

COOLING TECHNOLOGY INSTITUTE

Standard for Thermal Performance Certification of Evaporative Heat Rejection Equipment



April 2011

STD-201 (11)

This document was developed using the consensus procedure outlined in the CTI Operating Procedure 304
and has been approved for publication by the CTI Board of Directors

FOREWORD

This Cooling Technology Institute (CTI) publication is published as an aid to cooling tower purchasers and designers. It may be used by anyone desiring to do so, and efforts have been made by CTI to assure the accuracy and reliability of the data contained herein. However, CTI makes no warranty of fitness for particular purpose or merchantability nor any other warranty expressed, implied or statutory. In no event shall CTI be liable or responsible for Incidental, Consequential or Commercial losses or damage of any kind resulting from this publication's use; or violation of any federal, state, or municipal regulation with which this publication may conflict or for the infringement of any patent resulting from the use of this publication.

All CTI codes and standards are copyrighted with all rights reserved to CTI. The reproduction of any part of this or any other CTI code or standard is a violation of Federal Law. One must recognize and appreciate commitment by a number of volunteer members who donate their time to develop and update CTI codes and standards. The monies spent for code development, administrative staff support and publication are essential and constitute a substantial drain on CTI. The purchase price of these documents helps to offset these costs. Reproduction and distribution by others, in addition to being unethical, undermines this system and constitutes a further financial drain on CTI. When copies are needed, you are requested to call or write the Cooling Technology Institute, P.O. Box 73383, Houston, Texas 77273, (281) 583-4087. Please request that your associates buy the required codes and standards rather than copy them. Your cooperation in this matter is greatly appreciated.

Nothing contained herein is to be construed as granting any right for the manufacture, sale or use in connection with any method, apparatus, or product covered by letters patent, nor as insuring anyone against liability for infringement of letters patent.

This guideline document summarizes the best current state of knowledge regarding the specific subject. This document represents a consensus of those individual members who have reviewed this document, its scope and provisions. It is intended to aid all users or potential users of cooling towers.

Approved by the CTI Executive Board.



To assure CTI Standard STD-201, *Standard for Thermal Performance Certification of Evaporative Heat Rejection Equipment*, remains current with advancing technologies and to quickly address newly recognized concerns, it has been placed under continuous maintenance by the standing CTI Task Group on STD-201. Such designation provides for timely consideration of requests for change to any part of the standard and, as may be necessary, publication of addenda or revisions adapted by the Task Group as the result of such a request.

Approved by the
CTI Executive Board

Copyright 2011
by Cooling Technology Institute
Printed in U.S.A.

STD-201 (11)

Standard for Thermal Performance Certification of Evaporative Heat Rejection Equipment

Content

Section/Title	Page
1.0 Purpose	5
2.0 Scope	5
3.0 Definitions	5
4.0 Compliance	5
5.0 Operation of Program	6
6.0 Certification Program Committee	8
7.0 Testing Procedures	9
8.0 Complaint Procedures	10
9.0 Conformance	12
10.0 Cost of Program	14
 Appendices	
A References (Normative)	17
B Cooling Towers (CT)	18
C Closed Circuit Coolers (CC)	20
D Evaporative Refrigerant Condensers (EC)	22
E Data of Record - CT	24
E Data of Record – CC / EC	26
F Fan Coverage	28
G Test Failure (Figure 1)	29
G Test Failure (Figure 2)	30
H Certification Approval	31
I Certification Label Design	31

Standard for Thermal Performance Certification of Evaporative Heat Rejection Equipment

Section 1. Purpose

1.1 This Standard sets forth a program whereby the Cooling Technology Institute will certify that all models of a line of evaporative heat rejection equipment offered for sale by a specific Manufacturer will perform thermally in accordance with the Manufacturer's published ratings, as limited in Paragraph 4.5.

Section 2. Scope

2.1 This Standard applies to Mechanical Draft Evaporative Heat Rejection Equipment such as Cooling Towers, Closed Circuit Coolers and Evaporative Refrigerant Condensers where the thermal capacity is selected from published ratings.

Section 3. Definitions

3.1 The term "Manufacturer" as used in this standard pertains to the party offering the product for sale and responsible for the thermal performance claims.

3.2 The term "published ratings," as used in this Standard, pertains to the thermal performance ratings for the certified product line (presented in printed form or as computer output) available upon request to contractors, distributors, consultants, engineers, and owners for selecting equipment for applications. Preferably such ratings will permit the selection of models for specific duties over the full range of certified operating conditions claimed by the Manufacturer. As a minimum, the Manufacturer shall provide tabular data to the general public in which:

(a) The scope of the certification shall be clearly stated adjacent to the tables in terms of design parameters as referenced in Appendices "B" for Cooling Towers, "C" for Closed Circuit Coolers and "D" for Evaporative Refrigerant Condensers.

(b) The tables shall include at least twenty (20) operating conditions for each process fluid or refrigerant included in the certification that are

representative of the full scope of the certification.

3.3 The term "Line" or "Product Line", as used in this Standard, applies to a Manufacturer's grouping of products, models, or units, all of which are of consistent type and design in that they employ the same design configuration (induced draft crossflow, forced draft counterflow, etc.), and the same fan type (propeller or centrifugal), plus any other optional design or application considerations (such as range of capacities) as the Manufacturer may employ, and for which the Manufacturer issues a unique catalog, other sales literature or software providing a physical description and dimensions for all products, models, or units and a selection procedure/ratings.

Section 4. Compliance

4.1 Compliance with this Standard requires all models of the product line to be certified. All models comprising the line shall include as part of their model designation a descriptor unique to that line, and that line only (e.g., A certified line employs model designation such as XYZ-123 where "XYZ" is the unique descriptor for the line. That particular descriptor shall not be used as part of the model designation of a non-certified line.)

4.2 When hyphenated prefixes or suffixes are used, they shall only be used to denote changes made to a certified model, such as the addition of an accessory or special construction. These changes may or may not affect the certification of the model (see Para. 4.5 and 4.6.)

4.3 A Manufacturer participating in this certification program shall not publish a different set of performance ratings for a line having the same or substantially the same data of record information as the certified line. This shall apply whether or not the unique descriptor of the certified line is used for the non-certified version.

4.4 Compliance with this Standard requires initial qualification testing and annual

reverification testing of individual models selected from the line by the CTI Certification Administrator.

4.5 Certified ratings are established on the basis of entering wet bulb temperature for products located in a free and unobstructed environment and circulating fresh water over the fill or heat exchanger. The Manufacturer shall make available published criteria defining a free and unobstructed environment.

4.6 Certifications issued by CTI in accordance with the provisions of this Standard shall apply only to the exact products described in the approved certification report as maintained by the CTI Certification Administrator. Certification shall also apply to multiple cell arrangements of certified models provided the physical configuration and airflow through each cell remains unaltered.

4.7 When optional accessories available from the Manufacturer affect the thermal performance of the product and compensation must be made in the selection, the certification is no longer applicable unless certified as a separate model. This fact shall be clearly specified in all published literature and submittal documents pertaining to the certified line. The use of a hyphenated suffix is suggested to clearly show the accessory.

4.7.1 When optional accessories or custom modifications must be made to the product to meet the needs of the customer and those modifications or accessories void the certification:

(a) The certification label shall not be placed on the unit.

(b) A unique and clearly identified suffix shall be added to the model number to clearly denote the unit has special modifications or accessories that exclude it from certification.

4.8 The Manufacturer of a line of products certified under the provisions of this Standard shall not make any implication that the certification applies to any other line of products not duly certified under the provisions of this Standard.

4.8.1 Sales literature and product bulletins providing descriptions, dimensional data and/or ratings for a line of products certified under this standard shall be unique to that

product line and contain no references to other, uncertified, products.

Section 5. Operation of Program

5.1 This certification program shall be administered by a CTI Certification Administrator who shall be appointed by and serve at the discretion of the CTI Board of Directors.

5.2 The Manufacturer requesting certification of a product line shall submit an application for certification to the CTI Certification Administrator.

5.3 Included in the Manufacturer's application shall be:

(a) A general description of the product line to be certified, including catalogs, if available.

(b) The thermal performance capability for each model comprising the line.

(i) The thermal performance data submitted must be in a form suitable for the Certification Administrator to accurately calculate the capacity of the model at any condition within the certification limits. Acceptable forms of data include the Manufacturer's selection software, equations, and tables of numerical data sufficiently descriptive for interpolation as determined by the Certification Administrator. Graphical representation of thermal capability is not an acceptable form.

(c) Physical data (see Appendix E) for each model comprising the product line.

5.4 The CTI Certification Administrator shall evaluate the data submitted for reasonableness and consistency. Based upon this review, one model will be selected from the product line for the Initial Qualifying Test.

5.5 If, in the judgment of the CTI Certification Administrator, the evaluation of certification data submitted by the Manufacturer and/or the results of the Initial Qualifying Test so warrant, additional qualifying tests may be required on the same or other models.

5.6 The CTI Certification Administrator shall advise the Manufacturer in writing of the model(s) selected for the Initial Qualifying Test(s) and provide the current CTI Schedule of Fees for both the Licensed CTI Certification

Testing Agency and the services of the CTI Certification Administrator. If a selected model is unavailable, the Certification Administrator may select an alternative model. The Certification Administrator also may require that the originally selected model be made available and tested within one year of the issuance of certification of that line, or the model must be withdrawn from the line.

5.7 The Manufacturer shall submit a Purchase Order (or signed contract), to the CTI for the testing and administrative fees and specify when and where the initial qualification test(s) will be conducted.

5.8 All tests prescribed by this Standard shall be conducted by the Licensed CTI Certification Testing Agency. Original test data shall be retained by the CTI Certification Administrator and a copy given to the Manufacturer.

5.8.1 The Certification Administrator shall maintain a secure off-site back-up copy of all necessary files to recover from a disaster. This shall include documentation of all procedures in use by the Certification Administrator in the performance of his or her duties. In the event of incapacity of the Certification Administrator, means must be established in advance for a duly authorized representative of the CTI Board of Directors to gain access to the original and/or back-up files for use by a replacement Certification Administrator.

5.9 To substantiate the Manufacturer's published thermal rating, products tested under the provisions of this Standard must demonstrate a thermal performance capability (as defined in Appendices Para. B.3.2, C.3.2 or D.3.2) of 100%. The test tolerance on individual tests shall be - 5%.

5.10 In the event a model tested under any of the provisions of this Standard, including Initial Qualifying Tests, fails to demonstrate a thermal performance capability of at least 100%, (with an allowable tolerance of -5%), it shall be considered a test failure and the provisions of Paragraph 9.5 shall apply.

5.11 When the following have been successfully completed:

- (a) the evaluation of the certification data including ratings, the Data of Record (Appendix E), and dimensional drawings submitted by the Manufacturer is

satisfactory to the CTI Certification Administrator and

- (b) the results of the Initial Qualifying Test(s) demonstrate a thermal performance capability of at least 100% with an allowable tolerance of -5% and
- (c) the testing and administrative fees have been paid by the Manufacturer and
- (d) all information suitable for distribution to other participants including but not limited to performance and physical dimensions
 - (i) have been submitted in the form of a catalog, bulletin, or preferably an electronic equivalent
 - (ii) and made available through a link to the Manufacturer's website or the CTI website

to the CTI Certification Administrator

then a formal letter of acceptance (Appendix H) shall be sent to the Manufacturer advising the unique Certification Validation Number for the certified line; authorizing them to use the CTI Certification Logo in published literature pertaining to the certified line; and reiterating that a CTI Certification Label (Appendix I) shall be affixed to each certified unit sold. If the Manufacturer has more than one line of Certified products, they may include all Certification Validation Numbers on one CTI certification Label.

5.11.1 A copy of the letter of acceptance shall be retained on file by the CTI Certification Administrator and the CTI Office.

5.11.2 On the day a newly certified product line is introduced to the market, the Manufacturer shall notify the Certification Administrator to release within thirty (30) days to the other participants in the certification program the previously submitted information in 5.11(d).

5.12 The Manufacturer shall affix a permanent Serial Number and the CTI Certification Label displaying the appropriate validation number to each unit sold as certified. The CTI Certification Label shall conform to the wording as illustrated in the sample label presented in Appendix I.

5.13 The Manufacturer of a line of certified products may make design changes to the line at

any time. However, in making changes which affect any of the physical data of record (Appendices E and F), the ratings of one or more models comprising the line, or when adding new models to the line, the Manufacturer shall submit to the CTI Certification Administrator:

- (a) A description of the exact changes proposed, including any additions or modifications to the ratings and/or the Data of record described in Appendices E and F.
- (b) The approximate date on which the changes are to be implemented.
- (c) Within twenty (20) working days after the receipt of these data, the CTI Certification Administrator shall, at his discretion, either:
 - (i) Issue a formal acceptance of the change (using the format of Appendix H) based solely on his examination of the data.
 - (ii) Require testing of one or more models selected by the CTI Certification Administrator to verify the certified performance, which shall be treated as an additional qualifying test(s).

5.14 To demonstrate compliance with published ratings on an ongoing basis, an annual reverification test shall be conducted, at the Manufacturer's expense, on one model selected from each line of certified products by the CTI Certification Administrator. In the event any such unit fails to pass an annual reverification test (see Para. 5.9), the procedure of Paragraph 9.5 shall apply.

5.14.1 Annual reverification tests for each line of certified products shall be completed by December 31st of the applicable year. In the event of extenuating circumstances as deemed by the Certification Administrator, completion of the annual reverification test may be extended no later than July 31st of the following year. In the event an annual reverification test is not completed by this date, the procedure of Paragraph 9.8 shall apply.

5.15 The procedures set forth in the preceding paragraphs of this section shall be followed for each and every product line certified by the Cooling Technology Institute (CTI).

5.16 All data submitted by the Manufacturer of a certified line and all test reports shall be kept

permanently on file by the CTI Certification Administrator. Such files shall be held in strictest confidence by the CTI Certification Administrator and shall not be copied or distributed to any other parties, including the CTI Board of Directors, without the explicit, written authorization of the Manufacturer. When a product line has been withdrawn from the Certification Program for whatever reason, the CTI Certification Administrator shall maintain all of the files of said line for a period of two (2) years. At the end of the two (2) year period all files shall be returned to the Manufacturer. If the Manufacturer is no longer in business, then the files shall be destroyed.

5.17 The CTI shall publish annually a listing of each currently certified product line. This list shall include the name of the Manufacturer or distributor, the identification of the product line, the Certification Validation Number (see Para. 5.11) associated with the Manufacturer, and a link to a website containing the information suitable for distribution, i.e., certified ratings, physical dimensions, etc. (see Para 5.11(d)). Additionally, since there may be changes over the course of the year, such as the number of program participants, the number of product lines certified, or the certified ratings of any particular certified line, the CTI Certification Administrator shall supply, upon request, to any interested party, the current status of any participant or any product line model and will provide such changes for publication on the CTI website and routinely printed in the CTI Journals.

Section 6. Certification Program Committee

6.1 The CTI Certification Administrator shall be the Chairman and a non-voting representative on this Committee.

6.2 The functions of the Certification Program Committee shall include but not be limited to:

- (a) Advising the Certification Administrator
- (b) Ruling on any complaints regarding the interpretation of this standard.
- (c) Reviewing and approving the program administrative fee rate.

6.3 Each Manufacturer meeting all requirements of a certified Line(s) per this standard shall be duly represented on the Committee by one (1) voting representative.

(a) Voting representatives having their primary business locations outside of the United States shall be classified as International Voting Members.

6.4 Quorum to conduct business at meetings is established when the total number of Voting and International Voting Members in attendance (physically or electronically) is at least two-thirds (2/3) of the number of non-International Voting members both in attendance and absent.

(a) The number of affirmative votes for a motion to pass shall exceed one half (½) of the combined number of Voting and International Voting Members in attendance. The results of a vote shall be recorded in the meeting minutes.

(b) Letter or electronic ballots shall be distributed to all Voting Members and International Voting Members. The ballot shall specify the response deadline, which must allow a reasonable time period for responses. The results are tallied and reported when all Voting and International Voting Members have responded or the deadline is reached, whichever occurs first. Quorum for letter or electronic ballots is established when the number of ballot responses exceeds one half (½) of the total number of Voting and International Voting Members. The results of the vote shall be reported at the next meeting of the Certification Program Committee and recorded in the meeting minutes.

6.5 A simple majority vote of a letter or electronic ballot shall be required to overrule the Certification Administrator.

6.6 Failure to comply with administrative requirements adopted by the Certification Program Committee will be subject to the same penalties as available to the Administrator for failure to comply with provisions of this standard.

Section 7. Testing Procedures

7.1 Test Instrumentation employed on certification qualification or re-verification tests shall be as specified in the appropriate test code, except as hereinafter provided:

(a) All instruments and instrumentation systems shall be owned or approved by the Licensed CTI Certification Testing Agency.

(b) Remote reading temperature sensors and data acquisition system or thermometers, shall

be owned by CTI or its Licensed CTI Certification Testing Agency, and calibrated not less than annually to an accuracy of ± 0.05 °C (0.10 °F) or better against instrumentation traceable to the National Institute of Standards and Technology. The instrumentation shall be checked for calibration by the Licensed CTI Certification Testing Agency prior to each certification test series.

(c) Psychrometers used to measure wet bulb temperatures shall be as specified by CTI and be maintained by the Licensed CTI Certification Testing Agency.

(d) Appropriately sized Pitot tubes, Venturi meters or magnetic flow meters approved by the Certification Administrator and owned by the CTI or a Licensed CTI Certification Testing Agency shall be used for measuring the flow rates of non-volatile process fluids such as water and aqueous solutions of glycols.

Instruments approved for use in this program shall have National Institute of Standards and Technology (NIST) traceable flow calibrations, performed on a tri-annual basis, across the full range of their intended application. Laboratory calibration shall include a minimum of six (6) data points, spaced across the application range of the instrument. The calibration coefficient shall be expressed as a 2nd order polynomial, fit to the calibration data set, and expressed as a function of Reynolds number.

Non-Prandtl Pitot tube designs (such as the Simplex type commonly used by CTI Testing Agencies) shall be subject to the following limitations:

(i) The Pitot tube shall be calibrated over a range of Reynolds Numbers (expressed in terms of probe diameter or width) extending from 1.5E+04 to 6.5E+04. Calibrations shall be reported in the form of Pitot Coefficient versus Probe Tip Reynolds Number:

$$Re_{PT} = \frac{D \cdot V \cdot \rho}{\mu_e} \quad [\text{Eqn.1}]$$

Where:

D = Probe tip diameter (or width perpendicular to the axis of the pipe) in m (ft).

V = Process fluid velocity at the Pitot station in m/sec (ft/sec).

ρ = Density of process fluid for conditions at the Pitot station in kg/m^3 ($\text{lb}_\text{m}/\text{ft}^3$).

μ_e = Absolute viscosity of process fluid for conditions at the Pitot station in $\text{Pa}\cdot\text{s}$ ($\text{lb}_\text{m}/\text{ft}\cdot\text{sec}$).

- (ii) Due to the relative physical size of such Pitot Tubes, they shall not be used in pipes with a diameter less than 150 mm (6").
- (iii) To limit measurement uncertainty, the Reynolds Number of the fluid at the Pitot Station, expressed in terms of tip size, shall be neither greater nor less than the limits of calibration.
- (iv) During Pitot traverses, the pressure shall be sufficiently positive to bleed the pressure sensing device on all ports.
- (v) Such Pitot Tubes shall be checked at least twice annually against concurrent measurements made with an approved, CTI owned and calibrated, magnetic flow meter. Deviations of more than $\pm 4\%$ shall be cause for recalibration of both devices.

For volatile process fluids (refrigerants), a Coriolis flow meter shall be employed. Flow measurement devices shall be calibrated at least once every three years by a recognized hydraulics laboratory.

(e) A mercury manometer, calibrated pressure differential meter/transducer, and/or calibrated pressure gauges/transducers approved by the Certification Administrator and owned by CTI or the Licensed CTI Certification Testing Agency, shall be used to measure pressures and the pressure differential of the process fluid across the heat exchanger.

7.2 The Manufacturer may observe but not participate in reading or recording official test data.

7.3 The models selected for testing, as prescribed by this Standard, will preferably be production units. However, if prototypes are tested, subsequently, at the Manufacturer's expense, random production units shall be dimensionally and component checked by the CTI Certification Administrator or his designee as soon as practicable to verify conformance with the prototypes and the Physical Data Sheets of record.

Section 8. Complaint Procedures

8.1 Complaints regarding non-compliance with this Standard can be submitted to the CTI Certification Administrator by Certification Program Committee participants or by customers who have purchased a product certified under this program.

8.2 Complaints of non-compliance shall be submitted within twenty-four (24) months after shipment of the certified product from the Manufacturer. The unit in question shall have been in service for not less than one (1) month or more than twelve (12) months.

8.3 Complaints shall include the following:

- (a) The name of the Manufacturer and the Certification Validation Number affixed to the unit.
- (b) The model number of the certified product.
- (c) The serial number of the certified product.
- (d) The design operating conditions.
- (e) Drawings, sketches, or photographs of the installation site illustrating the relationship of the certified unit to the surrounding structures.
- (f) Actual measurements of temperatures, flow rates, fan motor output power, and any other evidence or information on which the party bases its complaint.

8.4 Upon receipt of such a complaint, the Certification Administrator shall:

- (a) Immediately notify the Manufacturer of the complaint.
- (b) Provide the Manufacturer with all known complaint details.