Update No. 1

ASSE 1016-2011/ASME A112.1016-2011/ CSA B125.16-11

May 2012

Note: *General Instructions for CSA Standards are now called Updates. Please contact CSA Information Products Sales or visit* ***shop.csa.ca*** *for information about the* ***CSA Standards Update Service****.*

Title: *Performance requirements for automatic compensating valves for individual showers and tub/shower combinations* — originally published October 2011

The following revisions have been formally approved and are marked by the symbol delta (Δ) in the margin on the attached replacement pages:

Revised	Preface, Clauses 4.5.2 and 4.5.3
New	None
Deleted	None

- Update your copy by inserting these revised pages.
- Keep the pages you remove for reference.

ASME

J1851QM1

Δ Preface

This is the first edition of ASSE 1016/ASME A112.1016/CSA B125.16, *Performance requirements for automatic compensating valves for individual showers and tub/shower combinations*. It supersedes the previous edition of ASSE 1016, published in 2005 and Clause 5.10 of ASME A112.18.1-2011/ CSA B125.1-11.

This Standard is considered suitable for use with conformity assessment within the stated scope of the Standard.

This Standard was prepared by the ASSE/ASME/CSA Harmonization Task Group on Plumbing Fittings, under the jurisdiction of the ASME A112 Main Committee, the ASSE Product Standards Committee, and the CSA Technical Committee on Plumbing Fittings. The CSA Technical Committee operates under the jurisdiction of the CSA Strategic Steering Committee on Water Management Products, Materials, and Systems.

This Standard will be submitted for formal approval by the ASME Standards Committee on Plumbing Materials and Equipment, the ASSE Product Standards Committee and the CSA Technical Committee. This Standard was approved as an American National Standard by the American National Standards Institute on July 12, 2011.

October 2011

ASME Notes:

(1) *This standard was developed under procedures accredited as meeting the criteria for American National Standards and it is an American National Standard. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed Standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.*

(2) *ASME does not "approve," "rate," or "endorse" any item, construction, proprietary device, or activity.*

(3) *ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assume any such liability. Users of a standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.*

(4) *Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this standard.*

(5) *ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which precludes the issuance of interpretations by individuals.*

(6) *ASME issues written replies to inquiries concerning interpretation of technical aspects of this Standard. All inquiries regarding this Standard, including requests for interpretations, should be addressed to:*
Secretary, A112 Standards Committee
The American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

A request for interpretation should be clear and unambiguous. The request should

- *cite the applicable edition of the Standard for which the interpretation is being requested.*
- *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, which are necessary to explain the question; however, they should not contain proprietary names or information.*

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.

Interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org/ as they are issued.

CSA Notes:

(1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*

(2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

(3) *This publication was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this publication.*

(4) *To submit a request for interpretation of CSA Standards, please send the following information to* ***inquiries@csa.ca*** *and include "Request for interpretation" in the subject line:*

(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;

(b) provide an explanation of circumstances surrounding the actual field condition; and

(c) where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.

Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are published in CSA's periodical* Info Update, *which is available on the CSA website at* ***http://standardsactivities.csa.ca****.*

(5) *CSA Standards are subject to periodic review, and suggestions for their improvement will be referred to the appropriate committee. To submit a proposal for change to CSA Standards, please send the following information to* ***inquiries@csa.ca*** *and include "Proposal for change" in the subject line:*

(a) Standard designation (number);

(b) relevant clause, table, and/or figure number;

(c) wording of the proposed change; and

(d) rationale for the change.

(6) *Attention is drawn to the possibility that some of the elements of this Standard may be the subject of patent rights. CSA is not to be held responsible for identifying any or all such patent rights. Users of this Standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.*

May 2012
(Replaces p. xiv, October 2011)

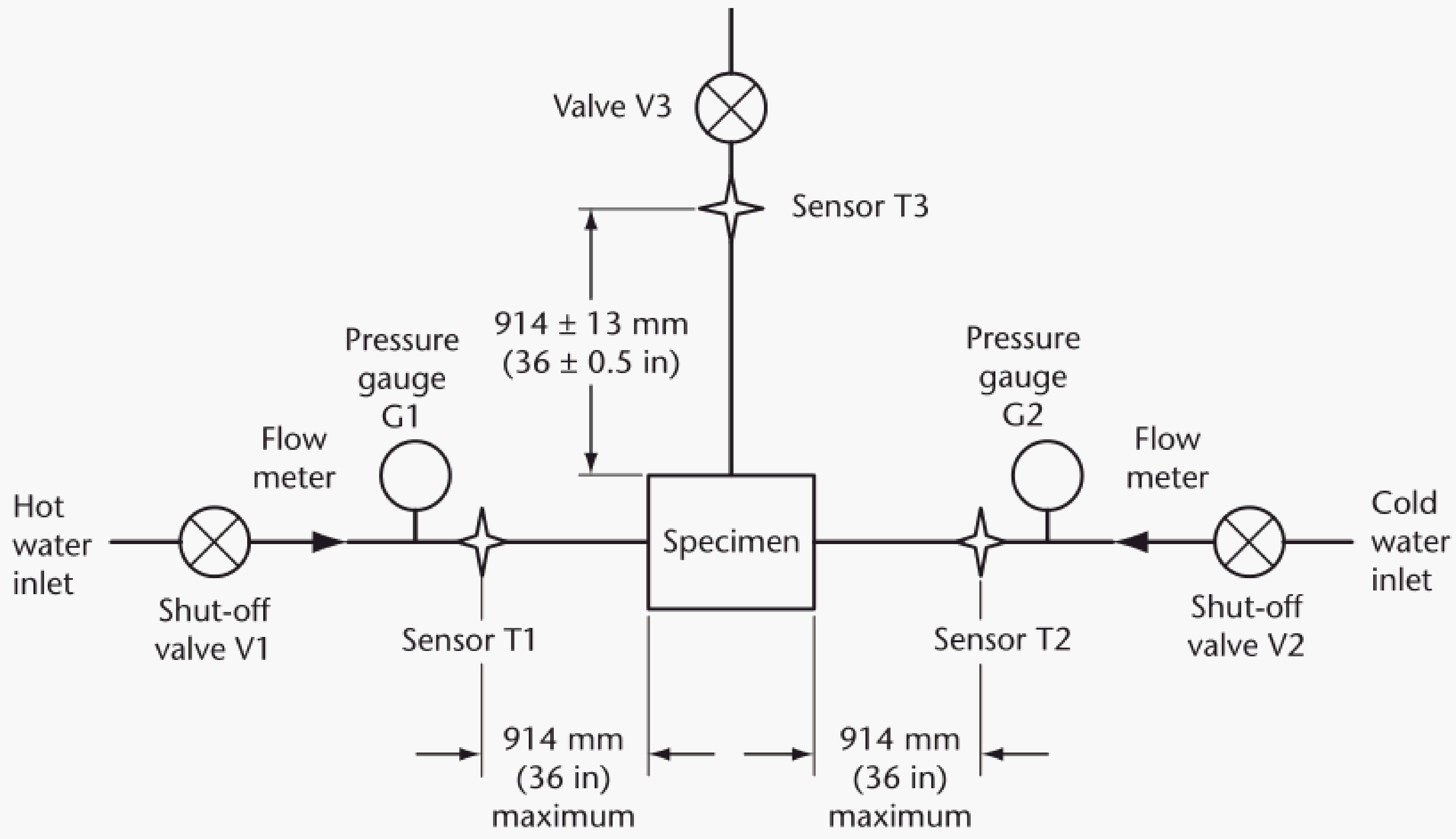

Figure 1
Set-up for high-temperature conditioning, pressure and temperature variation, and water supply pressure loss tests
(See Sections 4.2.2.2, 4.4.2.2, 4.6.2, 4.6.3, 4.7.2.1, 4.8.2, and 4.9.2.)

4.3 Working pressure test

4.3.1 Purpose

The purpose of this test is to determine if the device can withstand pressures between 140.0 and 860.0 kPa (20 and 125.0 psi).

4.3.2 Procedure with the valves closed

The device shall be tested in accordance with Section 4.3.4 with the device's valve in the closed position. The specimen shall be subjected to the pressures specified in Section 4, for 5 min each.

4.3.3 Procedure with the outlet(s) blocked

The device shall be tested in accordance with Section 4 with the device's valve in the fully open position. The outlet(s) shall then be blocked and the specimen shall be subjected to the pressures specified in Section 4, for 5 min each.

4.3.4 Test temperatures and pressures

4.3.4.1

The test shall be conducted in an ambient environment of 20.0 ± 5.0 °C (68.0 ± 9.0°F). The device shall be brought to equilibrium test temperatures by running water through it.

4.3.4.2

Test temperatures and pressures shall be as follows:
(a) 140.0 ± 13.8 kPa and 10.0 ± 6.0 °C (20.0 ± 2.0 psi and 50.0 ± 10.0°F);
(b) 860.0 ± 13.8 kPa and 10.0 ± 6.0 °C (125.0 ± 2.0 psi and 50.0 ± 10.0°F);

(c) 140.0 ± 13.8 kPa and 66.0 ± 6.0 °C (20.0 ± 2.0 psi and 150.0 ± 10.0°F); and
(d) 860.0 ± 13.8 kPa and 66.0 ± 6.0 °C (125.0 ± 2 psi and 150.0 ± 10.0°F).

4.3.5 Failure criteria
Leakage or other failures of the seals shall result in the rejection of the device.

4.4 Maximum operating torque or force adjustment test

4.4.1 Purpose
The purpose of this test is to determine the maximum torque or force required to adjust the device.

4.4.2 Procedure

4.4.2.1
Conduct the tests specified in Clause 5.5 of ASME A112.18.1/CSA B125.1.

4.4.2.2
After the tests specified in Section 4.4.2.1, the following tests shall be conducted:
(a) Set up the specimen as specified in Items (a) to (f) of Section 4.6.3. See Figure 1.
(b) Move the adjusting mechanism of the specimen (e.g., handle(s) or lever(s)) through its full operating range. The force shall be applied at the extreme end of the adjusting mechanism.
(c) Record the maximum operating torque or force.

4.4.3 Failure criteria
A maximum operating torque or force to adjust the device exceeding the requirements specified in ASME A112.18.1/CSA B125.1 shall result in the rejection of the device.

4.5 Life cycle tests

4.5.1 Purpose
The purpose of these tests is to determine if there is any deterioration in the performance of the device upon completion of the following cycles of operation:
(a) The operating control test shall simulate the intended operating motion of the device.
(b) The internal elements test shall simulate inlet pressure and temperature changes.

Δ 4.5.2 Procedure — Operating controls
The life cycle test for operating controls shall be conducted as follows:
(a) Set up and test the specimen in accordance with the set-up and conditions specified in Figure 2 with valves V1 and V3 and the device's valve fully open. This test shall simulate the intended operating motion of the device without impacting the end stops, except as agreed to by the manufacturer.
(b) Prior to starting the test, the following conditions shall be established and maintained for 1 min:
  (i) 344.8 ± 34.5 kPa (50.0 ± 5.0 psi) flowing as measured at the inlets;
  (ii) 40.6 ± 3.0 °C (105.0 ± 5.0°F) measured at the outlet;
  (iii) A minimum flow of 4.5 L/min (1.2 gpm) by adjusting valve V5; and
  (iv) the device's maximum outlet temperature adjusted to 49.0 +0.0, -6.0 °C (120.0 +0.0, -10.0°F) using the device's temperature limit stop adjustment.
(c) The temperature and volume control mechanism(s) shall be tested for 20,000 cycles of the control dial, handle, or knob, cycled at a constant rate between 5 and 20 cycles per minute, as specified in Items (i) to iv). The packing nut may be tightened once during the life cycle test to stop leakage.
  (i) Single-handle mixing valves of the cycling type: the control shall be operated from full-off to the full-on cold, position through full-on mixed to the full-on hot position, through full-on mixed to the full-on cold position, and back to the off position, to complete one cycle.

(ii) Single-control mixing valves with combined volume and temperature control: the control shall be adjusted to operate the volume control from off to the full-on 40.6 ± 3.0 °C (105.0 ± 5.0°F) position, to the full-on cold position, to the full-on hot limit stop position, to the 40.6 ± 3.0 °C (105.0 ± 5.0°F) position, to the off position, to complete one cycle.
(iii) Devices with a separate volume control: the volume control shall be turned full-on, the temperature control dial shall be turned through its full operating range and back, the volume control shall be turned off to complete one cycle.
(iv) Single-handle mixing valves that only have temperature control: the testing laboratory shall provide a shut-off valve, and the device shall be tested in accordance with Section 4.5.2(c)(iii).

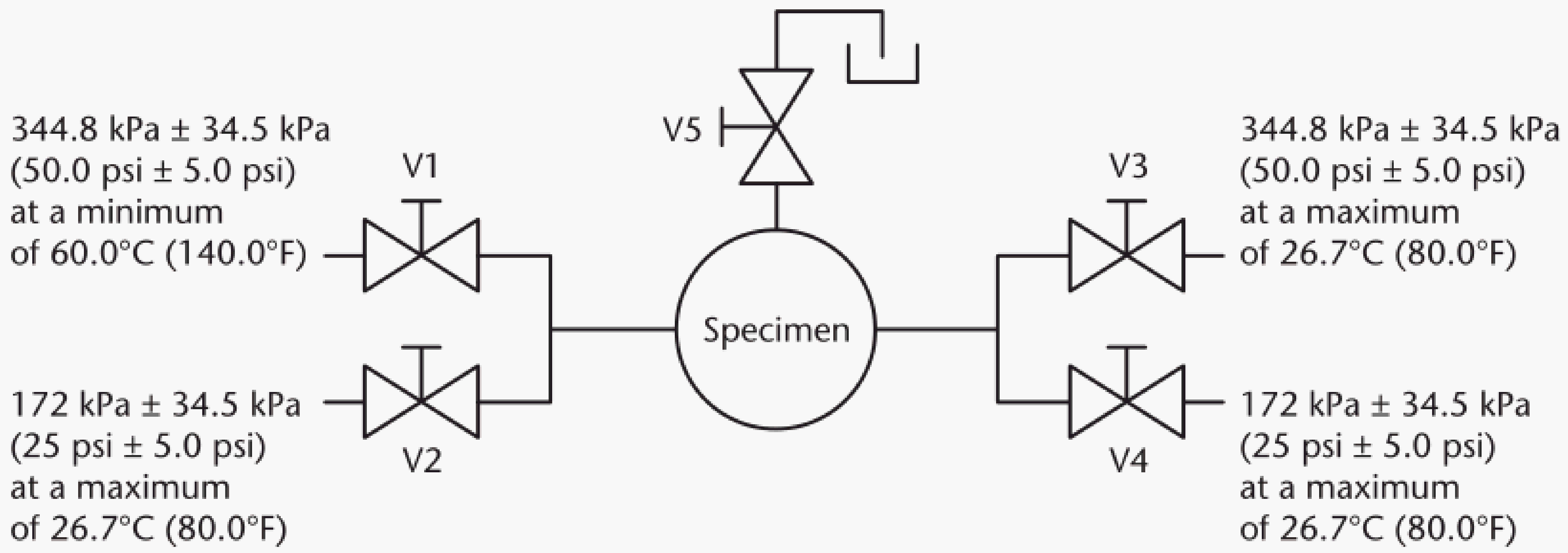

Figure 2
Set-up for life cycle test for automatic compensating valves
(See Sections 4.5.2 and 4.5.3.)

Δ 4.5.3 Procedure — Internal elements

The life cycle test for internal elements shall be conducted as follows:
(a) Set up and test the specimen in accordance with the set-up and conditions specified in Figure 2 with valves V1, V3 and the device's valve fully open.
(b) Before starting the test, establish and maintain for 1 min the following conditions:
(i) 344.8 ± 34.5 kPa (50.0 ± 5.0 psi) flowing as measured at the inlets;
(ii) 40.6 ± 3.0 °C (105.0 ± 5.0°F) measured at the outlet; and
(iii) A minimum flow of 4.5 L/min (1.2 gpm) by adjusting valve V5.
(c) Change the conditions to those described in Step 1 of Table 1 and maintain for 4 s, then change the conditions to Step 2 in Table 1 and maintain for 4 s. Return to the beginning conditions in Step 1 to complete one cycle.
(d) Test the internal elements for 80,000 cycles in accordance with Table 1.

Table 1
Life cycle test for the control mechanism
(See Section 4.5.3.)

	Valve 1	Valve 2	Valve 3	Valve 4	Duration
Step 1	Open	Closed	Closed	Open	4 s
Step 2	Closed	Open	Open	Closed	4 s

4.5.4 Working pressure

Retest the device in accordance with Section 4.3.

4.5.5 Maximum torque or operating force

Retest the device in accordance with Section 4.4.

4.5.6 Failure criteria

During the test, leakage or the need to tighten the packing nut more than once shall result in a rejection of the device.

During the test specified in Section 4.5.4, any leakage shall result in the rejection of the device.

During the test specified in Section 4.5.5, an operating torque or force that exceeds 120% of the requirements of Section 4.4 shall result in the rejection of the device. Accessible designs shall not exceed the requirements specified in Section 4.4.

4.6 Pressure and temperature variation test

4.6.1 Purpose

The purpose of this test is to determine if the outlet water temperature at the point-of-use is maintained within a set temperature range.

4.6.2 Data gathering, all types of devices (see Figure 1)

Data shall be gathered as follows:

(a) The temperature-recording device shall be started 10 s before the step changes.

(b) Temperature measurements shall be taken at temperature sensors T1, T2, and T3 with measuring equipment capable of detecting a 63.2% step change within 0.3 s with a frequency rate of 20 Hz (one value every 0.05 s) for 25 ± 5 s unless otherwise specified in this Standard. See Annex A.

(c) The outlet temperature measurements at sensor T3 shall be averaged every 0.25 s.

(d) Temperature sensors T1, T2, and T3 shall be located as follows:

  (i) Temperature sensors T1, T2, and T3, within the flow stream in Type K or Type L copper water tube.

  (ii) Temperature sensors T1 and T2, within 914 mm (36 in) of the device.

  (iii) Temperature sensor T3, within 914 ± 13 mm (36 ± 0.5 in) from the outlet of the device. The outlet tube shall be the same size as the outlet connection size of the device.

Notes:

(1) *For verifying the time constant of the temperature-measuring equipment, see Annex A.*

(2) *Data can be gathered in formats similar to those depicted in Figures B.1 to B.5.*

4.6.3 Procedure — All types of devices (see Figure 1)

Controllers with pressure feedback loops shall not be active during the tests, but may be used to set the test parameters.

Note: *Controllers with pressure feedback loops interact with the specimen and result in inaccurate test results.*

The pressure and temperature variation test shall be conducted as follows:

(a) Set up the specimen as shown in Figure 1, with valves V1, V2, and V3 and the device's valve in the fully open position.

(b) Adjust and maintain the hot and cold water supply pressures directly upstream of the inlet connections to a flowing pressure of 310.3 ± 13.8 kPa (45.0 ± 2.0 psi), as measured by gauges G1 and G2.

(c) Adjust the temperatures at temperature sensors T1 and T2 so that there is a temperature differential of 44.0 to 56.0 °C (80.0 to 100.0°F) between the hot water temperature [minimum of 60.0 °C (140.0°F)] and the cold water temperature [maximum of 21.1 °C (70.0°F)]. After the hot water and cold water inlet temperatures are established maintain the inlet temperatures at ±1.0 °C (±2.0°F).

(d) Adjust the device so that the outlet temperature at temperature sensor T3 (point of use outlet) is 40.5 ± 0.5 °C (105.0 ± 1.0°F).

CSA STANDARDS

ASSE 1016-2011/ ASME A112.1016-2011/ CSA B125.16-11

Performance requirements for automatic compensating valves for individual showers and tub/shower combinations

The American Society of Mechanical Engineers

Legal Notice for Harmonized Standard Jointly Developed by ASME, ASSE, and CSA

Intellectual property rights and ownership

As between The American Society of Mechanical Engineers ("ASME"), American Society of Sanitary Engineering ("ASSE"), and Canadian Standards Association ("CSA") (collectively "ASME, ASSE, and CSA") and the users of this document (whether it be in printed or electronic form), ASME, ASSE, and CSA are the joint owners of all works contained herein that are protected by copyright, all trade-marks (except as otherwise noted to the contrary), and all inventions and trade secrets that may be contained in this document, whether or not such inventions and trade secrets are protected by patents and applications for patents. The unauthorized use, modification, copying, or disclosure of this document may violate laws that protect the intellectual property of ASME, ASSE, and CSA and may give rise to a right in ASME, ASSE, and CSA to seek legal redress for such use, modification, copying, or disclosure. ASME, ASSE, and CSA reserve all intellectual property rights in this document.

Disclaimer and exclusion of liability

This document is provided without any representations, warranties, or conditions of any kind, express or implied, including, without limitation, implied warranties or conditions concerning this document's fitness for a particular purpose or use, its merchantability, or its non-infringement of any third party's intellectual property rights. ASME, ASSE, and CSA do not warrant the accuracy, completeness, or currency of any of the information published in this document. ASME, ASSE, and CSA make no representations or warranties regarding this document's compliance with any applicable statute, rule, or regulation.

IN NO EVENT SHALL ASME, ASSE, and CSA, THEIR RESPECTIVE VOLUNTEERS, MEMBERS, SUBSIDIARIES, OR AFFILIATED COMPANIES, OR THEIR EMPLOYEES, DIRECTORS, OR OFFICERS, BE LIABLE FOR ANY DIRECT, INDIRECT, OR INCIDENTAL DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES, HOWSOEVER CAUSED, INCLUDING BUT NOT LIMITED TO SPECIAL OR CONSEQUENTIAL DAMAGES, LOST REVENUE, BUSINESS INTERRUPTION, LOST OR DAMAGED DATA, OR ANY OTHER COMMERCIAL OR ECONOMIC LOSS, WHETHER BASED IN CONTRACT, TORT (INCLUDING NEGLIGENCE), OR ANY OTHER THEORY OF LIABILITY, ARISING OUT OF OR RESULTING FROM ACCESS TO OR POSSESSION OR USE OF THIS DOCUMENT, EVEN IF ASME OR CSA HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, INJURY, LOSS, COSTS, OR EXPENSES.

In publishing and making this document available, ASME, ASSE, and CSA are not undertaking to render professional or other services for or on behalf of any person or entity or to perform any duty owed by any person or entity to another person or entity. The information in this document is directed to those who have the appropriate degree of experience to use and apply its contents, and ASME, ASSE, and CSA accept no responsibility whatsoever arising in any way from any and all use of or reliance on the information contained in this document.

ASME, ASSE, and CSA have no power, nor do they undertake, to enforce compliance with the contents of the standards or other documents they jointly publish.

Authorized use of this document

This document is being provided by ASME, ASSE, and CSA for informational and non-commercial use only. The user of this document is authorized to do only the following:

If this document is in electronic form:

- load this document onto a computer for the sole purpose of reviewing it;
- search and browse this document; and
- print this document if it is in PDF format.

Limited copies of this document in print or paper form may be distributed only to persons who are authorized by ASME, ASSE, and CSA to have such copies, and only if this Legal Notice appears on each such copy.

In addition, users may not and may not permit others to

- alter this document in any way or remove this Legal Notice from the attached standard;
- sell this document without authorization from ASME, ASSE, and CSA; or
- make an electronic copy of this document.

If you do not agree with any of the terms and conditions contained in this Legal Notice, you may not load or use this document or make any copies of the contents hereof, and if you do make such copies, you are required to destroy them immediately. Use of this document constitutes your acceptance of the terms and conditions of this Legal Notice.

The American Society of Mechanical Engineers

CANADIAN STANDARDS ASSOCIATION

CSA Standards Update Service

ASSE 1016-2011/
ASME A112.1016-2011/
CSA B125.16-11
October 2011

Title: *Performance requirements for automatic compensating valves for individual showers and tub/shower combinations*
Pagination: 35 pages (xv preliminary and 20 text), each dated **October 2011**

To register for e-mail notification about any updates to this publication

- go to **www.ShopCSA.ca**
- click on **E-mail Services** under **MY ACCOUNT**
- click on **CSA Standards Update Service**

The **List ID** that you will need to register for updates to this publication is **2421370**.

If you require assistance, please e-mail **techsupport@csa.ca** or call 416-747-2233.

Visit CSA's policy on privacy at **www.csagroup.org/legal** to find out how we protect your personal information.

ASSE/ASME/CSA Standard

ASSE 1016-2011/ ASME A112.1016-2011/ CSA B125.16-11

Performance requirements for automatic compensating valves for individual showers and tub/shower combinations

[®]*Registered trade-mark of Canadian Standards Association*

Commitment for Amendments

This Standard is issued jointly by The American Society of Mechanical Engineers (ASME), the American Society of Sanitary Engineering (ASSE), and the Canadian Standards Association (CSA). Amendments to this Standard will be made only after processing according to the Standards development procedures of ASME, ASSE, and CSA.

The American Society of Mechanical
Engineers (ASME)
Three Park Avenue
New York, NY 10016-5990
USA
www.asme.org

ISBN 978-0-7918-3399-5

The 2011 edition of this Standard is being issued with an automatic addenda subscription service. The use of addenda allows revisions made in response to public review comments or committee actions to be published as necessary.

Published in October 2011by
Canadian Standards Association
A not-for-profit private sector organization
5060 Spectrum Way, Suite 100
Mississauga, Ontario, Canada
L4W 5N6
1-800-463-6727 or 416-747-4044
Visit the CSA Online Store at
www.ShopCSA.ca

ISBN 978-1-55491-702-0

American Society of Sanitary Engineering
901 Canterbury Road, Suite A
Westlake, Ohio 44145-1480 USA
Tel: 440-835-3040 or Fax: 440-835-3488

E-mail: general.info@asse-plumbing.org

www.asse-plumbing.org

Contents

Annexes

Tables

Figures

ASME Standards Committee on Plumbing Materials and Equipment

D.W. Viola	IAPMO, Mokena, Illinois, USA	*Chair*
S.A. Remedios	Delta Faucet Company, Indianapolis, Indiana, USA	*Vice-Chair*
R.H. Ackroyd	Rand Technical Consulting, Newburyport, Massachusetts, USA	
S.F. Aridi	NSF International, Ann Arbor, Michigan, USA	
J.A. Ballanco	JB Engineering & Code Consulting, PC, Munster, Indiana, USA	
J. Bouwer	Euro Sales Inc., Elora, Ontario	
M.N. Burgess	Burgess Group Incorporated, San Diego, California, USA	
S.L. Cavanaugh	Cavanaugh Consulting, Burbank, California, USA	
P.V. DeMarco	IAPMO, Dayton, New Jersey, USA	
G.S. Duren	Code Compliance Inc., Keystone Heights, Florida, USA	
A.R. Emmerson	Mundelein, Illinois, USA	
K. Fromme	Bradley Corporation, Menomonee Falls, Wisconsin, USA	
L.S. Galowin	Bethesda, Maryland, USA	
R.I. Greenwald	Dover, Delaware, USA	
G.W. Harrison	Wayne Harrison Consulting, Edmond, Oklahoma, USA	
S. Hazzard	ASSE, Westlake, Ohio, USA	
J.M. Koeller	Koeller and Company, Yorba Linda, California, USA	
N.M. Kummerlen	Lorain, Ohio, USA	

C.J. Lagan	American Standard, Piscataway, New Jersey, USA	
J.W. Lauer	Sloan Valve Company, Franklin Park, Illinois, USA	
L.A. Mercer	Moen Inc., North Olmsted, Ohio, USA	
T.C. Pitcherello	New Jersey Department of Community Affairs, Trenton, New Jersey, USA	
S. Rawalpindiwala	Kohler Co., Kohler, Wisconsin, USA	
G.L. Simmons	Charlotte Pipe and Foundry Co., Charlotte, North Carolina, USA	
W.M. Smith	Jay R. Smith Mfg. Co., Montgomery, Alabama, USA	
W.C. Whitehead	Whitehead Consulting Services, Danvers, Massachusetts, USA	
F. Constantino	ASME International, New York, New York, USA	*Secretary*

ASSE Product Standards Committee

CSA Technical Committee on Plumbing Fittings

K. Ernst	Oakville Stamping & Bending Limited, Oakville, Ontario, Canada	*Chair*
B. Lagueux	Saint-Nicolas, Québec, Canada *Consumer Representative*	*Vice-Chair*
W. Ball	Woodford Manufacturing Company, Colorado Springs, Colorado, USA	*Associate*
R. Beck	ICC Evaluation Service Inc., Birmingham, Alabama, USA	*Associate*
J.E. Bertrand	Moen Inc., North Olmsted, Ohio, USA	*Associate*
R. Bratsch-Blundel	George Brown College, Toronto, Ontario, Canada	
S. Breda	Breda & Associates Ltd., Toronto, Ontario, Canada	
S.L. Cavanaugh	Cavanaugh Consulting, Burbank, California, USA	
I.W. Chang	Intertek, Coquitlam, British Columbia, Canada	*Associate*
W.E. Chapin	Cash Acme, Cullman, Alabama, USA	*Associate*
R.B. Chauhan	Canadian Institute for Plumbing and Heating, Ottawa, Ontario, Canada	
M. Dennis	Moen Incorporated, Oakville, Ontario, Canada	
N. Dickey	CSA International, Cleveland, Ohio, USA	*Associate*
J. Drumm	City of Peterborough, Peterborough, Ontario, Canada	
Y. Duchesne	Régie du bâtiment du Québec, Québec, Québec, Canada	
W. Falcomer	City of Ottawa, Ottawa, Ontario, Canada *Representing the Ontario Plumbing Inspectors Association*	

D. Green	National Research Council Canada, Ottawa, Ontario, Canada	
J.C. Gunn	John C. Gunn Consulting, Roches Point, Ontario, Canada	
L. Himmelblau	Chicago Faucet Company, Des Plaines, Illinois, USA	
E. Ho	IAPMO Research & Testing, Inc., Ontario, California, USA	*Associate*
K.S. Hui	Ontario Ministry of Municipal Affairs and Housing, Toronto, Ontario, Canada	
A. Knapp	A. Knapp & Associates, Toronto, Ontario, Canada *Representing the Canadian Copper and Brass Development Association*	
J. Knapton	SAIT Polytechnic, Calgary, Alberta, Canada	
N.M. Kummerlen	Lorain, Ohio, USA	
F. Lemieux	Health Canada, Ottawa, Ontario, Canada	
M. Malatesta	American Standard, Piscataway, New Jersey, USA	*Associate*
S.E. Martin	International Code Council, Whittier, California, USA	*Associate*
D. McNamara	Franke Kindred Canada Limited, Midland, Ontario, Canada	*Associate*
S. O'Neill	Mohawk College, Stoney Creek, Ontario, Canada	
D. Orton	NSF International, Ann Arbor, Michigan, USA	*Associate*
P. Paré	Watts Industries (Canada) Inc., Burlington, Ontario, Canada	*Associate*
S. Rawalpindiwala	Kohler Co., Kohler, Wisconsin, USA	
S.A. Remedios	Delta Faucet Company, Indianapolis, Indiana, USA	
P. Saeed	Powers (a division of Watts Water Technologies, Inc.), Des Plaines, Illinois, USA	

C.W. Trendelman	Delta Faucet Company, Indianapolis, Indiana, USA	*Associate*
C. Wright	Ontario Pipe Trades, Dundalk, Ontario, Canada	
A.I. Murra	Canadian Standards Association, Mississauga, Ontario, Canada	*Project Manager*
L. Pilla	Canadian Standards Association, Mississauga, Ontario, Canada	*Project Manager*

ASME/ASSE/CSA Harmonization Task Group on Plumbing Fittings

W.J. Hall	Leonard Valve Company, Cranston, Rhode Island, USA	*Co-Chair*
F. Lemieux	Health Canada, Ottawa, Ontario, Canada	*Co-Chair*
M. Malatesta	American Standard, Piscataway, New Jersey, USA	*Co-Chair*
R.H. Ackroyd	Rand Technical Consulting, Newburyport, Massachusetts, USA	
J.E. Bertrand	Moen Inc., North Olmsted, Ohio, USA	
M. Campos	IAPMO Research & Testing, Inc., Ontario, California, USA	
W.E. Chapin	Cash Acme, Cullman, Alabama, USA	
S. Cleary	IAPMO, Scranton, Pennsylvania, USA	
N. Dickey	CSA International, Cleveland, Ohio, USA	
S. Hazzard	ASSE, Westlake, Ohio, USA	
L. Himmelblau	Chicago Faucet Company, Des Plaines, Illinois, USA	
J. Kajak	Palm Beach County, Boynton Beach, Florida, USA	
T.J. Kilbane	Symmons Industries Incorporated, Braintree, Massachusetts, USA	
N.M. Kummerlen	Lorain, Ohio, USA	
D. Orton	NSF International, Ann Arbor, Michigan, USA	
S. Rawalpindiwala	Kohler Co., Kohler, Wisconsin, USA	
S.A. Remedios	Delta Faucet Company, Indianapolis, Indiana, USA	

P. Saeed	Powers (a division of Watts Water Technologies, Inc.), Des Plaines, Illinois, USA	
A.I. Murra	Canadian Standards Association, Mississauga, Ontario, Canada	*Project Manager*
L. Pilla	Canadian Standards Association, Mississauga, Ontario, Canada	*Project Manager*

Preface

This is the first edition of ASSE 1016/ASME A112.1016/CSA B125.16, *Performance requirements for automatic compensating valves for individual showers and tub/shower combinations*. It supersedes the previous edition of ASSE 1016, published in 2005 and Clause 5.10 of ASME A112.18.1-2010/ CSA B125.1-10.

This Standard is considered suitable for use with conformity assessment within the stated scope of the Standard.

This Standard was prepared by the ASSE/ASME/CSA Harmonization Task Group on Plumbing Fittings, under the jurisdiction of the ASME A112 Main Committee, the ASSE Product Standards Committee, and the CSA Technical Committee on Plumbing Fittings. The CSA Technical Committee operates under the jurisdiction of the CSA Strategic Steering Committee on Water Management Products, Materials, and Systems.

This Standard will be submitted for formal approval by the ASME Standards Committee on Plumbing Materials and Equipment, the ASSE Product Standards Committee and the CSA Technical Committee. This Standard was approved as an American National Standard by the American National Standards Institute on July 12, 2011.

October 2011

ASME Notes:

(1) *This standard was developed under procedures accredited as meeting the criteria for American National Standards and it is an American National Standard. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed Standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.*

(2) *ASME does not "approve," "rate," or "endorse" any item, construction, proprietary device, or activity.*

(3) *ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assume any such liability. Users of a standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.*

(4) *Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this standard.*

(5) *ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which precludes the issuance of interpretations by individuals.*

(6) *ASME issues written replies to inquiries concerning interpretation of technical aspects of this Standard. All inquiries regarding this Standard, including requests for interpretations, should be addressed to:*
Secretary, A112 Standards Committee
The American Society of Mechanical Engineers
Three Park Avenue
New York, NY 10016-5990

A request for interpretation should be clear and unambiguous. The request should

- *cite the applicable edition of the Standard for which the interpretation is being requested.*
- *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, which are necessary to explain the question; however, they should not contain proprietary names or information.*

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.

Interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org/ as they are issued.

CSA Notes:

(1) *Use of the singular does not exclude the plural (and vice versa) when the sense allows.*

(2) *Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.*

(3) *This publication was developed by consensus, which is defined by* CSA Policy governing standardization — Code of good practice for standardization *as "substantial agreement. Consensus implies much more than a simple majority, but not necessarily unanimity". It is consistent with this definition that a member may be included in the Technical Committee list and yet not be in full agreement with all clauses of this publication.*

(4) *To submit a request for interpretation of CSA Standards, please send the following information to* **inquiries@csa.ca** *and include "Request for interpretation" in the subject line:*
(a) define the problem, making reference to the specific clause, and, where appropriate, include an illustrative sketch;
(b) provide an explanation of circumstances surrounding the actual field condition; and
(c) where possible, phrase the request in such a way that a specific "yes" or "no" answer will address the issue.
Committee interpretations are processed in accordance with the CSA Directives and guidelines governing standardization *and are published in CSA's periodical* Info Update, *which is available on the CSA website at* ***http://standardsactivities.csa.ca****.*

(5) *CSA Standards are subject to periodic review, and suggestions for their improvement will be referred to the appropriate committee. To submit a proposal for change to CSA Standards, please send the following information to* **inquiries@csa.ca** *and include "Proposal for change" in the subject line:*
(a) Standard designation (number);
(b) relevant clause, table, and/or figure number;
(c) wording of the proposed change; and
(d) rationale for the change.

(6) *Attention is drawn to the possibility that some of the elements of this Standard may be the subject of patent rights. CSA is not to be held responsible for identifying any or all such patent rights. Users of this Standard are expressly advised that determination of the validity of any such patent rights is entirely their own responsibility.*

ASSE Foreword

This Foreword is not part of the Standard; however, it is offered to provide background information.

Several suggestions received from persons having had a disturbing experience with shower valves which were potentially hazardous allowing sudden surges of high temperature water to flow from the shower head prompted the initiation of the ASSE 1016 standard in 1973. Documents and field experiences relating to the behavioural characteristics of different classes of devices were studied and evaluated, and from this, the standard text was developed. Since that time, extensive research has been conducted toward the development of this standard in its current form.

This harmonized Standard was developed in response to an industry request for a harmonized set of requirements between ASSE 1016-2005 and Clause 5.10 of ASME A112.18.1-2005/CSA B125.1-05. In recognition of energy and water efficiency requirements, which have further reduced the maximum flow rate requirements in certain areas, testing requirements to address the performance of shower valves rated for shower heads and body sprays rated at less than 9.5 L/min (2.5 GPM) flow rates were needed to be addressed.

In 2005 the CSA/ASME Joint Harmonization Task Group formed a task force FT-05-24 to accomplish this end. The TF was joined by members of ASSE and their historical 1016 Working Group. The first meeting was held on August 30, 2007.

The shower control valves covered by this Standard are only those which will, in cases of changes to the incoming water supply pressure or temperature, reduce the risk of scalding and thermal shock by protecting the bather from exposure to such changes in water temperature that produce these effects.

These devices generally have one cold water inlet connection, one hot water inlet connection, and a mixed water outlet connection(s).

This Standard provides engineers, designers, manufacturers, health authorities, inspection agencies and others with a set of minimum performance requirements for such individual automatic compensating valves.

Recognition is made of the time volunteered by members of the Joint Harmonization Task Group and Task Force, the ASME members, ASSE members and CSA members and of the support of the manufacturers who also participated in the meetings for this standard.

The Standard does not imply ASME, ASSE, or CSA's endorsement of a product which conforms with these requirements.

This Standard is considered suitable for use with conformity assessment within its stated scope.

It is recommended that these devices be installed consistent with local codes.

ASSE 1016-2011/ASME A112.1016-2011/ CSA B125.16-11
Performance requirements for automatic compensating valves for individual showers and tub/shower combinations

Section I

1 Scope

1.1
This Standard applies to automatic compensating valves intended to be installed at the point of use, where the user has access to flow or final temperature controls, and where no further mixing occurs downstream of the device.

Note: *In this Standard, automatic compensating valves are also referred to as devices.*

1.2
This Standard covers automatic compensating valves intended to control the water temperature to wall or ceiling mounted

(a) hand-held showers;
(b) shower heads;
(c) body sprays either in individual shower or tub/shower combination fittings; and
(d) tub spouts when part of tub/shower combination fittings.

1.3
In this Standard, "shall" is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the standard; "should" is used to express a recommendation or that which is advised but not required; and "may" is used to express an option or that which is permissible within the limits of the standard. Notes accompanying clauses do not include requirements or alternative requirements; the purpose of a note accompanying a clause is to separate from the text explanatory or informative material. Notes to tables and figures are considered part of the table or figure and may be written as requirements. Annexes are designated normative (mandatory) or informative (non-mandatory) to define their application.

1.4
SI units are the units of record in Canada. In this Standard the inch/pound units are shown in parentheses.

The values stated in each measurement system are equivalent in application; however, each system is to be used independently. Combining values from the two measurement systems can result in non-conformance with this Standard.

All references to gallons are to U.S. gallons.

Section II

2 Reference publications and definitions

2.1 Reference publications

This Standard refers to the following publications, and where such reference is made, it shall be to the edition listed below, including all amendments published thereto.

ASME/CSA (The American Society of Mechanical Engineers/Canadian Standards Association)
ASME A112.18.1-2011/CSA B125.1-11
Plumbing supply fittings

ASSE (American Society of Sanitary Engineering)
Plumbing Dictionary Sixth Edition — 2007

2.2 Definitions

In addition to the definitions in ASME A112.18.1/CSA B125.1 and in the ASSE Plumbing Dictionary, the following definitions shall apply in this Standard:

Automatic compensating valve — a water-mixing valve that is supplied with hot and cold water and that provides a means of automatically maintaining the water temperature selected for an outlet.
Note: Automatic compensating valves are used to reduce the risk of scalding and thermal shock.

Combination pressure-balancing and thermostatic compensating valve (Type T/P) — a compensating valve that senses inlet supply hot and cold water pressures before mixing, senses the water temperature at the outlet, and compensates for pressure and thermal variations to maintain the water temperature at the outlet.

Pressure-balancing compensating valve (Type P) — a compensating valve that senses inlet supply hot and cold water pressures and compensates for variations in the inlet supply pressures to maintain the water temperature at the outlet.

Thermostatic compensating valve (Type T) — a compensating valve that senses the water temperature at the outlet and compensates for thermal variations to maintain the water temperature at the outlet.

Initial outlet set temperature — the average of the values of the mixed temperature measured at the outlet for the 10 s immediately preceding the temperature change measured at the outlet resulting from a pressure or temperature change.

Point-of-use — the final outlet of the water supply system just prior to discharge to atmosphere.

Temperature limit setting — an adjustable means to limit the maximum setting of the device towards the hot position limiting the maximum discharge temperature.

Thermal shock — a rapid change in the outlet water temperature that is felt by the user and is sufficient to produce a potentially hazardous reaction.

User — an individual who can adjust the outlet water temperature at the point of use while he or she is in contact with the outlet water.

Section III

3 Design and general requirements

3.1 Types of devices

3.1.1

The types of devices covered by this Standard and the type-specific requirements that they shall meet are
(a) Type P, Section 4.6.7;
(b) Type T, Section 4.6.8; and
(c) Type T/P, Section 4.6.9.

3.1.2

Devices covered by this Standard shall comply with all the applicable requirements of this Standard and also comply with the applicable requirements of ASME A112.18.1/CSA B125.1.

3.2 Accessible designs

Devices intended for use in accessible designs shall comply with the requirements in Clause 4.6 of ASME A112.18.1/CSA B125.1.

3.3 Minimum rated flow

Devices shall comply with the requirements in this Standard when tested at the manufacturer's minimum rated flow or 9.5 L/min (2.5 gpm), whichever is lower.

3.4 Pressure

Devices shall be designed for a rated pressure between 140.0 and 862.0 kPa (20.0 and 125.0 psi).

3.5 Temperature

3.5.1

Devices shall be designed to be the final temperature control.

3.5.2

Devices shall be adjustable from the cold position up to at least 37.8 °C (100.0°F) with hot water inlet temperatures ranging from 48.9 to 82.2 °C (120.0 to 180.0°F) and cold water inlet temperatures ranging from 4.0 to 26.7 °C (40.0 to 80.0°F).

3.5.3

Devices shall
(a) be equipped with an adjustable means to limit the setting towards the hot position;
(b) be capable of limiting the maximum outlet temperature to 48.9 °C (120.0°F) or the manufacturer's stated maximum outlet temperature, whichever is less; and
(c) maintain an outlet temperature within ±2.0 °C (±3.6°F) from the set temperature in accordance with Section 4.6.

3.6 Servicing

The internal parts of concealed devices shall be accessible from the finished wall line for inspection, repairs, or replacement.

Section IV

4 Performance requirements and test methods

4.1 General
Tests shall be conducted on the same specimen, in the order listed in this Standard.

4.2 Conditioning

4.2.1 Preconditioning
Before testing, specimens shall be conditioned at ambient laboratory conditions for not less than 12 h.

4.2.2 High-temperature conditioning

4.2.2.1 Purpose
The purpose of the high-temperature conditioning is to determine if the device can withstand the maximum temperatures specified in Section 3.5.

4.2.2.2 Procedure
Specimens shall be conditioned as follows:

(a) Set up the specimen in accordance with Figure 1, with shut off valves V1 and V2 and valve V3 in the full open position.
(b) Establish and maintain an equal pressure of 310.3 ± 13.8 kPa (45.0 ± 2.0 psi) on both the hot and cold water supplies.
(c) Set the hot water temperature to 82.2 +0.0, -6.0 °C (180.0 +0.0, -10.0°F).
(d) Set the cold water temperature to 10.0 ± 3.0 °C (50.0 ± 5.0°F).
(e) Adjust the outlet temperature to the maximum allowable outlet temperature, not exceeding 48.9 °C (120.0°F).
(f) Adjust valve V3 to reduce the flow rate to 9.5 ± 1.0 L/min (2.5 ± 0.25 gpm) or the manufacturer's minimum rated flow ±10%.
(g) Allow the water to flow through the specimen for 5 min.

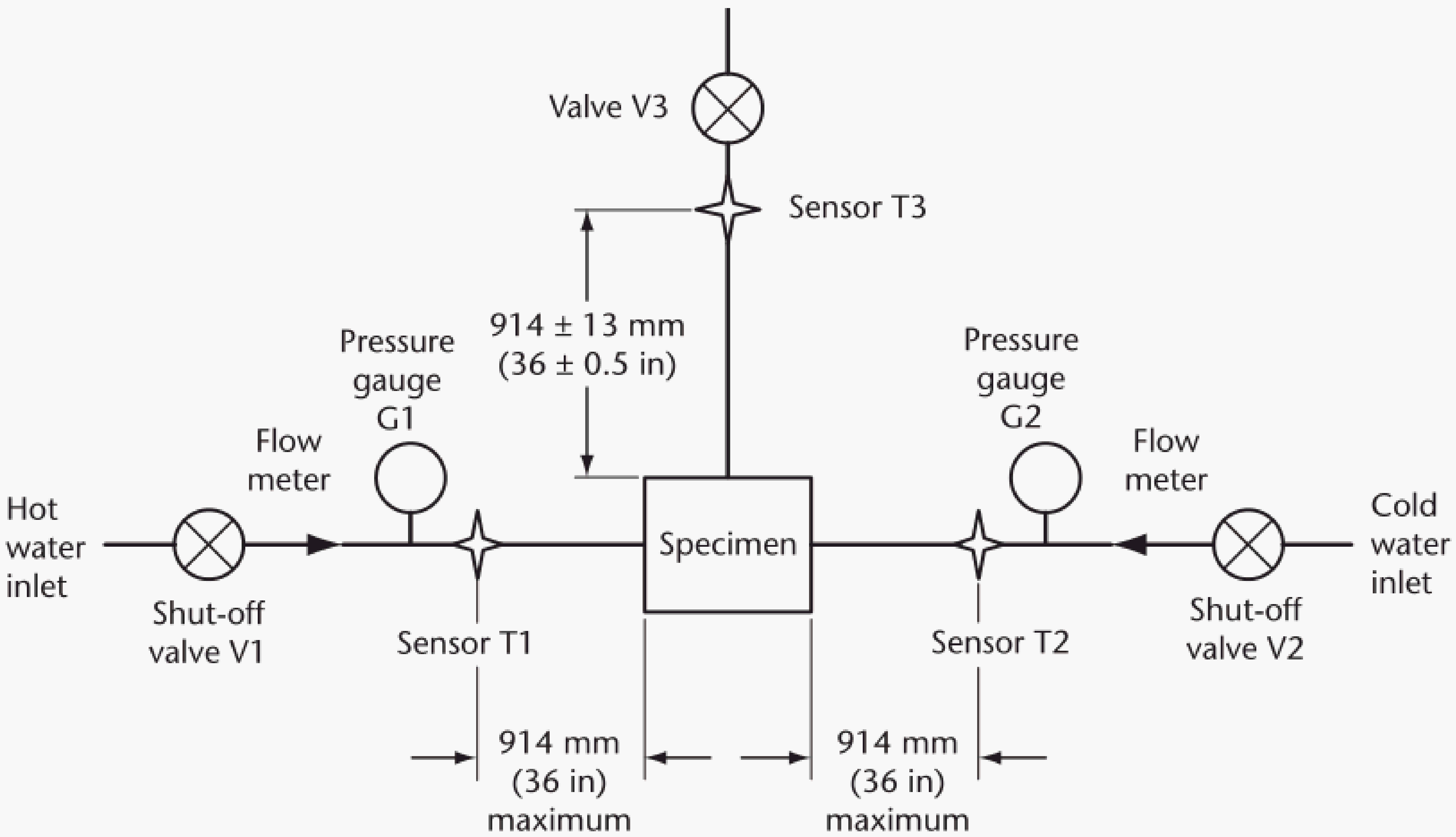

Figure 1
Set-up for high-temperature conditioning, pressure and temperature variation, and water supply pressure loss tests
(See Sections 4.2.2.2, 4.4.2.2, 4.6.2, 4.6.3, 4.7.2.1, 4.8.2, and 4.9.2.)

4.3 Working pressure test

4.3.1 Purpose
The purpose of this test is to determine if the device can withstand pressures between 140.0 and 860.0 kPa (20 and 125.0 psi).

4.3.2 Procedure with the valves closed
The device shall be tested in accordance with Section 4.3.4 with the device's valve in the closed position. The specimen shall be subjected to the pressures specified in Section 4, for 5 min each.

4.3.3 Procedure with the outlet(s) blocked
The device shall be tested in accordance with Section 4 with the device's valve in the fully open position. The outlet(s) shall then be blocked and the specimen shall be subjected to the pressures specified in Section 4, for 5 min each.

4.3.4 Test temperatures and pressures

4.3.4.1
The test shall be conducted in an ambient environment of 20.0 ± 5.0 °C (68.0 ± 9.0°F). The device shall be brought to equilibrium test temperatures by running water through it.

4.3.4.2
Test temperatures and pressures shall be as follows:
(a) 140.0 ± 13.8 kPa and 10.0 ± 6.0 °C (20.0 ± 2.0 psi and 50.0 ± 10.0°F);
(b) 860.0 ± 13.8 kPa and 10.0 ± 6.0 °C (125.0 ± 2.0 psi and 50.0 ± 10.0°F);

(c) 140.0 ± 13.8 kPa and 66.0 ± 6.0 °C (20.0 ± 2.0 psi and 150.0 ± 10.0°F); and
(d) 860.0 ± 13.8 kPa and 66.0 ± 6.0 °C (125.0 ± 2 psi and 150.0 ± 10.0°F).

4.3.5 Failure criteria

Leakage or other failures of the seals shall result in the rejection of the device.

4.4 Maximum operating torque or force adjustment test

4.4.1 Purpose

The purpose of this test is to determine the maximum torque or force required to adjust the device.

4.4.2 Procedure

4.4.2.1

Conduct the tests specified in Clause 5.5 of ASME A112.18.1/CSA B125.1.

4.4.2.2

After the tests specified in Section 4.4.2.1, the following tests shall be conducted:

(a) Set up the specimen as specified in Items (a) to (f) of Section 4.6.3. See Figure 1.
(b) Move the adjusting mechanism of the specimen (e.g., handle(s) or lever(s)) through its full operating range. The force shall be applied at the extreme end of the adjusting mechanism.
(c) Record the maximum operating torque or force.

4.4.3 Failure criteria

A maximum operating torque or force to adjust the device exceeding the requirements specified in ASME A112.18.1/CSA B125.1 shall result in the rejection of the device.

4.5 Life cycle tests

4.5.1 Purpose

The purpose of these tests is to determine if there is any deterioration in the performance of the device upon completion of the following cycles of operation:

(a) The operating control test shall simulate the intended operating motion of the device.
(b) The internal elements test shall simulate inlet pressure and temperature changes.

4.5.2 Procedure — Operating controls

The life cycle test for operating controls shall be conducted as follows:

(a) Set up and test the specimen in accordance with the set-up and conditions specified in Figure 2 with valves V1 and V3 and the device's valve fully open. This test shall simulate the intended operating motion of the device without impacting the end stops, except as agreed to by the manufacturer.
(b) Prior to starting the test, the following conditions shall be established and maintained for 1 min:
    (i) 344.8 ± 34.5 kPa (50.0 ± 5.0 psi) flowing as measured at the inlets;
    (ii) 40.6 ± 3.0 °C (105.0 ± 5.0°F) measured at the outlet;
    (iii) A minimum flow of 4.5 L/m (1.2 gpm) by adjusting valve V5; and
    (iv) the device's maximum outlet temperature adjusted to 49.0 +0.0, -6.0 °C (120.0 +0.0, -10.0°F) using the device's temperature limit stop adjustment.
(c) The temperature and volume control mechanism(s) shall be tested for 20,000 cycles of the control dial, handle, or knob, cycled at a constant rate between 5 and 20 cycles per minute, as specified in Items (i) to iv). The packing nut may be tightened once during the life cycle test to stop leakage.
    (i) Single-handle mixing valves of the cycling type: the control shall be operated from full-off to the full-on cold, position through full-on mixed to the full-on hot position, through full-on mixed to the full-on cold position, and back to the off position, to complete one cycle.

(ii) Single-control mixing valves with combined volume and temperature control: the control shall be adjusted to operate the volume control from off to the full-on 40.6 ± 3.0 °C (105.0 ± 5.0°F) position, to the full-on cold position, to the full-on hot limit stop position, to the 40.6 ± 3.0 °C (105.0 ± 5.0°F) position, to the off position, to complete one cycle.
(iii) Devices with a separate volume control: the volume control shall be turned full-on, the temperature control dial shall be turned through its full operating range and back, the volume control shall be turned off to complete one cycle.
(iv) Single-handle mixing valves that only have temperature control: the testing laboratory shall provide a shut-off valve, and the device shall be tested in accordance with Section 4.5.2(c)(iii).

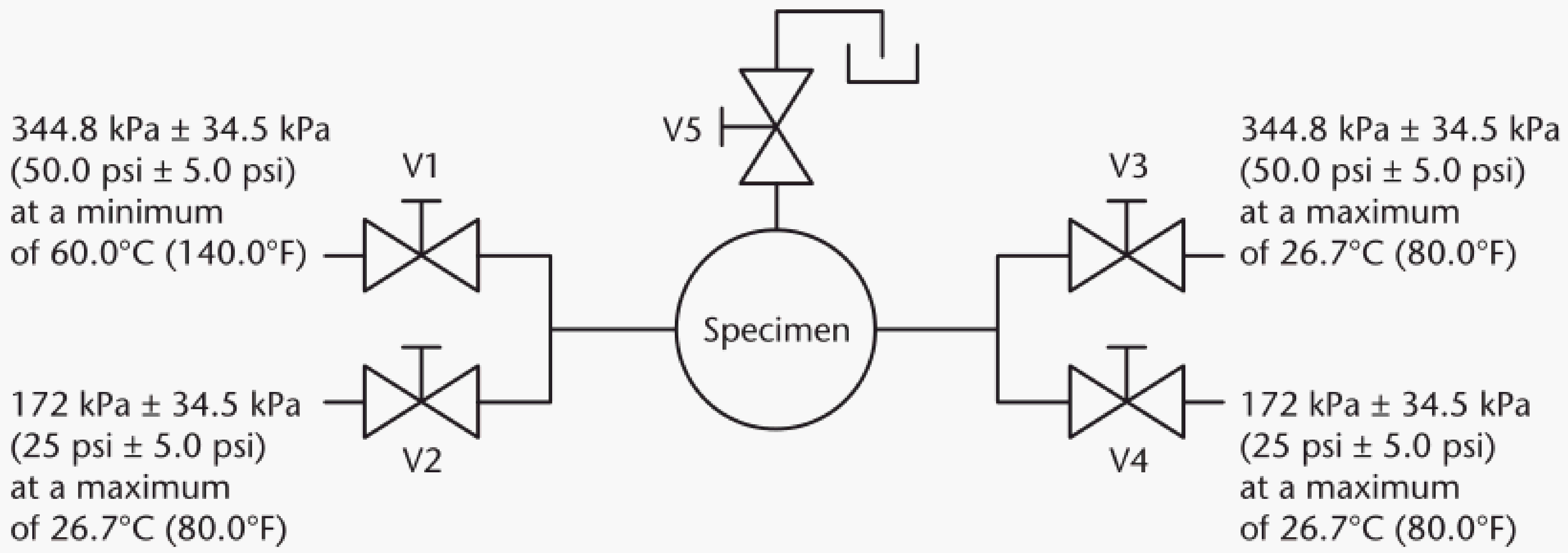

Figure 2
Set-up for life cycle test for automatic compensating valves
(See Sections 4.5.2 and 4.5.3.)

4.5.3 Procedure — Internal elements

The life cycle test for internal elements shall be conducted as follows:

(a) Set up and test the specimen in accordance with the set-up and conditions specified in Figure 2 with valves V1, V3 and the device's valve fully open.
(b) Before starting the test, establish and maintain for 1 min the following conditions:
  (i) 344.8 ± 34.5 kPa (50.0 ± 5.0 psi) flowing as measured at the inlets;
  (ii) 40.6 ± 3.0 °C (105.0 ± 5.0°F) measured at the outlet; and
  (iii) A minimum flow of 4.5 L/m (1.2 gpm) by adjusting valve V5.
(c) Change the conditions to those described in Step 1 of Table 1 and maintain for 4 s, then change the conditions to Step 2 in Table 1 and maintain for 4 s. Return to the beginning conditions in Step 1. This constitutes one cycle.
(d) Test the internal elements for 80,000 cycles in accordance with Table 1.

Table 1
Life cycle test for the control mechanism
(See Section 4.5.3.)

	Valve 1	Valve 2	Valve 3	Valve 4	Duration
Step 1	Open	Closed	Closed	Open	4 s
Step 2	Closed	Open	Open	Closed	4 s

4.5.4 Working pressure

Retest the device in accordance with Section 4.3.

4.5.5 Maximum torque or operating force

Retest the device in accordance with Section 4.4.

4.5.6 Failure criteria

During the test, leakage or the need to tighten the packing nut more than once shall result in a rejection of the device.

During the test specified in Section 4.5.4, any leakage shall result in the rejection of the device.

During the test specified in Section 4.5.5, an operating torque or force that exceeds 120% of the requirements of Section 4.4 shall result in the rejection of the device. Accessible designs shall not exceed the requirements specified in Section 4.4.

4.6 Pressure and temperature variation test

4.6.1 Purpose

The purpose of this test is to determine if the outlet water temperature at the point-of-use is maintained within a set temperature range.

4.6.2 Data gathering, all types of devices (see Figure 1)

Data shall be gathered as follows:

(a) The temperature-recording device shall be started 10 s before the step changes.
(b) Temperature measurements shall be taken at temperature sensors T1, T2, and T3 with measuring equipment capable of detecting a 63.2% step change within 0.3 s with a frequency rate of 20 Hz (one value every 0.05 s) for 25 ± 5 s unless otherwise specified in this Standard. See Annex A.
(c) The outlet temperature measurements at sensor T3 shall be averaged every 0.25 s.
(d) Temperature sensors T1, T2, and T3 shall be located as follows:
    (i) Temperature sensors T1, T2, and T3, within the flow stream in Type K or Type L copper water tube.
    (ii) Temperature sensors T1 and T2, within 914 mm (36 in) of the device.
    (iii) Temperature sensor T3, within 914 ± 13 mm (36 ± 0.5 in) from the outlet of the device. The outlet tube shall be the same size as the outlet connection size of the device.

Notes:

(1) *For verifying the time constant of the temperature-measuring equipment, see Annex A.*

(2) *Data can be gathered in formats similar to those depicted in Figures B.1 to B.5.*

4.6.3 Procedure — All types of devices (see Figure 1)

Controllers with pressure feedback loops shall not be active during the tests, but may be used to set the test parameters.

Note: *Controllers with pressure feedback loops interact with the specimen and result in inaccurate test results.*

The pressure and temperature variation test shall be conducted as follows:

(a) Set up the specimen as shown in Figure 1, with valves V1, V2, and V3 and the device's valve in the fully open position.
(b) Adjust and maintain the hot and cold water supply pressures directly upstream of the inlet connections to a flowing pressure of 310.3 ± 13.8 kPa (45.0 ± 2.0 psi), as measured by gauges G1 and G2.
(c) Adjust the temperatures at temperature sensors T1 and T2 so that there is a temperature differential of 44.0 to 56.0 °C (80.0 to 100.0°F) between the hot water temperature [minimum of 60.0 °C (140.0°F)] and the cold water temperature [maximum of 21.1 °C (70.0°F)]. After the hot water and cold water inlet temperatures are established maintain the inlet temperatures at ±1.0 °C (±2.0°F).
(d) Adjust the device so that the outlet temperature at temperature sensor T3 (point of use outlet) is 40.5 ± 0.5 °C (105.0 ± 1.0°F).

(e) Adjust valve V3 so that the device delivers 9.5 ± 1.0 L/min (2.5 ± 0.25 gpm) and maintain the conditions established in Items (b) to (d) or, if the manufacturer's minimum rated flow is less than 9.5 ± 1.0 L/min (2.5 ± 0.25 gpm), adjust valve V3 to the manufacturer's minimum rated flow +1.0, –0.0 L/min (+0.25, –0.0 gpm) and maintain the conditions established in Items (b) to (d).

Note: *Adjustments in Items (b) to (e) are an iterative process.*

(f) Flow water through the device for 1 min.
(g) Record the initial outlet set temperature.

4.6.4 Procedure — Type P devices

The pressure changes specified in this Section shall be accomplished in less than 1 s. In addition to the procedures specified in Sections 4.6.2 and 4.6.3, the following test procedure shall be conducted:

(a) Decrease the hot water supply pressure by 50% to 155.1 ± 13.8 kPa (22.5 ± 2.0 psi). Observe and record the temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.
(b) Restore the conditions as described in Section 4.6.3. Increase the hot water supply pressure by 50% to 465.4 ± 13.8 kPa (67.5 ± 2.0 psi). Observe and record the temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.
(c) Restore the conditions as described in Section 4.6.3. Decrease cold water supply pressure by 50% to 155.1 ± 1 3.8 kPa (22.5 ± 2.0 psi). Observe and record the temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.
(d) Restore the conditions as described in Section 4.6.3. Increase the cold water supply pressure by 50% to 465.4 ± 13.8 kPa (67.5 ± 2.0 psi). Observe and record the temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.

4.6.5 Procedure — Type T devices

The pressure changes specified in this Section shall be accomplished in less than 1 s. In addition to the procedures specified in Sections 4.6.2 and 4.6.3, the following test procedure shall be conducted:

(a) Decrease the hot water supply pressure by 20% to 248.2 ± 13.8 kPa (36.0 ± 2.0 psi). Observe and record temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.
(b) Restore conditions as described in Items (a) to (g) of Section 4.6.3. Increase the hot water supply pressure by 20% to 372.3 ± 13.8 kPa (54.0 ± 2.0 psi). Observe and record the temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.
(c) Restore conditions as described in Items (a) to (g) of Section 4.6.3. Decrease the cold water supply pressure by 20% to 248.2 ± 13.8 kPa (36.0 ± 2.0 psi). Observe and record the temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.
(d) Restore conditions as described in Items (a) to (g) of Section 4.6.3. Increase the cold water pressure by 20% to 372.3 ± 13.8 kPa (54.0 ± 2.0 psi). Observe and record the temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.
(e) Restore conditions as described in Items (a) to (g) of Section 4.6.3. Increase the hot water supply temperature by 13.8 ± 0.6 °C (25.0 ± 1.0°F) at a rate of 3.0 ± 0.6 °C (5.0 ± 1.0°F) per minute. Observe and record the temperature changes at the outlet temperature sensor T3 for 25 ± 5 s.

4.6.6 Procedure — Type T/P devices

Type T/P devices shall be tested in accordance with Sections 4.6.4 and 4.6.5.

4.6.7 Failure criteria — Type P devices

When tested in accordance with Section 4.6.4, an outlet temperature variation exceeding ±2.0 °C (±3.6°F) from the initial outlet set temperature at the outlet temperature sensor T3 shall result in a rejection of the device.

4.6.8 Failure criteria — Type T devices

When tested in accordance with Section 4.6.5, the temperature change from the initial outlet set temperature shall not

(a) within the initial 5 s following a temperature change at sensor T3,
  (i) exceed +3.0 °C (+5.4°F) for more than 1.5 s (see Figures B.1 and B.3); and
  (ii) exceed –5.0 °C (–9.0°F) for more than 1 s (see Figures B.2 and B.3); and

(b) after the initial 5 s following a temperature change at sensor T3, exceed ±2.0 °C (±3.6°F) (see Figure B.3).

4.6.9 Failure criteria — Type T/P devices

When tested in accordance with Section 4.6.6, an outlet temperature variation exceeding ±2.0 °C (±3.6°F) from the initial outlet set temperature at the outlet temperature sensor T3 shall result in a rejection of the device.

4.7 Water supply failure test — All types

4.7.1 Purpose

The purpose of the water supply failure test is to determine if the device automatically reduces the discharge flow to reduce the risk of scalding and thermal shock of the user when the water supply is suddenly interrupted.

4.7.2 Procedure

4.7.2.1

The specimen shall be set up as shown in Figure 1 and in accordance with the conditions specified in Items (a) to (f) of Section 4.6.3.

4.7.2.2

After the device flows for 1 min at the parameters specified in Section 4.7.2.1, the following tests shall be conducted:

(a) Close the cold water supply valve within 1 s (cold water supply failure test). Continuously record the outlet temperature at sensor T3 and flow rate for 5 s after the cold water supply valve has been fully closed.

(b) Re-establish the initial test parameters specified in Section 4.7.2.1.

(c) Repeat the test by closing the hot water supply valve within 1 s (hot water supply failure test). Continuously record the outlet temperature at sensor T3 and flow rate for 5 s after the hot water supply valve has been fully closed.

4.7.3 Failure criteria

When tested in accordance with Section 4.7.2, failure of the device to reduce the flow to 1.9 L/min (0.5 gpm) or 30% of the manufacturer's minimum rated flow, whichever is less, within 5 s, shall result in a rejection of the device.

During the procedure specified in Section 4.7.2.2(a) (i.e., the cold water supply failure test), failure of the device to reduce the flow to 1.9 L/min (0.5 gpm) or 30% of the manufacturer's minimum rated flow, whichever is less, prior to the water temperature at sensor T3 exceeding 48.9 °C (120.0°F) shall result in a rejection of the device.

4.8 Mechanical temperature limit stop test

4.8.1 Purpose

The purpose of the mechanical temperature limit stop test is to ensure that the temperature control that stops against a limit stop can maintain its set position.

4.8.2 Procedure

The mechanical temperature limit stop test shall be conducted as follows:

(a) Set up the specimen in accordance with Figure 1.
(b) Pressurize the hot and cold water inlets to 310.3 ± 13.8 kPa (45.0 ± 2.0 psi).
(c) Flow water through the device at a rate of 9.5 ± 1.0 L/min (2.5 ± 0.25 gpm) or the manufacturer's minimum rated flow ±10%, whichever is less.
(d) Set the cold inlet temperature at 10.0 ± 2.8 °C (50.0 ± 5.0°F).
(e) Set the hot inlet temperature at 82.2 +0, –5.6 °C (180.0 +0, -10°F).
(f) Set the limit stop to an outlet temperature of 46.1 +0, –2.8 °C (115.0 +0, –5.0°F), or the manufacturer's specified maximum temperature, whichever is less.
(g) Set the device at the full hot position, flow for 1 min and measure and record the outlet temperature at sensor T3.
(h) Apply a torque of 5.1 N•m (45.0 lbf•in) to the temperature control (handle or valve stem) for 20 ± 5 s.
(i) While applying the torque specified in Item (h) and for 1 min after, measure and record the outlet temperature at sensor T3.

4.8.3 Failure criteria

When tested in accordance with Section 4.8.2, the device shall be rejected if

(a) the outlet temperature measured in Section 4.8.2(i) exceeds the outlet temperature recorded in Section 4.8.2(g) by 2.0 °C (3.6°F); or
(b) there are any observable fractures in the limit stop.

4.9 Outlet temperature and flow capacity test

4.9.1 Purpose

The purpose of the outlet temperature and flow capacity test is to determine compliance with the design requirements of Sections 3.3 and 3.5.

4.9.2 Procedure for all devices (see Figure 1)

The outlet temperature and flow capacity test shall be conducted as follows:

(a) Set up the specimen as shown in Figure 1, with valves V1, V2, and V3 in the fully open position.
(b) Set the hot and cold water supply pressures directly upstream of the inlet connections to 310.3 ± 13.8 kPa (45.0 ± 2.0 psi), as measured by gauges G1 and G2.
(c) After the hot water and cold water inlet temperatures are established in Items (e) (i) to (iv), maintain these inlet temperatures within ±1.0 °C (±2.0°F) without exceeding the limits specified in Items (e) (i) to (iv).
(d) Adjust valve V3 so that the device delivers 9.5 ± 1.0 L/min (2.5 ± 0.25 gpm) and maintain the conditions established in Items (b) to (d), or if the manufacturer's minimum rated flow is less than 9.5 ± 1.0 L/min (2.5 ± 0.25 gpm) adjust valve V3 to the manufacturer's minimum rated flow +0.1, –0.0 L/min (+0.3, –0.0 gpm) and maintain the conditions established in Items (b) to (d).
Note: *Adjustments in Items (b) to (d) are an iterative process.*
(e) The temperature limit stop and the valve V3 may be readjusted to conduct the following tests:
   (i) Set the cold inlet temperature to 10.0 ± 2.8 °C (50.0 ± 5.0°F) and the hot inlet temperature to 48.9 +0.0, –2.8 °C (120.0 +0.0, –5.0°F). Set the device to the full cold position and then adjust the device to an outlet temperature of 37.8 +2.8, –0 °C (100.0 +5.0, –0°F). Flow for 1 min and record the outlet temperature and flow.
   (ii) Set the cold inlet temperature to 10.0 ± 2.8 °C (50.0 ± 5.0°F) and the hot inlet temperature to 82.2 +0.0, –6.0 °C (180.0 +0.0, –10.0°F). Set the device to the full cold position and then adjust the device to an outlet temperature of 37.8 +2.8, –0 °C (100.0 +5.0, –0°F). Flow for 1 min and record the outlet temperature and flow. Set the temperature limit stop to a maximum outlet temperature of 48.9 °C (120.0°F). Set the device at the full hot position, flow for 1 min, and record the outlet temperature.

(iii) Set the cold inlet temperature to 26.7 +0, –5.6 °C (80.0 +0, –10.0°F) and the hot inlet temperature to 82.2 +0.0, –6.0 °C (180.0 +0.0, –10.0°F). Set the device to the full cold position and then adjust the device to an outlet temperature of 37.8 +2.8, –0 °C (100.0 +5.0, –0°F). Flow for 1 min and record the outlet temperature and flow. Set the temperature limit stop to a maximum outlet temperature of 48.9 °C (120.0°F). Set the device at the full hot position, flow for 1 min, and record the outlet temperature.

(iv) Set the cold inlet temperature to 26.7 +0, –5.6 °C (80.0 +0, –10.0°F) and the hot inlet temperature to 48.9 +0.0, –2.8 °C (120.0 +0.0, –5.0°F). Maintain a minimum outlet temperature of 37.8 +2.8, –0 °C (100.0 +5.0, –0°F). Flow for 1 min and record the outlet temperature and flow.

4.9.3 Failure criteria

When tested in accordance with Section 4.9.2, the device shall be rejected if it

(a) fails to flow a minimum of 8.5 L/min (2.25 gpm) or the manufacturer's minimum rated flow;

(b) cannot be adjusted to a minimum of 37.8 °C (100.0°F) outlet water temperature; or

(c) cannot limit the outlet temperature to a maximum of 48.9 °C (120.0°F).

4.10 Hydrostatic pressure test

4.10.1 Purpose

The purpose of this test is to determine if any leakage occurs at a hydrostatic pressure of 3,447.5 kPa (500.0 psi).

4.10.2 Procedure

With the outlet(s) blocked and seating member(s) fully open, the device's body shall be pressurized to 3,447.5 ± 34.8 kPa (500.0 ± 5.0 psi) for 1 min with water at ambient temperature.

4.10.3 Failure criteria

When tested in accordance with Section 4.10.2, any leakage shall result in a rejection of the device.

Section V

5 Markings, packaging, and installation instructions and included literature

5.1 Markings

5.1.1 General

Devices covered by and complying with this Standard shall be marked with
(a) the name of the manufacturer, trademark, or other mark known to identify the manufacturer or, in the case of private labelling, the name, trademark, or other mark of the customer for whom the device was manufactured;
(b) the model; and
(c) the type of the device (i.e., Type P, Type T, or Type T/P).

5.1.2 Visibility of markings

Markings shall be clear, permanent, and visible after installation (e.g., during field servicing).

5.1.3 Temperature control setting identification

Devices shall have identifiable control settings
(a) in which the settings are indicated by words (e.g., "cold", "warm", or "hot"), numbers, or graphically (e.g., colour coding); and
(b) that indicate the direction or means of adjustment to change the temperature.

5.2 Installation and maintenance instructions

5.2.1 Instructions

Manufacturer's instructions for installation, adjustment, and maintenance of the device shall be packaged with each device.

If the device is not equipped with an integral shut-off, the instructions shall provide a warning to install check valves on the inlets.

5.2.2 Temperature limit setting

The manufacturer's instructions shall specify how the handle position or the limit setting is to be adjusted.

Note: *The authority having jurisdiction might require temperature limits lower than those specified in this Standard.*

5.3 Packaging

Packaging or included literature shall specify the device's minimum flow rate, determined at a flowing pressure of 310.3 kPa (45.0 psi), in the following statement: "For use with shower heads rated at xxx L/min (yyy gpm) or higher", where "xxx L/min (yyy gpm)" is the manufacturer's minimum rated flow used to verify conformance to this Standard in accordance with Sections 4.6.3 to 4.6.5.

Annex A (informative)
Verifying the time constant of the temperature-measuring equipment

Note: *This Annex is an informative (nonmandatory) part of this Standard.*

A.1 General

The temperature should be recorded using a device capable of achieving a sampling rate of 200 readings per second (200 Hz). A lower sampling rate may be used; however, the data will not be as precise at a lower sampling rate.

A.2 Procedure

The procedure is as follows:

(a) Prepare the water at 88 ± 5 °C (190 ± 10°F).
(b) Set the thermocouple to 24 ± 5 °C (75 ± 10°F).
(c) Plunge the thermocouple into the water.
(d) Determine the difference between the maximum temperature (water bath) and the room temperature.
(e) Determine the time that elapsed between the thermocouple entering the hot water and the temperature reaching 63.2% of the difference determined in Item (d) or, if the recording device has not recorded a temperature value exactly equivalent to 63.2%, calculate the elapsed time based on the lower recorded value most nearly equivalent to 63.2%.

A.3 Sample verification (see Figure A.1)

The following table shows a sample verification:

	SI (metric)	Inch/pound
Starting temperature of the thermocouple	19.3 °C	66.7°F
Water temperature	89.4 °C	192.9°F
Step change (difference between maximum water temperature and starting temperature)	89.4 °C – 19.3 °C = 70.1 °C	192.9°F – 66.7°F = 126.2°F
63.2% of step change	0.632 × 70.1 °C = 44.3 °C	0.632 × 126.2°F = 79.8°F
Starting temperature plus 63.2% of step change temperature	19.3 °C + 44.3 °C = 63.6 °C	66.7°F + 79.8°F = 146.5°F
Time elapsed	0.14 s	0.14 s

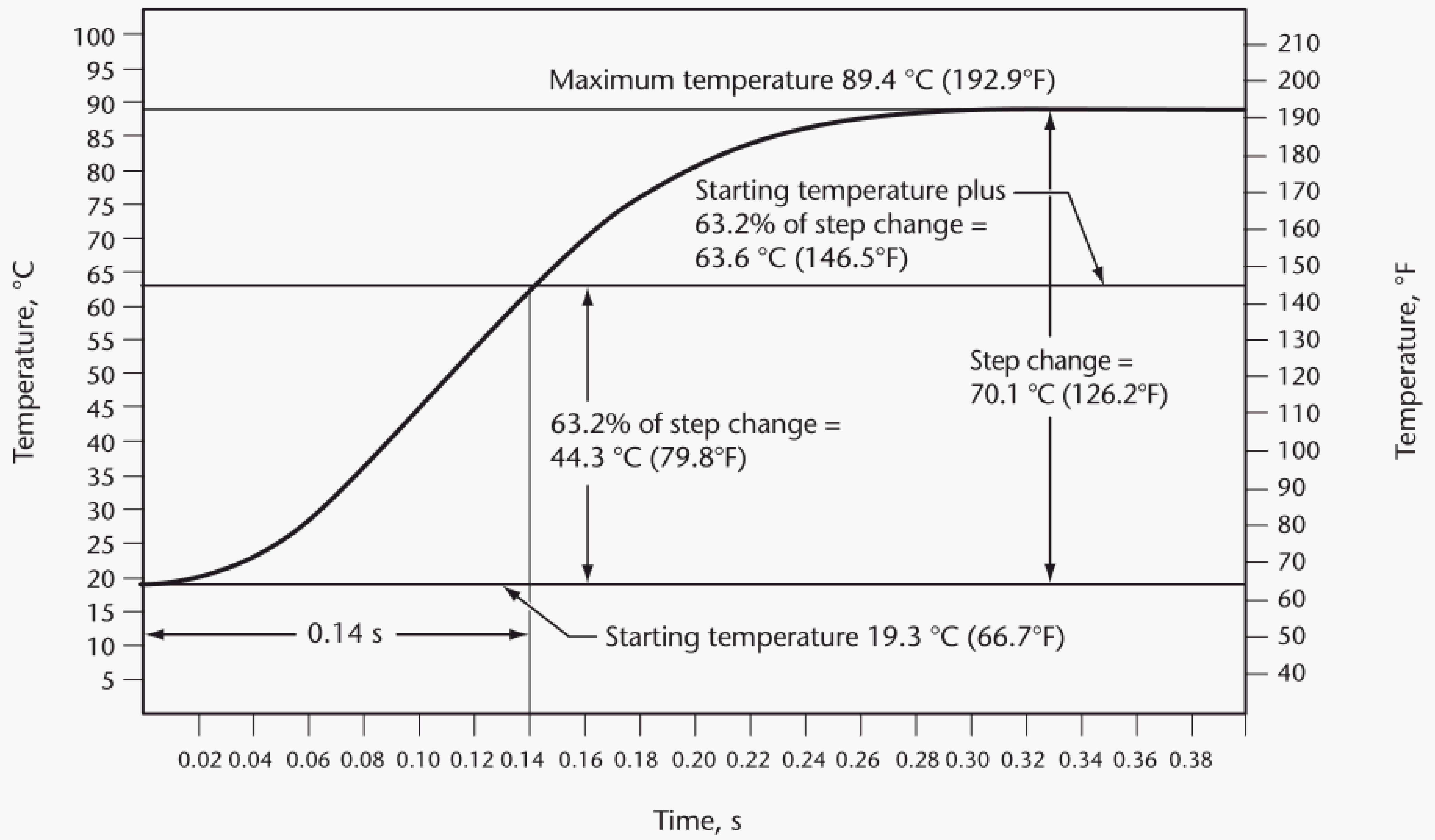

Figure A.1
Time constant graph
(See Section A.3.)

Annex B (informative
Temperature variation for thermostatic-compensating valves

Note: *This Annex is an informative (nonmandatory) part of this Standard.*

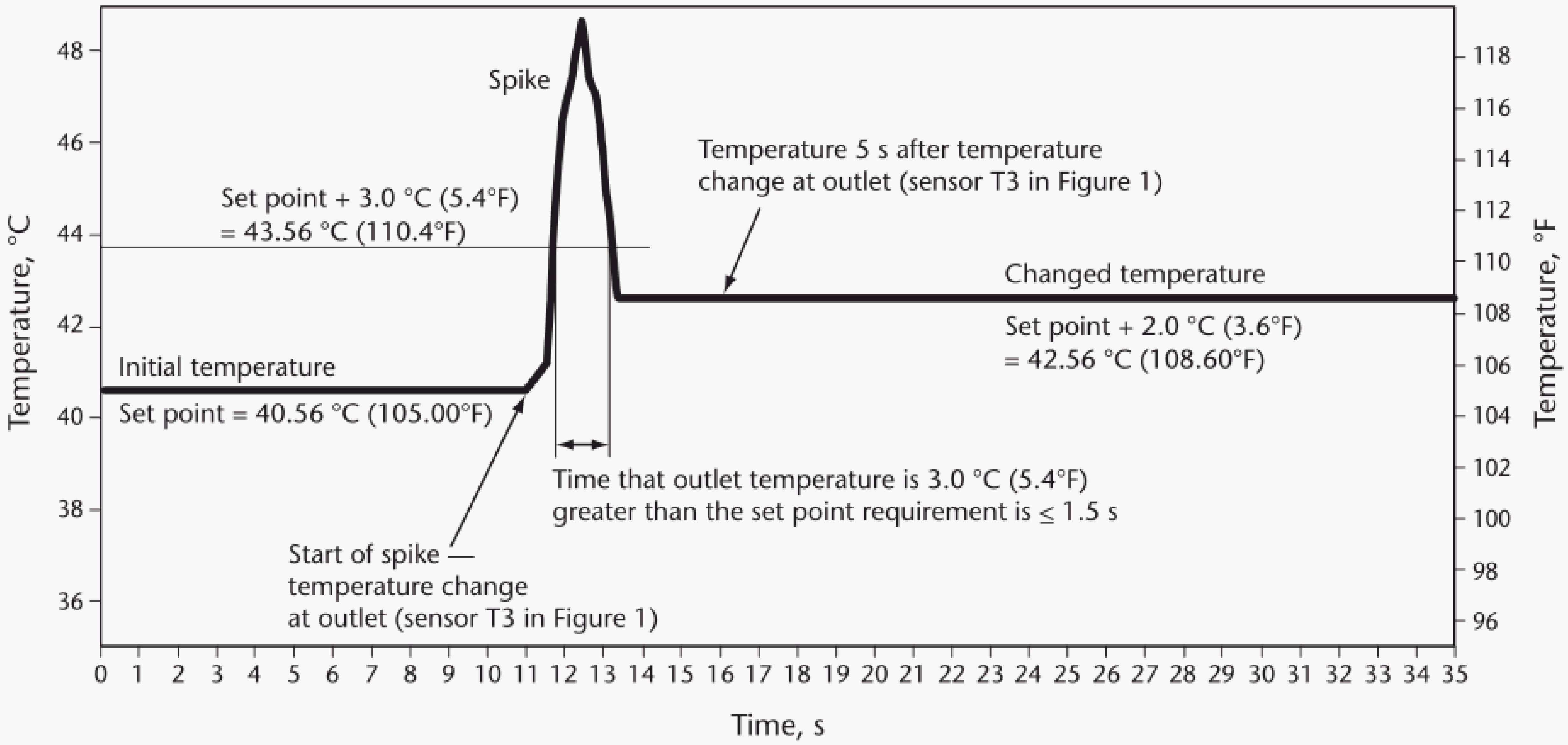

Figure B.1
Example of temperature increase spike
(See Sections 4.6.2 and 4.6.8.)

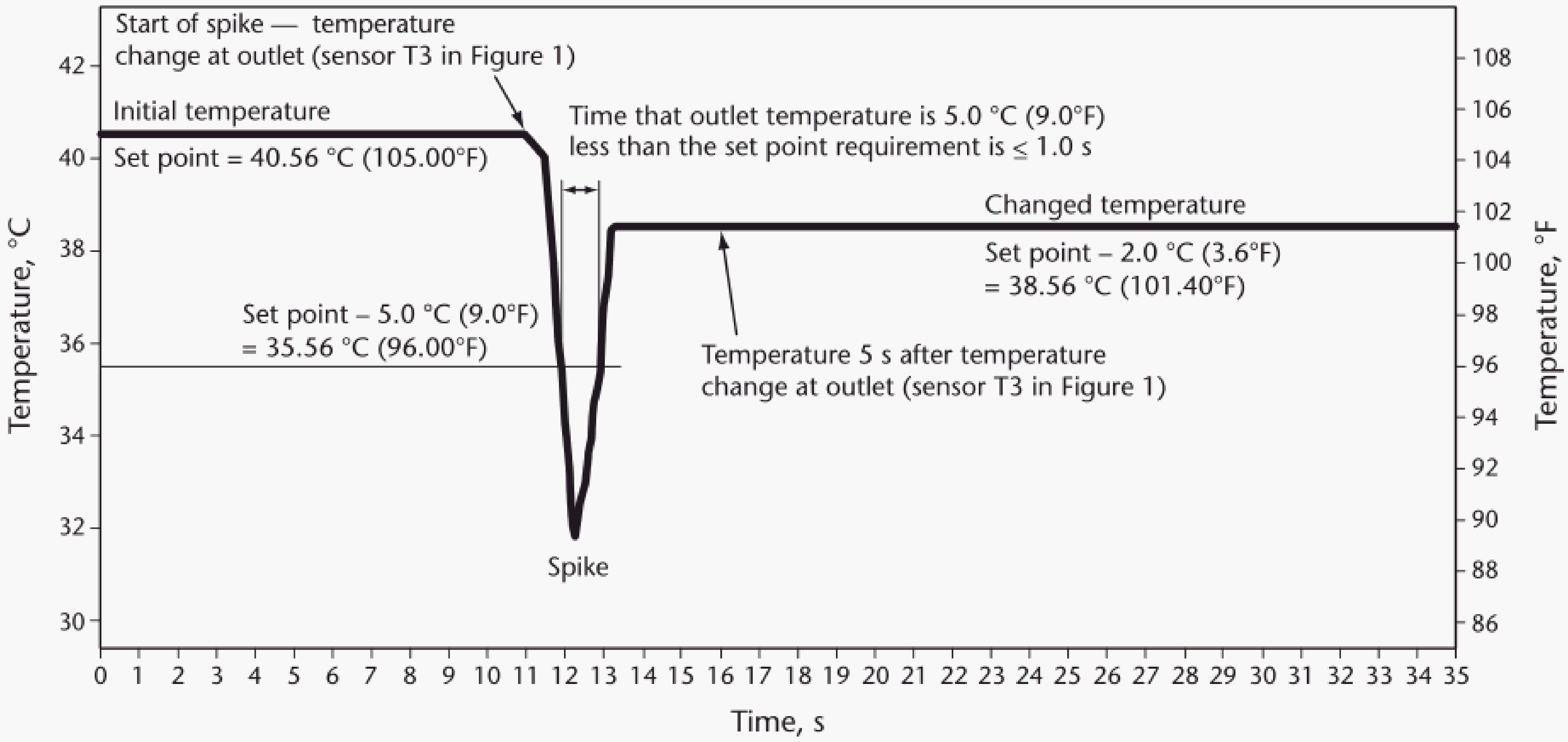

Figure B.2
Example of temperature decrease spike
(See Sections 4.6.2 and 4.6.8.)

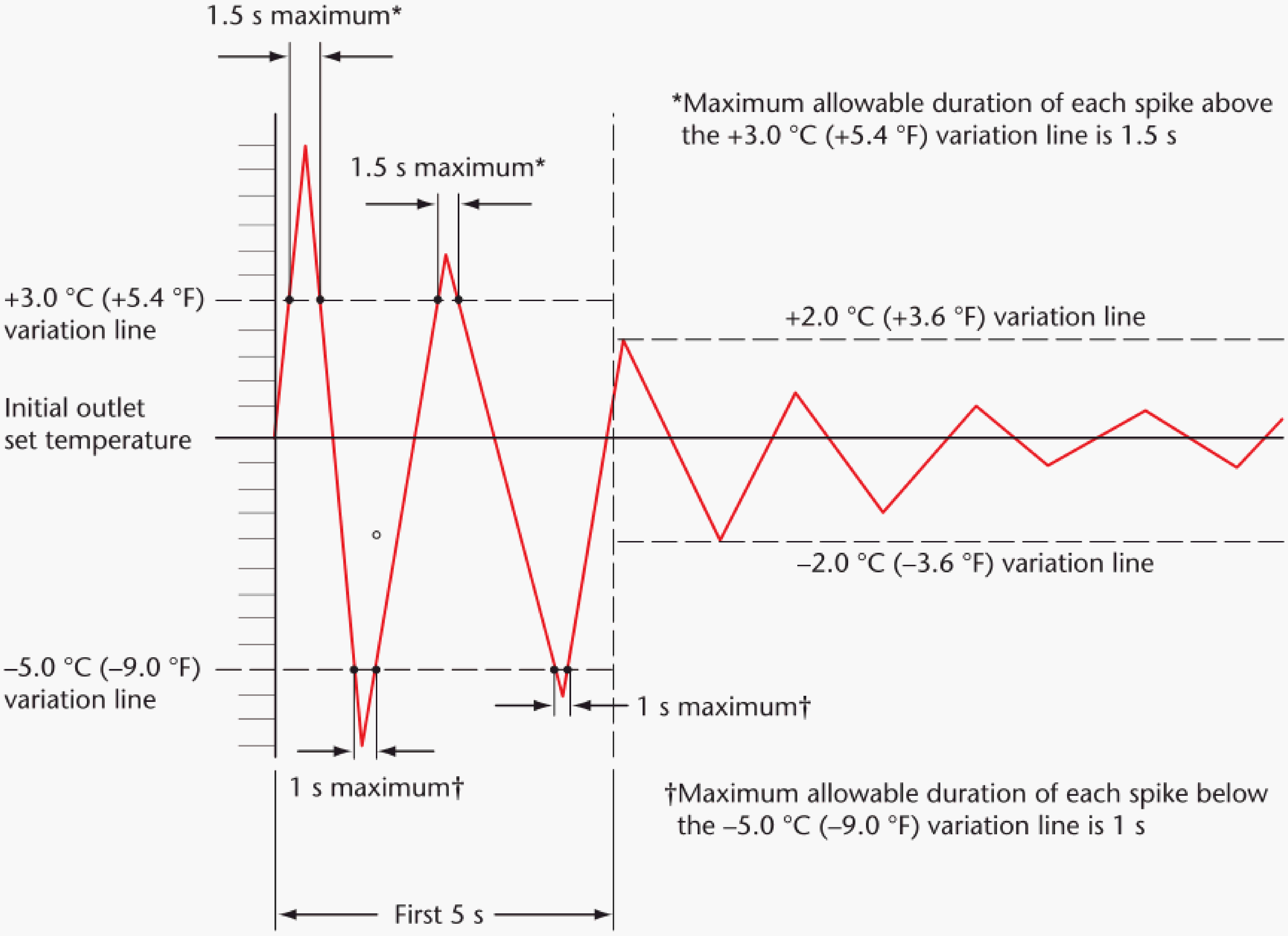

Figure B.3
Examples of temperature increase and decrease spikes
(See Sections 4.6.2 and 4.6.8.)

Initial conditions (average of measurements 10 s before pressure change)

	Temperature, °C (°F)	Pressure, kPa (psi)	Flow, L/min (gpm)
Mix	40.56 (105.00)	—	9.24 (2.44)
Hot	60.00 (140.00)	312.00 (45.25)	5.38 (1.42)
Cold	15.56 (60.00)	310.26 (45.00)	3.86 (1.02)

Cold pressure decrease

Did temperature spike exceed +3.0 °C (+5.4°F) from the set point?	Yes
Seconds that temperature remained more than +3.0 °C (+5.4°F) from the set point	1.00
Pass or fail 1.5 s > 3.0 °C (5.4°F) requirement?	Pass

Changed conditions (steady state after pressure change)

	Temperature, °C (°F)	Pressure, kPa (psi)	Flow, L/min (gpm)
Mix	42.56 (108.60)	—	8.35 (2.21)
Hot	60.11 (140.20)	313.00 (45.40)	5.06 (1.34)
Cold	15.44 (59.80)	248.21 (36.00)	3.29 (0.87)
Mix temperature difference between initial and final	2.00 (3.60)	—	—
Pass or fail 2.0 °C (3.6°F) maximum temperature variation requirement?	Pass	—	—

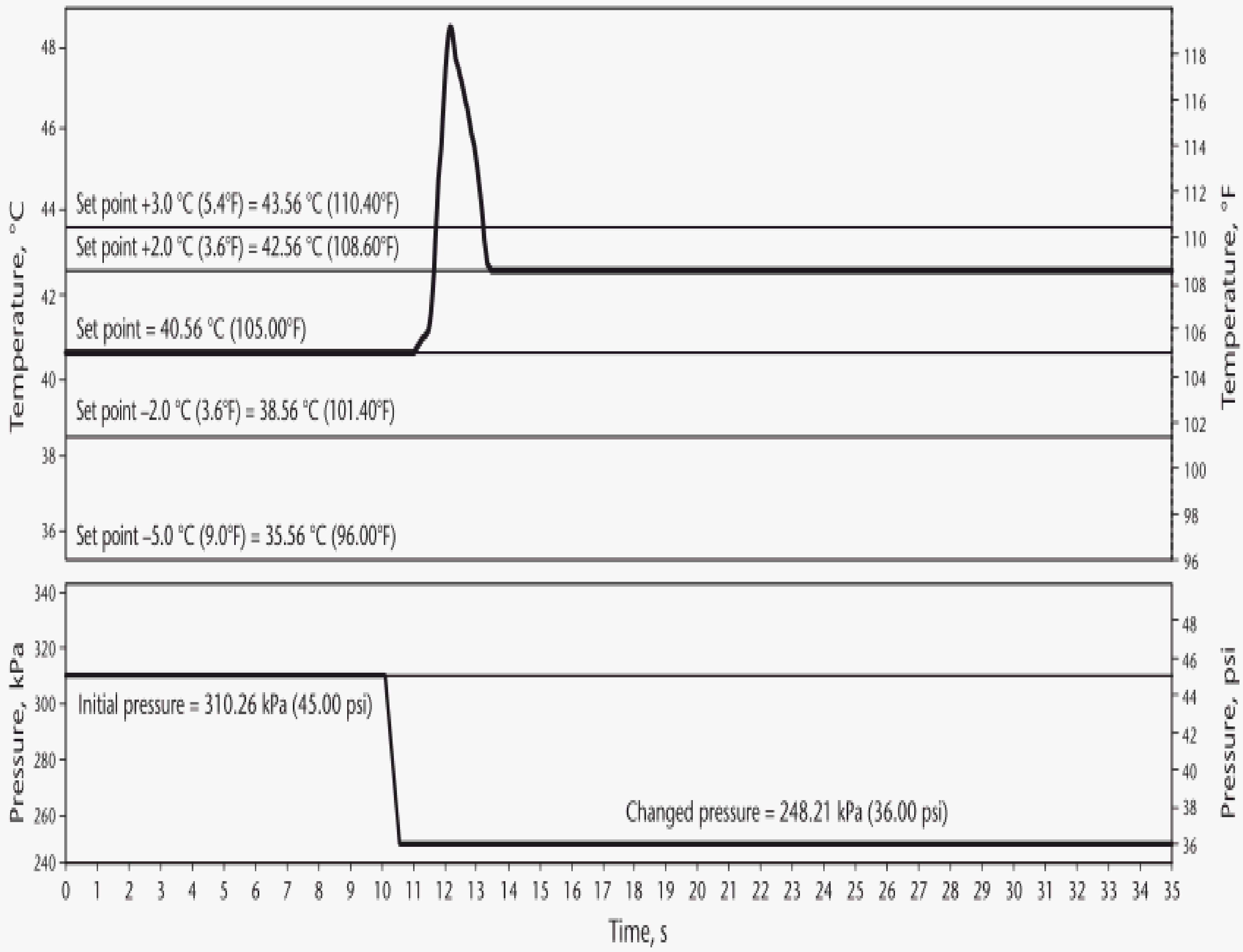

Figure B.4
Example of temperature record for temperature increase spike
(See Section 4.6.2.)

Initial conditions (average of measurements 10 s before pressure change)

	Temperature, °C (°F)	Pressure, kPa (psi)	Flow, L/min (gpm)
Mix	40.56 (105.00)	—	9.42 (2.49)
Hot	60.00 (140.00)	312.00 (45.25)	5.56 (1.47)
Cold	15.56 (60.00)	310.26 (45.00)	3.86 (1.02)

Cold pressure increase

Did temperature spike exceed –5.0 °C (–9.0°F) from the set point?	Yes
Seconds that temperature remained more than –5.0 °C (–9.0°F) from the set point	1.00
Pass or fail 1.0 s < 5.0 °C (9.0°F) requirement?	Pass

Changed conditions (steady state after pressure change)

	Temperature, °C (°F)	Pressure, kPa (psi)	Flow, L/min (gpm)
Mix	38.56 (101.40)	—	9.42 (2.49)
Hot	60.11 (140.20)	312.00 (45.25)	5.56 (1.47)
Cold	15.44 (59.80)	372.32 (54.00)	3.86 (1.02)
Mix temperature difference between initial and final	–2.00 (–3.60)	—	—

Pass or fail 2.0 °C (3.6°F) maximum temperature variation requirement?	Pass

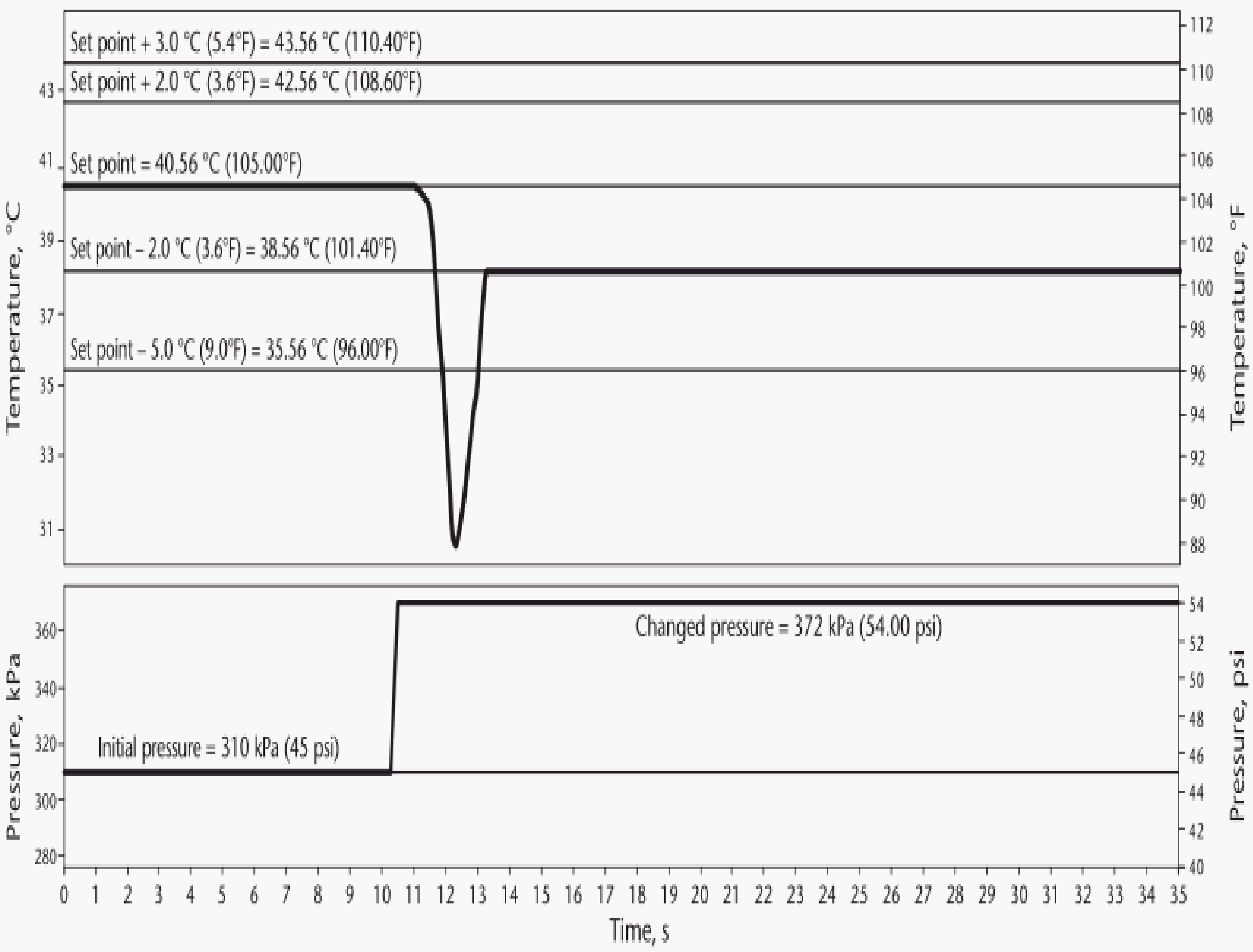

Figure B.5
Example of temperature record for temperature decrease spike
(See Section 4.6.2.)

The Canadian Standards Association (CSA) prints its publications on Rolland Enviro100, which contains 100% recycled post-consumer fibre, is EcoLogo and Processed Chlorine Free certified, and was manufactured using biogas energy.

100%

ASME

ISBN 978-0-7918-3399-5

9 780791 833995

J1851Q

CSA

ISBN 978-1-55491-702-0