ASME PTC 47.1-2017

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Cryogenic Air Separation Unit of an Integrated Gasification Combined Cycle Power Plant

Performance Test Codes

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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NOTICE

All Performance Test Codes must adhere to the requirements of ASME PTC 1, General Instructions. The following information is based on that document and is included here for emphasis and for the convenience of the user of the Code. It is expected that the Code user is fully cognizant of Sections 1 and 3 of ASME PTC 1 and has read them prior to applying this Code.

ASME Performance Test Codes provide test procedures that yield results of the highest level of accuracy consistent with the best engineering knowledge and practice currently available. They were developed by balanced committees representing all concerned interests and specify procedures, instrumentation, equipment-operating requirements, calculation methods, and uncertainty analysis.

When tests are run in accordance with a Code, the test results themselves, without adjustment for uncertainty, yield the best available indication of the actual performance of the tested equipment. ASME Performance Test Codes do not specify means to compare those results to contractual guarantees. Therefore, it is recommended that the parties to a commercial test 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 Code to determine or interpret how such comparisons shall be made.

FOREWORD

ASME Performance Test Codes (PTCs) have been developed and have long existed for determining the performance of most major components used in electric power production facilities. A Performance Test Code has heretofore not existed to determine the overall performance of an integrated gasification combined cycle (IGCC) power generation plant. The ability to fire a wide range of fuels has been a key advantage of gas turbines over competing technologies. Until recently, the traditional fuels for gas turbines have been natural gas and liquid fuels. Today, future environmental concerns and future economic scenarios are causing power generation suppliers to develop gasification systems that can use solid and liquid fuels (e.g., coal, biomass, waste, heavy oils). Preparation of an alternative fuel suitable for a gas turbine includes removal of ash, contaminants, and erodents/corrodents. In response to these needs, the ASME Board on Performance Test Codes approved the formation of a committee (PTC 47) in 1993 with the charter of developing a Code for the determination of overall performance for IGCC power generation plants. The organizational meeting of the PTC 47 Committee was held in November 1993. The resulting committee included experienced and qualified users, manufacturers, and general interest category personnel.

The Committee has strived to develop an objective code that addresses the multiple needs for explicit testing methods and procedures, while attempting to provide maximum flexibility in recognition of the wide range of plant designs and the multiple needs for this Code.

This Code was approved by the PTC 47 Committee and the Performance Test Codes Standards Committee. It was approved as an American National Standard by the American National Standards Institute (ANSI) Board of Standards Review on December 14, 2017.

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Performance Test Codes

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Secretary, PTC Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
http://go.asme.org/Inquiry

Proposing Revisions. Revisions are made periodically to the Code 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 periodically.

The Committee welcomes proposals for revisions to this Code. 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.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Code and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Code to which the proposed Case applies.

Interpretations. Upon request, the PTC Standards Committee will render an interpretation of any requirement of the Code. Interpretations can only be rendered in response to a written request sent to the Secretary of the PTC Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at http://go.asme.org/InterpretationRequest. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may mail the request to the Secretary of the PTC Standards Committee at the above address. The request for an 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 the topic of the inquiry in one or two words.
Edition:	Cite the applicable edition of the Code 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. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable.
Proposed Reply(ies):	Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If entering replies to more than one question, please number the questions and replies.
Background Information:	Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

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

Moreover, 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 inquiry information submitted, it is the opinion of the Committee that the Inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

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.

Attending Committee Meetings. The PTC Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the PTC Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at http://go.asme.org/PTCcommittee.

INTRODUCTION

ASME PTC 47 comprises five Performance Test Codes (PTCs) that describe testing procedures for an integrated gasification combined cycle (IGCC) power plant. ASME PTC 47, Integrated Gasification Combined Cycle Power Generation Plants, is used for testing the overall performance of an IGCC plant. If a plant passes the ASME PTC 47 test, no further testing is required. If a plant does not pass the ASME PTC 47 test, one or more secondary subsystems may be tested to isolate the problem(s), using the following PTCs:

(a) ASME PTC 47.1, Cryogenic Air Separation Unit of an Integrated Gasification Combined Cycle Power Plant, for testing the performance of the air separation unit (ASU)

NOTE: If the physical IGCC plant includes an ASU, the inclusion of the ASU within the overall test envelope is recommended, but not required.

(b) ASME PTC 47.2, Gasification Block of an Integrated Gasification Combined Cycle Power Plant, for testing the thermal performance of the gasification equipment

(c) ASME PTC 47.3, Syngas Conditioning Block of an Integrated Gasification Combined Cycle Power Plant, for testing the thermal performance of the syngas cleaning equipment

(d) ASME PTC 47.4, Power Block of an Integrated Gasification Combined Cycle Power Plant, for testing the thermal performance of the gas turbine combined cycle power block

It is recommended that the overall plant and various subsystems be tested separately rather than simultaneously to accommodate any boundary constraints and valve isolations and lineups that may be needed for subsystem testing. In highly integrated IGCC plants, the entire plant may need to be operating during a subsystem test, even if the only performance parameters being measured are those of the subsystem.

Test results can be used to determine the fulfillment of contract guarantees. Test results can also be used by a plant owner to compare plant performance to a design number, or to track plant performance changes over time. However, the results of a test conducted in accordance with this Code shall not provide a basis for comparing the thermoeconomic effectiveness of different plant designs.

APPLICATIONS AND LIMITATIONS. Air separation units that separate air into oxygen, nitrogen, and/or argon streams are included within the scope of this Code. Although primarily intended for application to cryogenic ASUs, the Code may also be used for noncryogenic processes such as adsorption-based systems. The Code applies to the following types of ASUs:

(a) Nonintegrated ASUs in which the primary product is oxygen for use in an oxygen-blown gasification system or nitrogen for use as a diluent in the power block's gas turbine. Air and nitrogen may also be produced for use within the general facility.

(b) Air-integrated ASUs that obtain all or a part of the required ASU compressed air supply from the power block's gas turbine or other source and in which the primary product is oxygen for use in an oxygen-blown gasification system or nitrogen for use as a diluent in the power block's gas turbine. Air and nitrogen may also be produced for use within the general facility.

(c) Nonintegrated ASUs in which the primary product is nitrogen for use in an air-blown gasification system. Air and nitrogen may also be produced for use within the general facility.

(d) Air-integrated ASUs that obtain all or a part of the required ASU compressed air supply from the power block's gas turbine or other source and in which the primary product is nitrogen for use in an air-blown gasification system. Air and nitrogen may also be produced for use within the general facility.

There are many types of cryogenic ASUs employing different combinations of product compression, product liquid pumping, and "cold box" processes. This Code provides procedures for the determination of ASU performance when electrically driven compressors and/or pumps are employed in any process configuration. While not specifically excluded, no explicit procedures are provided for determining the performance of equipment within the ASU test boundary driven by gas turbines, steam turbines, non-ASU process stream expanders, or other non-motor drivers. Other PTCs may be of use in determining the performance of non-motor-drive equipment in conjunction with the procedures described in this Code for analyzing ASU compression power performance.

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Section 1
Object and Scope

1-1 OBJECT

The object of this Code is to provide uniform test methods and procedures for conducting performance tests of air separation units (ASUs) supplying products to a gasification block and/or power block within an integrated gasification combined cycle (IGCC) facility. This Code provides test procedures that can yield results giving the highest level of accuracy consistent with engineering knowledge and practice.

1-1.1 Accuracy

The accuracy of a particular test may be affected by factors within the discretion of the operator. A test is considered an ASME Code test if the following conditions are met:

(a) Test procedures comply with the procedures and variations defined in this Code.

(b) The uncertainty of the test results does not exceed the uncertainty limit given in Table 1-3-1 and determined in Section 7 of this Code.

1-1.2 Performance Characteristics

This Code is used to determine the production rate and effectiveness of an ASU. The ASU effectiveness is defined as the power consumed per mass flow of pressurized product.

This Code provides procedures for the determination of the following performance characteristics:

(a) corrected net ASU power input

(b) corrected ASU production rate (mass flow of pressurized oxygen)

(c) corrected ASU effectiveness

These performance characteristics are typically required for comparing actual performance to guaranteed performance or to a reference, and for determining the performance of the equipment after modifications.

1-2 SCOPE

This Code applies to ASUs of any size, in either a single-train or multitrain configuration. It can be used to measure the performance of an ASU in its normal operating condition, with all equipment in a new, clean, and fully functional condition.

This Code provides methods and procedures explicitly for ASUs employing electric-motor-drive compression equipment, with or without the use of steam and/or electric power for internal regenerative processes. There is no intent to restrict the use of this Code for non-motor-driven compression equipment, nor for ASUs that use other heat inputs for internal regenerative processes, provided the explicit test procedures can be met.

(a) Test Conditions. To test a particular ASU, the following conditions shall be met:

(1) A means shall be available to determine, through either direct or indirect measurements, all of the electric power inputs entering the test boundary, as well as any electric power outputs leaving the test boundary.

(2) A means shall be available to determine, through either direct or indirect measurements, the purity and conditions of all of the pressurized flows entering or leaving the test boundary.

(3) A means shall be available to determine, through either direct or indirect measurements, all of the parameters to correct the results from the test to a base reference condition.

(4) The test uncertainties shall be less than or equal to the uncertainty limits specified in Table 1-3-1.

(b) Tests Outside the Scope of ASME PTC 47.1. Tests addressing performance-related issues other than those specified in (a) are outside the scope of this Code. These include, but are not limited to, the following:

(1) emissions tests

(2) operational demonstration tests pertaining to non-steady-state or off-design conditions

(3) liquid production tests conducted to determine the capability of producing liquefied products from the ASU at rates other than the specified design flows

(4) reliability tests conducted over extended periods of time beyond the required testing period