

**ASME PTC 22-2014**  
**(Revision of ASME PTC 22-2005)**

# Gas Turbines

---

## Performance Test Codes

**AN AMERICAN NATIONAL STANDARD**



**The American Society of  
Mechanical Engineers**

**ASME PTC 22-2014**  
**(Revision of ASME PTC 22-2005)**

# Gas Turbines

---

## Performance Test Codes

**AN AMERICAN NATIONAL STANDARD**



**The American Society of  
Mechanical Engineers**

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: December 31, 2014

This Code will be revised when the Society approves the issuance of a new edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Code. Interpretations are published on the Committee Web page and under [go.asme.org/InterpsDatabase](http://go.asme.org/InterpsDatabase). Periodically certain actions of the ASME PTC Committee may be published as Cases. Cases are published on the ASME Web site under the PTC Committee Page at [go.asme.org/PTCcommittee](http://go.asme.org/PTCcommittee) as they are issued.

Errata to codes and standards may be posted on the ASME Web site under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be used on the date posted.

The PTC Committee Page can be found at [go.asme.org/PTCcommittee](http://go.asme.org/PTCcommittee). There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting “Errata” in the “Publication Information” section.

ASME is the registered trademark of The American Society of Mechanical Engineers.

This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not “approve,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assumes any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which precludes the issuance of interpretations by individuals.

No part of this document may be reproduced in any form,  
in an electronic retrieval system or otherwise,  
without the prior written permission of the publisher.

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

Copyright © 2014 by  
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS  
All rights reserved  
Printed in U.S.A.

# CONTENTS

|  |           |
|--|-----------|
| Notice .....   | v         |
| Foreword .....   | vi        |
| Committee Roster .....   | vii       |
| Correspondence With the PTC Committee .....                              | viii      |
| <b>Section 1 Object and Scope .....</b>                                  | <b>1</b>  |
| 1-1 Object .....   | 1         |
| 1-2 Scope .....  | 1         |
| 1-3 Test Uncertainty .....   | 1         |
| 1-4 Other Requirements and References .....                              | 2         |
| <b>Section 2 Definitions and Descriptions of Terms .....</b>             | <b>3</b>  |
| 2-1 General .....  | 3         |
| 2-2 Definitions .....  | 3         |
| <b>Section 3 Guiding Principles .....</b>                                | <b>7</b>  |
| 3-1 Agreements .....   | 7         |
| 3-2 Preparations for Test .....  | 10        |
| 3-3 Conduct of Test .....  | 11        |
| 3-4 Test Records .....   | 12        |
| 3-5 Test Validity .....  | 12        |
| 3-6 Uncertainty .....  | 13        |
| <b>Section 4 Instruments and Methods of Measurement .....</b>            | <b>15</b> |
| 4-1 General Requirements .....   | 15        |
| 4-2 Pressure Measurement .....   | 19        |
| 4-3 Temperature Measurement .....  | 22        |
| 4-4 Gas Fuel Heat Input .....  | 26        |
| 4-5 Liquid Fuel Heat Input .....   | 29        |
| 4-6 Electrical Generation Measurement .....                              | 31        |
| 4-7 Mechanical Power Measurement .....                                   | 36        |
| 4-8 Speed Measurement .....  | 36        |
| 4-9 Humidity Measurement .....   | 36        |
| 4-10 Heat Losses .....   | 37        |
| 4-11 Other Measurements .....  | 37        |
| <b>Section 5 Computation of Results .....</b>                            | <b>39</b> |
| 5-1 Electrical Power Calculations .....                                  | 39        |
| 5-2 Mechanical Power Output Calculation .....                            | 41        |
| 5-3 Heat Rate Calculations .....   | 41        |
| 5-4 Correction of Test Results — Fundamental Performance Equations ..... | 44        |
| 5-5 Application of Correction Factors .....                              | 46        |
| 5-6 Degradation .....  | 48        |
| <b>Section 6 Report of Results .....</b>                                 | <b>49</b> |
| 6-1 General Requirements .....   | 49        |
| 6-2 Summary .....  | 49        |
| 6-3 Test Description .....   | 49        |
| 6-4 Test Equipment .....   | 49        |
| 6-5 Calculations and Results .....                                       | 49        |
| 6-6 Appendices .....   | 49        |

|                                |  |    |
|--------------------------------|--|----|
| <b>Section 7</b>               | <b>Test Uncertainty</b> .....  | 50 |
| 7-1                            | Introduction .....   | 50 |
| 7-2                            | Understanding Test Uncertainty .....   | 50 |
| 7-3                            | Unit Output and Thermal Efficiency .....   | 53 |
| 7-4                            | Comparative Testing Uncertainty .....  | 61 |
| 7-5                            | Uncertainty of Flow Calculation From Heat Balance .....                                    | 62 |
| <br>                           |  |    |
| <b>Figures</b>                 |  |    |
| 3-1.5.1-1                      | Generic Test Boundaries .....  | 9  |
| 4-2.3.8-1                      | Five-Way Manifold for Differential Pressure (DP) Instruments .....                         | 20 |
| 4-2.3.9-1                      | Differential Pressure (DP) Correction for Flow on Nonhorizontal Lines .....                | 21 |
| 4-3.2.1-1                      | Four-Wire RTDs .....   | 22 |
| 4-3.2.1-2                      | Three-Wire RTDs .....  | 22 |
| 4-4.2-1                        | Generic Gas Fuel Test Boundary .....   | 27 |
| 4-5.2-1                        | Generic Liquid Fuel Test Boundary .....  | 30 |
| 4-6.2.1-1                      | Two-Meter Metering System for Use on Three-Wire Delta Connected<br>Power Systems .....     | 32 |
| 4-6.2.1-2                      | Two-Meter Metering System for Use on Three-Wire Wye Connected<br>Power Systems .....       | 32 |
| 4-6.2.2-1                      | Three-Meter Metering System for Use on Four-Wire Power Systems .....                       | 33 |
| 7-2.1.1-1                      | Illustration of Measurement Errors .....   | 51 |
| 7-2.4-1                        | Test Uncertainty Diagram .....   | 52 |
| <br>                           |  |    |
| <b>Tables</b>                  |  |    |
| 2-2.1-1                        | Symbols .....  | 5  |
| 2-2.1-2                        | Subscripts .....   | 6  |
| 3-1.5.2-1                      | Required Measurements .....  | 9  |
| 3-3.5-1                        | Maximum Permissible Variations in Operating Conditions .....                               | 12 |
| 4-1.2.1-1                      | Maximum Allowable Measurement Uncertainties .....  | 15 |
| 5-3.1.1-1                      | Typical Values for Unit Conversion Factor, $N_1$ , Using Common Units of<br>Measure .....  | 42 |
| 5-3.1.3-1                      | Typical Values for Unit Conversion Factor, $N_2$ , Using Common Units of<br>Measure .....  | 43 |
| 5-4-1                          | Summary of Additive Correction Factors for Power Fundamental<br>Performance Equation ..... | 45 |
| 5-4-2                          | Summary of Correction Factors in All Fundamental Performance<br>Equations .....            | 45 |
| 7-3.1-1                        | Step 1: Code Limit Uncertainty (Example) .....   | 54 |
| 7-3.1-2                        | Step 2: Pretest Uncertainty Calculation (Example) .....                                    | 55 |
| 7-3.1-3                        | Step 3: Post-test Uncertainty Calculation (Example) .....                                  | 56 |
| 7-3.3.2.2-1                    | Heat Input Uncertainty for Mass Flow Meter .....   | 60 |
| 7-3.3.3-1                      | Heat Input Uncertainties for Liquid Fuel .....   | 60 |
| 7-4.3-1                        | Comparative Test Example .....   | 62 |
| 7-5.4-1                        | Exhaust Flow Uncertainty .....   | 63 |
| 7-5.6-1                        | Exhaust Energy Uncertainty .....   | 64 |
| <br>                           |  |    |
| <b>Mandatory Appendix</b>      |  |    |
| I                              | Determination of Gas Turbine Exhaust Energy, Flow, and Temperature .....                   | 65 |
| <br>                           |  |    |
| <b>Nonmandatory Appendices</b> |  |    |
| A                              | Sample Calculations .....  | 88 |
| B                              | PTC Uncertainty Estimates From ASTM Repeatability and Reproducibility<br>Data .....        | 96 |
| C                              | References .....   | 99 |