INTERNATIONAL STANDARD

**ISO 16345**

First edition
2014-06-01

# Water-cooling towers — Testing and rating of thermal performance

*Tours de refroidissement de l'eau — Essais et détermination des caractéristiques de performance*

Reference number
ISO 16345:2014(E)

© ISO 2014



## COPYRIGHT PROTECTED DOCUMENT

© ISO 2014

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

# Contents

Page

**Foreword** ..... **v**

**1 Scope** ..... **1**

**2 Terms and definitions** ..... **1**

**3 Symbols and abbreviations** ..... **7**

**4 Performance tests — General** ..... **10**
4.1 Application of standard ..... 10
4.2 Test schedule ..... 11
4.3 Pretest agreements ..... 11
4.4 Flexibility ..... 11

**5 Objective of tests** ..... **12**
5.1 General ..... 12
5.2 Basis of guarantee ..... 12
5.3 Form of the guarantee documents ..... 12

**6 Test preparation** ..... **17**
6.1 Purpose ..... 17
6.2 Test scheduling and site preparation ..... 17
6.3 Tower physical condition ..... 18
6.4 Provisions for instrumentation ..... 19
6.5 Fan driver input power ..... 22
6.6 Site conditions ..... 23
6.7 Miscellaneous ..... 23

**7 Instrumentation and test setup** ..... **24**
7.1 Calibration ..... 24
7.2 Flow measurements ..... 24
7.3 Temperature measurements ..... 24
7.4 Pressure measurements ..... 26
7.5 Fan/pump driver power ..... 27
7.6 Wind velocity (speed and direction) ..... 27
7.7 Tower pump head ..... 28
7.8 Water or process fluid analysis ..... 28

**8 Execution of test** ..... **28**
8.1 Requirements for testing type ..... 28
8.2 Basic tests ..... 28
8.3 Extended tests ..... 32

**9 Evaluation of tests** ..... **34**
9.1 General ..... 34
9.2 Computation of test period values from test reading values ..... 34
9.3 Basic thermal performance test evaluation (for all tower types) ..... 38
9.4 Extended thermal performance test evaluation (applicable to natural draft towers, only if required by contract) ..... 51

**10 Reporting of results** ..... **55**
10.1 General ..... 55
10.2 Final report ..... 55
10.3 Security ..... 55
10.4 Limitations ..... 56

**11 Published ratings** ..... **56**

**Annex A** (normative) **Instruments and measurements** ..... **57**

**Annex B** (normative) **Wet-bulb determination** ..... **63**

**Annex C** (normative) **Inlet-air temperature measurement locations** ..... **68**

© ISO 2014 – All rights reserved

**Annex D** (normative) **Thermodynamic properties of moist air** ..... **71**

**Annex E** (informative) **Values of crossflow correction factor** ..... **84**

**Annex F** (informative) **Example evaluation of an open-circuit, mechanical draft cooling tower test using the performance curve method** ..... **86**

**Annex G** (informative) **Example evaluation of an open-circuit, mechanical draft cooling tower test using the characteristic curve method** ..... **95**

**Annex H** (normative) **Example evaluation of a natural draft cooling tower test using the performance curve method** ..... **102**

**Annex I** (normative) **Example evaluation of a natural draft cooling tower using the extended test method** ..... **119**

**Annex J** (normative) **Example evaluation of an open-circuit, wet/dry, mechanical draft cooling tower** ..... **125**

**Annex K** (normative) **Example evaluation of a closed-circuit cooling tower test using the performance curve method** ..... **138**

**Annex L** (informative) **Alternative measurements of test *L/G*** ..... **144**

**Annex M** (informative) **Precheck list** ..... **147**

**Bibliography** ..... **150**

 © ISO 2014 – All rights reserved

# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 6, *Testing and rating of air-conditioners and heat pumps*.

© ISO 2014 – All rights reserved

# Water-cooling towers — Testing and rating of thermal performance

## 1 Scope

This International Standard covers the measurement of the thermal performance and pumping head of open- and closed-circuit, mechanical draft, wet and wet/dry cooling towers and natural draft and fan-assisted natural draft, wet and wet/dry cooling towers. The standard rating boundaries for series mechanical draft, open- and closed-circuit cooling towers are specified.

This International Standard does not apply to the testing and rating of closed-circuit towers where the process fluid undergoes a change in phase as it passes through the heat exchanger or where the thermophysical properties of the process fluid are not available.

## 2 Terms and definitions

For the purposes of this document, the following terms and definitions apply. The symbols used to identify the terms contained in this International Standard are listed and defined in Clause 3.

**2.1**
**airflow rate**
total amount of dry air and associated vapour water moving through the cooling tower

**2.2**
**ambient air conditions**
atmosphere adjacent to, but not affected by, the cooling tower

**2.3**
**approach**
difference between cold (re-cooled) water temperature and the inlet-air wet-bulb temperature

**2.4**
**approach deviation**
deviation between the guaranteed and adjusted test approach

**2.5**
**atmospheric gradient (lapse rate)**
average rate of change of dry-bulb temperature with change in altitude from cold water basin curb, or sill, level to around twice the height of the cooling tower

Note 1 to entry: The convention for use with this International Standard will be to use a negative value for decrease in temperature as height increases.

**2.6**
**average wind direction**
predominant direction of the wind over the duration of the test period

**2.7**
**average wind speed**
arithmetical average of wind speed measurements taken over the duration of the test period

**2.8**
**barometric pressure**
atmospheric pressure taken over the duration of each test period

© ISO 2014 – All rights reserved