ASME PTC 18-2020
(Revision of ASME PTC 18-2011)

Hydraulic Turbines and Pump-Turbines

Performance Test Codes

AN INTERNATIONAL CODE

The American Society of Mechanical Engineers

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The American Society of Mechanical Engineers
Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: October 29, 2021

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 http://go.asme.org/InterpsDatabase. Periodically certain actions of the ASME PTC Committee may be published as Cases. Cases are published on the ASME website under the PTC Committee Page at http://go.asme.org/PTCcommittee as they are issued.

Errata to codes and standards may be posted on the ASME website 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 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.

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

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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

The "Rules for Conducting Tests of Waterwheels" was one of a group of ten test codes published by the American Society of Mechanical Engineers (ASME) in 1915. The Pelton Water Wheel Company published a testing code for hydraulic turbines, which was approved by the Machinery Builders' Society on October 11, 1917. This code included the brine velocity method of measuring flow wherein the time of passage of an injection of brine was detected by electrical resistance. Also in October 1917, the ASME Council authorized the appointment of a joint committee to undertake the task of revising the "Rules for Conducting Tests of Waterwheels." The joint committee consisted of thirteen members, four from ASME and three each from the American Society of Civil Engineers, the American Institute of Electrical Engineers, and the National Electric Light Association. The code was printed in the April 1922 issue of *Mechanical Engineering* in preliminary form. It was approved in the final revised form at the June 1923 meeting of the Main Committee and was later approved and adopted by the ASME Council as the standard practice of the Society.

Within three years, the 1923 revised edition was out of print and a second revision was ordered by the Main Committee. In November 1925, the ASME Council appointed a new committee, the Power Test Codes Individual Committee No. 18 on Hydraulic Power Plants. This committee organized itself quickly and completed a redraft of the code in time for a discussion with the advisory committee on Prime Movers of the International Electrotechnical Commission at the New York meeting held in April 1926. The code was redrafted in line with this discussion and was approved by the Main Committee in March 1927. It was approved and adopted by the ASME Council as the standard practice of the Society on April 14, 1927.

In October 1931, the ASME Council approved personnel for a newly organized committee, Power Test Codes Individual Committee No. 18 on Hydraulic Prime Movers, to undertake revision of the 1927 test code. The committee completed the drafting of the revised code in 1937. The Main Committee approved the revised code on April 4, 1938. The code was then approved and adopted by the Council as the standard practice of the Society on June 6, 1938. The term "Hydraulic Prime Movers" is defined as reaction and impulse turbines, both of which are included in the term "hydraulic turbines."A revision of this Code was approved by the Power Test Codes Standards Committee and by the ASME Council in August 1942. Additional revisions were authorized by Performance Test Code Committee No. 18 (PTC 18) in December 1947. Another revision was adopted in December 1948. It was also voted to recommend the reissue of the 1938 Code to incorporate all of the approved revisions as a 1949 edition. A complete rewriting of the Code was not considered necessary, because the 1938 edition had been successful and was in general use. A supplement was prepared to cover index testing. The revised Code including index testing was approved on April 8, 1949, by the Power Test Codes Committee and was approved and adopted by the Council of ASME by action of the Board on Codes and Standards on May 6, 1949.

The members of the 1938 to 1949 committees included C. M. Allen, who further developed the salt velocity method of flow rate measurement; N. R. Gibson, who devised the pressure–time method of flow rate measurement; L. F. Moody, who developed a method for estimating prototype efficiency from model tests; S. Logan Kerr, successful consultant on pressure rise and surge; T. H. Hogg, who developed a graphical solution for pressure rise; G. R. Rich, who wrote a book on pressure rise; and other well-known hydro engineers.

In 1963, Hydraulic Prime Movers Test Code Committee, PTC 18, was charged with the preparation of a Test Code for the Pumping Mode/Pump Turbines. The Code for the pumping mode was approved by the Performance Test Codes Supervisory Committee on January 23, 1978, and was then approved by the American National Standards Institute (ANSI) Board of Standards Review as an American National Standard on July 17, 1978.

The PTC 18 Committee then proceeded to review and revise the 1949 Hydraulic Prime Movers Code as a Test Code for Hydraulic Turbines.

The result of that effort was the publication of ASME PTC 18-1992, Hydraulic Turbines. Since two separate but similar Codes now existed, the ASME PTC 18 Committee proceeded to consolidate them into a single Code, encompassing both the turbine and pump modes of pump/turbines. The consolidation also provided the opportunity to improve upon the clarity of the preceding Codes, as well as to introduce newer technologies such as automated data-acquisition and computation techniques, and the dye-dilution method. Concurrently, the flow methods of salt velocity, pitot tubes and weirs, which had become rarely used, were removed from the 2002 Edition. However, detailed descriptions of these methods remain in previous versions of ASME PTC 18 and ASME PTC 18.1.

Following the publication of the 2002 revision of ASME PTC 18, the PTC 18 Committee began work on the next revision to further modernize and increase the accuracy of measuring techniques and to improve clarity. The 2011 revision was characterized by the following features: increased harmonization of text with other ASME Performance Test Codes according to ASME PTC 1, General Instructions; improvement of text and illustrations; modernization of techniques with increased guidance on electronic data acquisition systems and — in the case of the ultrasonic method — increased ultrasonic flow-measurement accuracy with additional paths. This edition deleted from the code the seldom-used Venturi, volumetric and pressure–time Gibson flow-measurement methods and the seldom practical direct method of power measurement. Also in this edition, the Relative Flow Measurement–Index Test was removed from the main text of the Code to a nonmandatory appendix.

Following the publication of the 2011 revision of ASME PTC 18, the PTC 18 Committee began work on the next revision to consider current trends in field performance testing of hydraulic units including flow measurement at intakes and environmental performance measures. The 2020 revision includes the following changes:

(a) Thermodynamic method for efficiency measurement has been added.

(b) Current meter flow measurement method has been expanded to include measurements taken at the intake.

(c) Additional integration methods for ultrasonic flow measurement have been added.

(d) Key concepts of uncertainty calculations with emphasis on applicability to hydroturbines and harmonization with international codes have been added.

(e) Guidance for measuring flow at intakes using the acoustic scintillation flow measurement method (nonmandatory appendix) has been added.

A discussion of field testing of turbines equipped with aerating systems installed for the purpose of improving dissolved oxygen is, at this time, included as a nonmandatory appendix and, depending on stakeholder interest, may be expanded in subsequent publications.

The methods of measuring flow rate included in this Code meet the criteria of the PTC 18 Committee for soundness of principle, have acceptable limits of accuracy, and have demonstrated application under laboratory and field conditions. There are other methods of measuring flow rate under consideration for inclusion in the Code at a later date.

ASME PTC 18-2020 was approved by the Board on Standardization and Testing on October 28, 2020, and approved as an American National Standard by the ANSI Board of Standards Review on October 30, 2020.

ASME PTC COMMITTEE
Performance Test Codes

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

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PTC 18 — HYDRAULIC PRIME MOVERS

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CORRESPONDENCE WITH THE PTC COMMITTEE

General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

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 Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. 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 Standard 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 Standard to which the proposed Case applies.

Interpretations. Upon request, the PTC Standards Committee will render an interpretation of any requirement of the Standard. 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 Standard 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 Standard 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.

Section 1
Object and Scope

1-1 OBJECT

This Code defines procedures for field performance and acceptance testing of hydraulic turbines and pump-turbines operating with water in either the turbine or pump mode.

1-2 SCOPE

This Code applies to all sizes and types of hydraulic turbines or pump-turbines. It defines methods for ascertaining performance by measuring flow rate (discharge), head, power, and thermodynamic losses from which efficiency may be determined. Requirements are included for pretest arrangements, types of instrumentation, methods of measurement, testing procedures, methods of calculation, and contents of test reports. This Code also contains appendices providing recommended procedures for additional test methods and guidance for unique test conditions.

1-3 UNCERTAINTIES

The test procedures specified herein and the limitations placed on measurement methods and instrumentation are capable of providing total uncertainties, calculated in accordance with the procedures of PTC 19.1 and of this Code, of not more than the following:

(a) Head: ±0.40%
(b) Power: ±0.90%
(c) Flow rate: ±1.75%
(d) Efficiency: ±2.00%

Where favorable measurement conditions exist and the best methods can be used, smaller uncertainties should result. Any test with an efficiency uncertainty greater than the above value does not meet the requirements of this Code.