

ASME PTC 51-2011

Gas Turbine Inlet Air-Conditioning Equipment

Performance Test Codes

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**

ASME PTC 51-2011

Gas Turbine Inlet Air-Conditioning Equipment

Performance Test Codes

AN AMERICAN NATIONAL STANDARD



**The American Society of
Mechanical Engineers**

Three Park Avenue • New York, NY • 10016 USA

Date of Issuance: February 29, 2012

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 document. Periodically certain actions of the ASME PTC Committee may be published as Code Cases. Code Cases and interpretations are published on the ASME Web site under the Committee Pages at <http://cstools.asme.org/> 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 Committee Pages can be found at <http://cstools.asme.org/>. 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
Three Park Avenue, New York, NY 10016-5990

Copyright © 2012 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved
Printed in U.S.A.

CONTENTS

Notice	vi
Foreword	vii
Acknowledgments	vii
Committee Roster	viii
Correspondence With the PTC Committee	ix
Section 1 Object and Scope	1
1-1 Object	1
1-2 Scope	1
1-3 Uncertainty	1
1-4 Other Requirements and References	2
Section 2 Definitions and Description of Terms	3
2-1 Symbols	3
2-2 Definitions	5
Section 3 Guiding Principles	11
3-1 Preparations for Testing	11
3-2 Tests	13
3-3 Operation of Test	13
3-4 Records	16
3-5 Calculation and Reporting of Results	16
Section 4 Instruments and Methods of Measurement	18
4-1 General Requirements	18
4-2 Pressure Measurement	22
4-3 Temperature Measurement	26
4-4 Humidity Measurement	32
4-5 Liquid and Steam Flow Measurement	35
4-6 Air-Flow Measurement	41
4-7 High-Voltage Electrical Measurement	51
4-8 Intermediate- and Low-Voltage Electrical Measurement	55
4-9 Droplet Carryover and Droplet Size	56
4-10 Data Collection and Handling	59
Section 5 Computation of Results	62
5-1 General Calculation Methodology	62
5-2 Common Parameters and Variables	62
5-3 General Correction Methodology	68
5-4 Inlet Cooling Using Evaporative Media	69
5-5 Inlet Cooling Using Fogging	70
5-6 Inlet Cooling Using Chillers (Multiple Arrangements)	74
5-7 Inlet Heating Using Closed-Loop Systems (Coils)	86
5-8 Inlet Heating Using Open-Loop Heating Systems (Compressor Bleed)	88
Section 6 Report of Results	90
6-1 General Requirements	90
6-2 Executive Summary	90
6-3 Introduction	90
6-4 Calculations and Results	90
6-5 Instrumentation and Measurements	90
6-6 Conclusion	91
6-7 Appendices	91

Section 7	Test Uncertainty	92
7-1	Introduction	92
7-2	Inputs for an Uncertainty Analysis	92
7-3	Error Sources	92
7-4	Calculation of Uncertainty	92
7-5	Correlated and Noncorrelated Approaches to Uncertainty Measurement	93
7-6	Measurements	93
7-7	Estimated Uncertainties	93
7-8	Posttest Uncertainty Analysis	93
7-9	Repeatability	93
7-10	Spatial Systematic Uncertainty	93
Section 8	References	95
8-1	References	95
8-2	Additional Referenced ASME Documents	95
Figures		
3-1.2-1	Sample Test Boundary	12
3-3.7-1	Three Posttest Cases	15
4-2.6.2-1	Five-Way Manifold	26
4-2.6.2-2	Water Leg Correction for Flow Measurement	26
4-3.3.2.1-1	Four-Wire Resistance Temperature Detector (RTD)	29
4-3.3.2.2-1	Three-Wire Resistance Temperature Detector (RTD)	29
4-3.6.2-1	Flow-Through Well.....	31
4-6.3.1-1	Five-Hole Probe	44
4-6.3.1-2	Three-Hole Probe.....	45
4-6.3.3-1	Directional Thermal Anemometer: Triaxial Probe (Three Wire).....	46
4-6.4-1	Free-Stream Flow Nozzle Jet.....	47
4-6.4-2	ASME Flow Chamber	47
4-6.4-3	Wind Tunnel.....	49
4-6.4.1-1	Typical Calibration Curve for a Five-Hole Probe	50
5-2-1	Generic Test Boundary Diagram	63
5-4.1-1	Evaporative Cooler Test Boundary Diagram	70
5-5.1-1	Inlet Fogger Test Boundary Diagram	71
5-5.2.2-1	Sample Fogging System Design Curve for System Cooling Capability vs. Potential Cooling Level.....	72
5-5.2.4-1	Sample Fogging System Design Curve for Water Flow vs. Expected Inlet Air Cooling.....	73
5-6.2.1-1	Inlet Chiller Test Boundary Diagram: Coils Only	76
5-6.3.1-1	Inlet Chiller Test Boundary Diagram: Coils and Primary Cooling Loop	78
5-6.4.1-1	Inlet Chiller Test Boundary Diagram: Coils, Primary Cooling Loop, and Chiller Loop.....	81
5-6.5.1-1	Inlet Chiller Test Boundary Diagram: Entire Chiller System	84
5-7.1-1	Inlet Heater Test Boundary Diagram.....	86
5-8.1-1	Compressor Air Heater Test Boundary Diagram.....	88
7-10-1	Outlet Air Temperature Distribution at the Outlet of an Evaporative Condenser	94
Tables		
1-3-1	Representative Test Uncertainties	2
2-1-1	Symbols.....	3
2-1-2	Subscripts.....	5
3-3.1-1	Maximum Permissible Deviation From Base Reference Conditions and Minimum and Maximum Requirements	13
3-3.3-1	Maximum Permissible Variation in Test-Run Conditions	15
4-5.3.1-1	Units and the Conversion Factor for Mass Flow Through a Differential Pressure Class Meter	37
4-5.3.1-2	Summary Uncertainty of Discharge Coefficient and Expansion Factor.....	38

4-6.3-1	Air-Velocity Measurement Devices.....	43
4-8.4-1	Electrical Horsepower.....	56
4-8.4-2	Properties of Conductors.....	57
4-8.4-3	Multiplying Factors for Converting DC Resistance to 60-Hz AC Resistance.....	58
7-10-1	Spatial Systematic Uncertainty Calculation (Step-by-Step)	94
Nonmandatory Appendices		
A	Method of Testing Atomizing Nozzles.....	97
B	Sample Uncertainty Analyses	110