ASME PTC 22-2023
(Revision of ASME PTC 22-2014)

Gas Turbines

Performance Test Codes

AN AMERICAN NATIONAL STANDARD

The American Society of
Mechanical Engineers

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Two Park Avenue • New York, NY • 10016 USA

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The American Society of Mechanical Engineers
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NOTICE

All ASME Performance Test Codes (PTCs) shall adhere to the requirements of ASME PTC 1, General Instructions. It is expected that the Code user is fully cognizant of the requirements of ASME PTC 1 and has read them before applying ASME PTCs.

ASME PTCs provide unbiased test methods for both the equipment supplier and the users of the equipment or systems. The Codes are developed by balanced committees representing all concerned interests and specify procedures, instrumentation, equipment-operating requirements, calculation methods, and uncertainty analysis. Parties to the test can reference an ASME PTC confident that it represents the highest level of accuracy consistent with the best engineering knowledge and standard practice available, taking into account test costs and the value of information obtained from testing. Precision and reliability of test results shall also underlie all considerations in the development of an ASME PTC, consistent with economic considerations as judged appropriate by each technical committee under the jurisdiction of the ASME Board on Standardization and Testing.

When tests are run in accordance with a Code, the test results, without adjustment for uncertainty, yield the best available indication of the actual performance of the tested equipment. Parties to the test shall ensure that the test is objective and transparent. All parties to the test shall be aware of the goals of the test, technical limitations, challenges, and compromises that shall be considered when designing, executing, and reporting a test under the ASME PTC guidelines.

ASME PTCs do not specify means to compare test results to contractual guarantees. Therefore, the parties to a commercial test should agree before starting the test, and preferably before signing the contract, on the method to be used for comparing the test results to the contractual guarantees. It is beyond the scope of any ASME PTC to determine or interpret how such comparisons shall be made.

FOREWORD

The original Performance Test Codes Committee No. 22 was established in 1945 to develop a test code on Gas Turbine Power Plants. This initial Code was published in 1953. Subsequent versions of the Code were published in 1966 and 1985, each time incorporating latest practices in accordance with the directives of ASME PTC 1, General Instructions.

The 1997 edition addressed for the first time the issue of measurement uncertainty, and also recognized the significant advances in gas turbine and instrumentation technologies.

The efforts on the 2005 edition began during the publication period of the 1997 Code. Its objectives were to develop procedures for comparative (back-to-back, or before and after) testing and for determining exhaust flow and energy for heat recovery applications. The 2005 edition incorporated these procedures, as well as updated calculations in many areas to reduce the uncertainty of the results.

The efforts on the 2014 edition began in 2007. The key objectives of this revision were to correct errors and omissions, provide harmonization with other codes and standards, and provide clarification to the intent of the Code as a result of industry feedback and interpretations to the 2005 edition. Some of the most significant changes included incorporating the methodology for determination of gas turbine exhaust energy, flow, and temperature into mandatory sections and a mandatory appendix when these performance results are part of the object of the Code. Similarly, when comparative performance is a test goal, the requirements and guidelines for comparative testing are included in mandatory sections of the Code. As a result of advances in instrumentation, Section 4 was revised to include additional flow-metering technology. Section 7, Test Uncertainty, was revised to provide compliance with the methodology for determination of uncertainty used in the revised ASME PTC 19.1, Test Uncertainty, and to incorporate the most current engineering analysis and experience.

The efforts on this edition began in 2015. The most significant changes in this edition are to Sections 1, 4, 5, and 7 and Nonmandatory Appendix C. Section 1 has been updated to indicate that aero-derivative and industrial frame gas turbines are part of the object of the Code. The Code's scope has been updated to differentiate extended scope technologies between ASME PTC 22 and ASME PTC 46. In Section 4, the methodology for electrical generator measurement has been revised to align with the methodology used in ASME PTC 19.6-2018. Section 5 has been revised to expand subsection 5-6 and to recommend the use of model-based corrections as the preferred method, as a result of gas turbine technology advances with complex operation. Requirements and guidelines have been included for the use of simulation models to generate corrections. Section 7 has been revised to update the sample uncertainty calculation tables. The sample exhaust flow calculation formerly in Mandatory Appendix I has been revised and relocated to a new Nonmandatory Appendix C. Former Nonmandatory Appendix C has been redesignated as Nonmandatory Appendix D.

ASME PTC 22-2023 was approved by the American National Standards Institute on February 9, 2023.

ASME PTC COMMITTEE
Performance Test Codes

(The following is the roster of the Committee at the time of approval of this Code.)

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General. ASME codes and standards are developed and maintained by committees with the intent to represent the consensus of concerned interests. Users of ASME codes and standards may correspond with the committees to propose revisions or cases, report errata, or request interpretations. Correspondence for this Code should be sent to the staff secretary noted on the committee's web page, accessible at http://go.asme.org/PTCcommittee.

Revisions and Errata. The committee processes revisions to this Code on a periodic basis to incorporate changes that appear necessary or desirable as demonstrated by the experience gained from the application of the Code. Approved revisions will be published in the next edition of the Code.

In addition, the committee may post errata on the committee web page. Errata become effective on the date posted. Users can register on the committee web page to receive e-mail notifications of posted errata.

This Code is always open for comment, and the committee welcomes proposals for revisions. 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 background information and supporting documentation.

Cases

(a) The most common applications for cases are

(1) to permit early implementation of a revision based on an urgent need

(2) to provide alternative requirements

(3) to allow users to gain experience with alternative or potential additional requirements prior to incorporation directly into the Code

(4) to permit the use of a new material or process

(b) Users are cautioned that not all jurisdictions or owners automatically accept cases. Cases are not to be considered as approving, recommending, certifying, or endorsing any proprietary or specific design, or as limiting in any way the freedom of manufacturers, constructors, or owners to choose any method of design or any form of construction that conforms to the Code.

(c) A proposed case shall be written as a question and reply in the same format as existing cases. The proposal shall also include the following information:

(1) a statement of need and background information

(2) the urgency of the case (e.g., the case concerns a project that is underway or imminent)

(3) the Code and the paragraph, figure, or table number(s)

(4) the edition(s) of the Code to which the proposed case applies

(d) A case is effective for use when the public review process has been completed and it is approved by the cognizant supervisory board. Approved cases are posted on the committee web page.

Interpretations. Upon request, the committee will issue an interpretation of any requirement of this Code. An interpretation can be issued only in response to a request submitted through the online Interpretation Submittal Form at http://go.asme.org/InterpretationRequest. Upon submitting the form, the inquirer will receive an automatic e-mail confirming receipt.

ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Code requirements. If, based on the information submitted, it is the opinion of the committee that the inquirer should seek assistance, the request will be returned with the recommendation that such assistance be obtained. Inquirers can track the status of their requests at http://go.asme.org/Interpretations.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Interpretations are published in the ASME Interpretations Database at http://go.asme.org/Interpretations as they are issued.

Committee Meetings. The PTC Standards Committee regularly holds meetings that are open to the public. Persons wishing to attend any meeting should contact the secretary of the committee. Information on future committee meetings can be found on the committee web page at https://go.asme.org/PTCcommittee.

ASME PTC 22-2023
SUMMARY OF CHANGES

Following approval by the ASME PTC Committee and ASME, and after public review, ASME PTC 22-2023 was approved by the American National Standards Institute on February 9, 2023.

ASME PTC 22-2023 includes the following changes identified by a margin note, **(23)**.

Page	*Location*	*Change*
1	1-2	Revised in its entirety
3	Table 1-2.2-1	Added
4	2-2	(1) Definitions of *aero-derivative gas turbine* and *Wobbe index* added (2) Definitions of *inlet air-conditioning*, *open cycle*, and *test boundary* revised
6	Table 2-2.1-1	(1) Symbol *WI* and General Note added (2) Description of *d* revised
9	3-1.2	Subparagraph (e) revised
10	3-1.4	Editorially revised
10	3-1.6	Subparagraph (r) revised
12	3-2.5	Revised
13	3-3.2.1	Subparagraph (a)(3) revised
13	3-3.3.1	Revised
17	4-1.2.2	Revised
20	4-1.4.1	Second paragraph revised
20	4-1.4.3	Revised
23	4-2.3.9	Revised
26	4-3.3.2	Revised
27	4-3.3.3	Second paragraph revised
28	4-4.2	Editorially revised
28	4-4.3.1.1	Revised
29	Figure 4-4.2-1	Legend editorially revised
30	4-4.3.2	Revised
30	4-4.4	Third paragraph revised
30	4-4.6	Revised
31	4-4.7	First paragraph revised
32	Figure 4-5.2-1	Revised
33	4-5.6	Editorially revised
34	4-6	(1) In para. 4-6.1, second and third paragraphs added (2) Former paras. 4-6.2 through 4-6.5 and 4-6.8 deleted (3) Former paras. 4-6.6 and 4-6.7 redesignated as 4-6.2 and 4-6.3, respectively, and revised
35	4-9.1	Revised
35	4-10	Second paragraph revised

Page	*Location*	*Change*
37	Section 5	Subsection 5-1 added and subsequent subsections redesignated
37	5-2.1	Former para. 5-1.1 revised
38	5-2.4.1	Former para. 5-1.4.1 revised
39	5-4.1.1	Former para. 5-3.1.1 revised
40	5-4.1.3	(1) Former para. 5-3.1.3 revised (2) Former eq. (5-3.5) redesignated as eq. (5-4-5) and revised (3) Table 5-3.1.3-1 deleted
41	5-4.1.9	Equations (5-4-12) and (5-4-14) [formerly eqs. (5-3.12) and (5-3.14)] revised
41	5-4.1.10	Former para. 5-3.1.10 revised
42	5-5	Former subsection 5-4 revised
44	5-6	Former subsection 5-5 revised in its entirety
47	6-2	Revised
47	6-3	(1) First sentence and subpara. (b)(4) added (2) Subparagraphs (b)(1) and (e) revised
47	6-4	(1) First sentence added (2) Subparagraph (c) revised
47	6-5	Revised
48	6-6	(1) First sentence added (2) Subparagraphs (c), (d), and (g) revised
49	7-1	Revised
52	7-2.6	Revised
52	7-3	Title revised
52	7-3.1	First paragraph revised
52	7-3.2	First paragraph and subparas. (b) and (d) revised
53	Table 7-3.1-1	Revised
55	Table 7-3.1-2	Revised
57	Table 7-3.1-3	Revised
59	7-3.3.1	Revised
60	7-3.3.2	Revised
60	7-3.3.2.1	Subparagraph (a) revised
61	7-3.3.2.2	Revised
61	7-3.3.4	Revised
63	7-3.6	Revised
64	7-4.3	Revised
65	7-4.4	Revised
65	7-5.2	Revised
65	7-5.3	Revised
70	I-3.1.4	Step 12 revised
74	I-3.2.5.3	Revised
75	I-3.2.7.1	Revised
77	I-4	Revised in its entirety
78	Nonmandatory Appendix A	(1) Subsection A-1 added and subsequent subsections redesignated (2) Subsection A-4 deleted
79	Table A-2.1-1	Former Table A-1.1-1 revised

Page	*Location*	*Change*
79	A-2.8	Revised
80	A-2.12	Former para. A-1.12 revised
81	Table A-2.14-1	First row of former Table A-1.14-1 revised
86	B-4	Revised
88	Nonmandatory Appendix C	Added and subsequent appendix redesignated
100	Nonmandatory Appendix D	Former Nonmandatory Appendix C updated

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Section 1
Object and Scope

1-1 OBJECT

ASME PTC 22 provides directions and rules for conduct and report of results of thermal performance tests for open-cycle gas turbine power plants and gas turbine engines, whether aero-derivative or industrial frame, hereafter referred to as gas turbines. The object is to determine the thermal performance of the gas turbine when operating at test conditions, and correcting these test results to specified reference conditions. This Code provides explicit procedures for the determination of the following performance results:

(a) corrected power
(b) corrected heat rate (efficiency)
(c) corrected exhaust flow
(d) corrected exhaust energy
(e) corrected exhaust temperature

Tests may be designed to satisfy different goals, including absolute performance and comparative performance.

It is the intent of the Code to provide results with the highest level of accuracy that is consistent with the best engineering knowledge and practice in the gas turbine industry. In planning the test, an uncertainty analysis shall demonstrate that the proposed instrumentation and measurement techniques meet the requirements of the Code.

(23) 1-2 SCOPE

1-2.1 General Scope

This Code provides for the testing of aero-derivative or industrial frame gas turbines supplied with gaseous or liquid fuels (or solid fuels converted to liquid or gas prior to entry into the gas turbine).

This Code provides for comparative (back-to-back) tests designed to verify performance differentials of the gas turbine, primarily for testing before and after modifications, uprates, or overhauls. Improvements to achieve additional performance may include application of advanced gas path components, modification of combustion system, control scheme changes, increased mass flow, and changes to the inlet and exhaust systems of the gas turbine.

1-2.2 Tests Inside and Outside the Scope of ASME PTC 22

In developing this Code, the PTC 22 Committee collaborated with the PTC 46 Committee to determine which gas turbine extended scope technologies would be covered within ASME PTC 22 and which would be within ASME PTC 46, Mandatory Appendix I. Table 1-2.2-1 lists what is covered within ASME PTC 22 and ASME PTC 46 with regard to gas turbine testing for extended scope when the specified technologies are within the test boundary.

The PTC 22 Committee and the PTC 46 Committee agreed that this Code will cover the gas turbine extended scopes when ASME PTC 22 is the appropriate Test Code per Table 1-2.2-1. Refer to ASME PTC 46 for gas turbine extended scope not included in the table.

Additionally, this Code does not apply to the following:

(a) gas turbines where useful output is other than power to drive a generator or other load device.

(b) environmental compliance testing for gas turbines for stack emissions and sound levels. Procedures developed by regulatory agencies, the American National Standards Institute (ANSI), other ASME PTC committees, International Organization for Standardization (ISO) committees, or another equivalent standard are available to govern the conduct of such testing.

(c) absolute or comparative performance of specific components of the gas turbine.

(d) performance of auxiliary systems of the gas turbine power plant, such as inlet cooling devices, fuel gas booster compressors, and fuel delivery systems.

(e) operational demonstration tests and reliability testing.

(f) itemized performance changes that are the result of multiple actions, such as modifications, repairs, or cleanings (i.e., compressor, inlet air filtration systems, etc.).

1-3 TEST UNCERTAINTY

1-3.1 Absolute Performance Test Uncertainty

For absolute performance tests, this Code establishes a limit for the uncertainty of each required measurement (parameter or variable), and also limits the variation of the critical parameters during the test. The test uncertainty is then calculated in accordance with the