ASME PTC 12.1-2015
[Revision of ASME PTC 12.1-2000 (R2005)]

# Closed Feedwater Heaters

## Performance Test Codes



AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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

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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

The Performance Test Code Committee 12.1 was assembled to review, edit, and update the 1978 Code edition. The Code was extensively revised to comply with the requirements in ASME PTC 1-1991, General Instructions, including the required uncertainty analysis. The 2000 edition of this Code incorporated a revised calculation procedure including examples. The calculation method requires iterations and may be performed manually but is best done by computer. The Code incorporated an alternative for using ultrasonic flow measurement techniques to test individual or split-string feedwater heaters when flow nozzles are not available.

The PTC 12.1 Committee was once again assembled to review, edit, and update the 2000 edition. This Code has been extensively revised to make it more intuitive including more descriptive subscripts, variable names, modified figures, test forms, and notes, an expanded Nonmandatory Appendix A, and a general emphasis on educating the engineer on heater testing and performance. The uncertainty calculations have been updated to reflect the latest ASME PTC 19.1 terminology.

The 2015 edition of the Code provides a relatively simple but accurate method of calculating the performance of a feedwater heater utilizing the Code procedure with a minimum knowledge of the design characteristics of the feedwater heater.

The PTC 12.1 Committee would like to acknowledge the contributions from Mr. George Osolsobe to this Performance Test Code. This revision was approved by the Board on Performance Test Codes on June 25, 2015 and as an American National Standard on October 26, 2015.

# 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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# CORRESPONDENCE WITH THE PTC COMMITTEE

**General.** ASME Codes are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Code 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 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 for the purpose of providing 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 at go.asme.org/Inquiry.

The request for 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. |
| 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. 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 this format may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

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 and PTC Committees regularly hold 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 go.asme.org/PTCcommittee.

# CLOSED FEEDWATER HEATERS

# Section 1
# Object and Scope

## 1-1 GENERAL

*(a)* For the purpose of this Code, a closed feedwater heater is a power plant heat exchanger designed to heat a given quantity of feedwater through a specified temperature range. The heating medium is steam or condensate at a specified temperature and pressure. In feedwater heaters, the feedwater and heating medium typically are routed through the tubes and shell, respectively. Feedwater heaters are typically designed to be configured in one of the following ways:

*(1)* horizontal

*(2)* vertical channel down

*(3)* vertical channel up

*(4)* duplex (two separate tube bundles in a single divided shell)

*(b)* In some cases, more than one feedwater heater is required for a given feedwater flow and extraction steam source. In such instances, the feedwater heater is divided into two or three parallel heaters, which constitute a multiple string arrangement.

The shell side of the heater may be constructed with one, two, or three independent zones and arranged in various combinations:

*(1)* desuperheating zone

*(2)* condensing zone

*(3)* drain cooling zone

Each zone is considered to be an independent heat transfer entity contained within the same shell.

Extraction steam from the turbine is the heating medium in the desuperheating zone. Depending on the heater design, extraction steam from the turbine together with other possible energy sources such as incoming drains are the heating medium in the condensing zone. Condensate is the heating medium in the drain cooling zone.

*(c)* This Code is written in accordance with the ASME PTC 1, General Instructions. ASME PTC 2, Definitions and Values, defines certain technical terms and numerical constants which are used in this Code with the significance and value therein established. The PTC 19 Series, Supplements on Instruments and Apparatus, which covers the instruments described in this Code, should be used for reference.

## 1-2 OBJECT

The object of this Code is to provide the procedures, direction, and guidance for determining the thermo-hydraulic performance of a closed feedwater heater. It can be utilized to verify contractual performance for a new heater or to calculate performance of an existing heater in comparison to the design point. The overall performance parameters utilized to accomplish this are the following:

*(a)* terminal temperature difference (TTD), which is the difference between the saturation temperature corresponding to the steam inlet pressure and the feedwater outlet temperature

*(b)* drain cooler approach (DCA), which is the difference between drain outlet temperature and feedwater inlet temperature

*(c)* tube-side (feedwater) pressure loss through the heater

*(d)* shell-side pressure loss through the desuperheating zone

*(e)* shell-side pressure loss through the drain cooling zone

The Code methodology adjusts the manufacturer's guaranteed performance parameters to the actual test conditions, for a comparison to as-tested performance.

## 1-3 SCOPE

This Code applies to all horizontal and vertical heaters except those with partial pass full-length drain cooling zones. The heater design is based on a specific operating condition that includes flow, temperature, and pressure. This specific condition constitutes the design point that is found on the manufacturer's feedwater heater specification sheet.

Generally, it is not possible to conduct the test at the exact design point. Therefore, it is necessary to predict the heater performance by adjusting the design parameters for the actual test conditions. Methods of calculating