

**ASME PTC 4.4-2023**  
[Revision of ASME PTC 4.4-2008 (R2013)]

# **Gas Turbine Heat Recovery Steam Generators**

---

## **Performance Test Codes**

**AN AMERICAN NATIONAL STANDARD**



**The American Society of  
Mechanical Engineers**

**ASME PTC 4.4-2023**  
[Revision of ASME PTC 4.4-2008 (R2013)]

# Gas Turbine Heat Recovery Steam Generators

---

## Performance Test Codes

AN AMERICAN NATIONAL STANDARD



The American Society of  
Mechanical Engineers

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: March 29, 2024

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

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 ensure that individuals from competent and concerned interests had an opportunity to participate. The proposed code or standard was made available for public review and comment, which provided an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not "approve," "certify," "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 does ASME assume 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 representatives or persons 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.

The endnotes and preamble in this document (if any) are part of this American National Standard.



ASME Collective Membership Mark

All rights reserved. "ASME" and the above ASME symbol are registered trademarks of The American Society of Mechanical Engineers. No part of this document may be copied, modified, distributed, published, displayed, or otherwise reproduced in any form or by any means, electronic, digital, or mechanical, now known or hereafter invented, without the express written permission of ASME. No works derived from this document or any content therein may be created without the express written permission of ASME. Using this document or any content therein to train, create, or improve any artificial intelligence and/or machine learning platform, system, application, model, or algorithm is strictly prohibited.

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

Copyright © 2024 by  
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS  
Printed in U.S.A.

# CONTENTS

Notice .....	vi
Foreword .....	vii
Committee Roster .....	viii
Correspondence With the PTC Committee .....	ix
<b>Section 1      Object, Scope, and References .....</b>	<b>1</b>
1-1      Object .....	1
1-2      Scope .....	1
1-3      Test Uncertainty .....	1
1-4      References .....	1
<b>Section 2      Definitions of Terms, Symbols, and Conversion Factors .....</b>	<b>3</b>
2-1      Definitions .....	3
2-2      Symbols .....	5
2-3      Conversion Factors .....	5
2-4      Descriptive Figures .....	5
<b>Section 3      Guiding Principles .....</b>	<b>15</b>
3-1      Introduction .....	15
3-2      Planning for the Test .....	15
3-3      Prior Agreements .....	16
3-4      Test Preparations .....	17
3-5      Conducting the Test .....	18
3-6      Calculation, Analysis, and Reporting of Results .....	20
<b>Section 4      Instruments and Methods of Measurement .....</b>	<b>23</b>
4-1      Introduction .....	23
4-2      General .....	23
4-3      Temperature Measurement .....	25
4-4      Pressure Measurement .....	31
4-5      Flow Measurement .....	37
4-6      Liquid and Gaseous Fuel Sampling .....	38
4-7      Power Measurement .....	39
4-8      Data Collection and Handling .....	39
<b>Section 5      Calculations .....</b>	<b>40</b>
5-1      Introduction .....	40
5-2      Intermediate Calculations .....	40
5-3      Gas Flow by HRSG Energy Balance .....	51
5-4      Gas Flow by GT Energy Balance .....	54
5-5      Correction of Test Conditions to Guarantee .....	54
<b>Section 6      Report of Results .....</b>	<b>58</b>
6-1      Section 1: Executive Summary .....	58

6-2	Section 2: Introduction . . . . .	58
6-3	Section 3: Test Data . . . . .	58
6-4	Section 4: Data Reduction, Corrections, and Results . . . . .	58
6-5	Section 5: Appendices . . . . .	58
<b>Section 7</b>	<b>Test Uncertainty . . . . .</b>	<b>59</b>
7-1	Introduction . . . . .	59
7-2	Principles of an Uncertainty Analysis . . . . .	59
7-3	Pretest Uncertainty Analysis . . . . .	59
7-4	Post-Test Uncertainty Analysis . . . . .	59
7-5	Inputs for an Uncertainty Analysis . . . . .	59
7-6	Weighted Capacity . . . . .	60
7-7	Additional Considerations . . . . .	60
<b>Nonmandatory Appendices</b>		
A	Bypass Damper Leakage . . . . .	61
B	Fuel Sensible Heat . . . . .	62
C	HRSG Heat Loss . . . . .	63
D	Uncertainty Sample Calculation . . . . .	65
E	Sample Calculations . . . . .	77
<b>Figures</b>		
2-4-1	Typical GT HRSG Diagram . . . . .	10
2-4-2	Typical Three-Pressure-Level HRSG With Supplementary Firing . . . . .	11
2-4-3	Typical Two-Pressure-Level HRSG With Feedwater Heater and Supplementary Firing . . . . .	12
2-4-4	Typical Single-Pressure-Level HRSG With Feedwater Heater and Supplementary Firing . . . . .	13
3-6.2-1	Repeatability of Runs . . . . .	21
4-3.3.2.1-1	Four-Wire RTDs . . . . .	28
4-3.3.2.2-1	Three-Wire RTDs . . . . .	28
4-4.6.2-1	Five-Way Manifold . . . . .	36
4-4.6.2-2	Water Leg Correction for Flow Measurement . . . . .	36
5-5.2-1	Measured Capacity Comparison to Predicted Capacity . . . . .	56
D-3-1	Sensitivity Calculation Table for the Measured HP Steam Flow Uncertainty Example . . . . .	67
D-3-2	Calculation Table for the Measured HP Steam Flow Post-Test Uncertainty Example . . . . .	68
D-4-1	Sensitivity Calculation Table for the Predicted HP Steam Flow Uncertainty Example — HRSG Energy Balance Method . . . . .	69
D-4-2	Calculation Table for the Predicted HP Steam Flow Uncertainty Example — HRSG Energy Balance Method . . . . .	70
D-5-1	Sensitivity Calculation Table for the Predicted HP Steam Flow Uncertainty Example — GT Energy Balance Method . . . . .	72
D-5-2	Calculation Table for the Predicted HP Steam Flow Uncertainty Example — GT Energy Balance Method . . . . .	74
E-1-1	Duty Summary Table . . . . .	78
E-1-2	Sheet A: Air Composition . . . . .	79
E-1-3	Sheet C: Fuel Gas Combustion Mole Change . . . . .	80
E-1-4	Sheet E: Inlet Gas Composition . . . . .	82
E-1-5	Sheet I: Gas Enthalpy . . . . .	83

E-1-6	Sheet H: Outlet Gas Composition .....	84
E-1-7	Sheet J: Air Enthalpy .....	85

## Tables

2-2-1	Symbols Used in ASME PTC 4.4 .....	6
2-3-1	Conversion Factors .....	8
2-4-1	Legend for Figures 2-4-1 Through 2-4-4 .....	14
3-1-1	Typical Ranges of Uncertainties .....	15
3-5.2.2-1	Suggested Maximum Permissible Variations From Design Conditions .....	19
3-5.3-1	Suggested Maximum Permissible Variations in Test Conditions .....	19
4-3.2-1	List of Potential Sources and Typical Ranges of Uncertainties .....	26
4-4.2-1	Potential Pressure Systematic Uncertainty Limits .....	32
4-5.2-1	Maximum Allowable Flow Measurement Uncertainty .....	37
5-2.2.3-1	Combustion Ratios .....	43
5-2.4.3-1	Fuel Compound Heating Values .....	45
5-2.4.4-1	Gas Enthalpy Correlation Constants .....	48
C-2-1	Physical Properties of Example Gas Composition .....	64
D-6-1	Example of Uncertainty Weighted Average in Determination of the Predicted HP Steam Flow Using Both the HRSG and GT Energy Balance Methods .....	76
E-1-1	Main Sheet: Working Fluid Data .....	77