Productivity should be evaluated with respect to the expected use of the system, including such aspects as software, ergonomics, and the frequency of calibration.

### 1.1 Contents and Specification Forms

Any specification described as complying with this Standard shall include, as a minimum, the following items:

(*a*) a machine classification form (see Fig. 1). If no classification is applicable, the actual configuration shall be described in equivalent detail.

(*b*) an environmental specification form (see Fig. 2).

(*c*) a performance specification form (see Fig. 3).

### 1.2 Alternatives

This Standard allows parts of the environmental test section to be deferred or bypassed and only the performance tests to be carried out. This alternative is acceptable only if it is agreeable to both the user and the supplier, and if deferred as specified.

## 2 DEFINITIONS

### 2.1 Glossary

**2.1.1 Terms.** This glossary contains brief definitions of the majority of technical terms used in this Standard. Some of the definitions listed are used in the non-