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1984

Basic environmental testing procedures

Part 2:

Tests – Test N: Change of temperature

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

BASIC ENVIRONMENTAL TESTING PROCEDURES

Part 2: Tests — Test N: Change of temperature

FOREWORD

- 1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
- 2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
- 3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendations and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by Sub-Committee 50B: Climatic Tests, of IEC Technical Committee No. 50: Environmental Testing.

A first draft was discussed at the meeting held in The Hague 1982. As a result of this meeting, a draft, Document 50B(Central Office)242, was submitted to the National Committees for approval under the Six Months' Rule in September 1982.

This fifth edition supersedes the fourth edition (1974) of Test N: Change of Temperature.

The National Committees of the following countries voted explicitly in favour of publication:

Australia	Italy
Belgium	Japan
Bulgaria	Korea (Democratic People's Republic of)
Canada	Netherlands
China	New Zealand
Czechoslovakia	Norway
Egypt	Poland
Finland	South Africa (Republic of)
France	Spain
German Democratic Republic	Sweden
Germany	Switzerland
Hungary	Union of Soviet
Israel	Socialist Republics

Other IEC publications quoted in this standard:

Publications Nos.: 68-2-1: Basic Environmental Testing Procedures, Part 2: Tests — Tests A: Cold.

68-2-2: Tests B: Dry Heat.

68-2-33: Guidance on Change of Temperature Tests.

HISTORICAL SURVEY OF TEST N: CHANGE OF TEMPERATURE

- First edition, 1954** Contained one procedure only, Test Na: Rapid change of temperature, two-chamber method.
- Second edition, 1960** Equivalent to the previous Test Na, however, change-over time 2-3 min instead of maximum 5 min.
- Third edition, 1969** *Introduced:*
Test Na — Two-chamber method, equivalent to the previous Test Na, however a test duration of 30 min added as an alternative to 3 h while the temperatures are preferably the upper and lower category temperatures instead of mandatory restrictions to Tests A and B.

Test Nb — One-chamber method.
Test Nc — Two-water-bath method.
- Fourth edition, 1974** *Introduced:*
Test Na — Two-chamber method, equivalent to the previous Test Na, however, some chamber requirements have been added and the testing of heat dissipating specimens covered.
Test Nb — One-chamber method, equivalent to the previous Test Nb, however some chamber requirements have been added and the testing of heat dissipating specimens covered.
Test Nc — Two-water-bath method, no changes.
- Fifth edition, 1984** *Introduces:*
Test Na — Rapid change of temperature with prescribed time of transition, equivalent to the previous test Na, however the transition time is now prescribed more precisely, and a greater number of exposure times are given.
Test Nb — Change of temperature with specified rate of change, equivalent to the previous test Nb, however with a specified rate of change of temperature and a greater number of exposure times are given.

Test Nc — Rapid change of temperature, two fluid-bath method, equivalent to the previous test Nc, however the test is no longer restricted to the use of water and the duration parameters are more strictly described.
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BASIC ENVIRONMENTAL TESTING PROCEDURES

Part 2: Tests — Test N: Change of temperature

Introduction

A change of temperature test is intended to determine the effect on the specimen of a change of temperature or a succession of changes of temperature.

It is not intended to show effects which are due only to the high or low temperature. For these effects, the dry heat test or the cold test should be used.

The effect of such tests is determined by:

- values of high and low conditioning temperature between which the change is to be effected;
- the conditioning times for which the test specimen is kept at these temperatures;
- the rate of change between these temperatures;
- the number of cycles of conditioning;
- the amount of heat transfer into or from the specimen.

Guidance on the choice of suitable test parameters for inclusion in the detail specification is given in Publication 68-2-33: Basic Environmental Testing Procedures, Part 2: Tests — Guidance on Change of Temperature Tests, which should be read in conjunction with this standard.

1. Test Na: Rapid change of temperature with prescribed time of transition

1.1 Scope

This test determines the ability of components, equipment or other articles to withstand rapid changes of ambient temperature. The exposure times adequate to accomplish this will depend upon the nature of the specimen.

1.2 General description of the test

The specimen is exposed to rapid changes of temperature in air, or in a suitable inert gas, by alternate exposure to low temperature and to high temperature.

1.3 Description of the test apparatus

1.3.1 Testing chamber

- 1.3.1.1 Two separate chambers shall be provided, one for the low temperature and one for the high temperature, the location being such as to allow transfer of the specimen from one chamber to the other within the prescribed time. Either manual or automatic transfer methods may be used.

- 1.3.1.2 The chambers shall be capable of maintaining the atmosphere at the appropriate temperature for the test in any region where the specimen is placed.
- 1.3.1.3 The absolute humidity of the atmosphere should not exceed 20 g/m³.
- 1.3.1.4 The temperature of the walls of the hot and cold chambers shall not differ by more than 3% and 8% respectively from the specified ambient temperature of the test, expressed in kelvins. This requirement applies to all parts of the chamber walls and the specimens shall be unable to “see” any heating or cooling elements which do not comply with this requirement.
- 1.3.1.5 The volume of the chambers and the air velocity shall be such that after insertion of the test specimens, the temperature of the atmosphere shall be within the specified tolerance after a time of not more than 10% of the exposure time.
- 1.3.1.6 The air in the chamber shall be circulated. Air velocity measured close to the test specimen, shall be not less than 2 m/s.

1.3.2 *Mounting or supporting of the test specimen*

Unless otherwise specified in the relevant specification, the thermal conduction of the mounting or supports shall be low, such that for practical purposes the specimen is thermally isolated. When testing several specimens simultaneously they shall be so placed that free circulation should be provided between specimens, and between specimens and chamber surfaces.

1.4 *Severities*

- 1.4.1 The severity of the test is defined by the combination of the two temperatures, the transition time (see Sub-clause 1.6.5) and the number of cycles.
- 1.4.2 The lower temperature T_A shall be specified in the relevant specification and should be chosen from the test temperatures of IEC Publications 68-2-1: Tests A: Cold and 68-2-2: Tests B: Dry Heat.

The higher temperature T_B shall be specified in the relevant specification and should be chosen from the test temperatures of IEC Publications 68-2-1 and 68-2-2.

- 1.4.3 The number of cycles shall be five, unless otherwise specified in the relevant specification.

1.5 *Initial measurements*

The specimen shall be visually examined and electrically and mechanically checked, as required by the relevant specification.

1.6 *Conditioning*

- 1.6.1 The specimen shall be either in the unpacked, switched-off, ready for use state, or as otherwise specified in the relevant specification. At the beginning of the conditioning the specimen shall be at the ambient temperature of the laboratory.
- 1.6.2 The exposure time t_1 of each of the two temperatures depends upon the heat capacity of the specimen. It shall be 3 h, 2 h, 1 h, 30 min or 10 min as specified in the relevant specification. Where no exposure period is specified in the relevant specification it is understood to be 3 h.

Notes 1. — The 10 min exposure time applies to the testing of small specimens.

2. — Attention is drawn to the requirements of Sub-clause 1.3.1.5 taking into account the thermal time constant of the test specimens and the technical capabilities of existing test chambers.

1.6.3 The test specimen shall be placed in the cold chamber, the atmosphere of which has been previously adjusted to the appropriate low temperature T_A .

1.6.4 The atmosphere in the test chamber shall be maintained at the low temperature T_A for the specified period t_1 ; t_1 includes an initial time, not longer than $0.1 t_1$, for temperature stabilization of the atmosphere (see Sub-clause 1.3.1.5).

Note. — The exposure time is measured from the moment of insertion of the specimen into the chamber.

1.6.5 Transition time t_2

The specimen shall then be removed from the cold chamber and transferred to the hot chamber in a period t_2 which shall be not less than 2 min and not more than 3 min. In the case of automatic two-chamber test equipment, a change-over period of less than 30 s is allowed. The relevant specification should indicate if automatic transfer test equipment may be used.

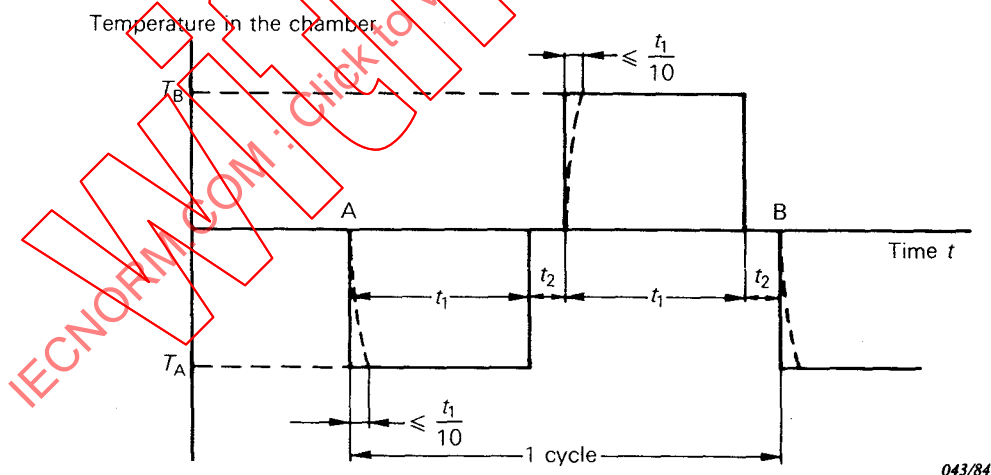
The transition time t_2 shall include the time of removal from one chamber and the insertion into the second chamber as well as any dwell time at the ambient temperature of the laboratory.

1.6.6 The atmosphere in the hot chamber shall be maintained at the high temperature T_B for the appropriate period t_1 ; t_1 includes an initial time, not longer than $0.1 t_1$, for temperature stabilization of the atmosphere (see Sub-clause 1.3.1.5).

Note. — The exposure time is measured from the moment of insertion of the specimen into the chamber.

1.6.7 For the next cycle the specimen shall be transferred to the cold chamber in a transition time t_2 as prescribed in Sub-clause 1.6.5.

1.6.8 The first cycle comprises the two exposure times t_1 and the two transition times t_2 (see Figure 1).



A = start of first cycle

B = end of first cycle and start of second cycle

Note. — The dotted curve is explained in Sub-clause 1.3.1.5.

FIGURE 1

1.6.9 The specimen shall be subjected to five cycles as detailed in Sub-clauses 1.6.3 to 1.6.8 inclusive, unless otherwise specified in the relevant specification.

If it is not possible to commence the next transition from low to high temperature, or vice versa, immediately after the appropriate time t_1 , the specimen may remain in the cold or hot chamber (preferably cold), for example overnight or during a week-end period.

1.6.10 At the end of the last cycle the specimen shall be subjected to the recovery procedures specified in Sub-clause 1.7.

1.7 Recovery

1.7.1 At the end of the conditioning period, the specimen shall remain in standard atmospheric conditions for testing for a period adequate for the attainment of temperature stability.

1.7.2 The relevant specification may prescribe a specific recovery period for a given type of specimen.

1.8 Final measurements

The specimen shall be visually examined and electrically and mechanically checked, as required by the relevant specification.

1.9 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	<i>Sub-clause</i>
a) Mounting or supporting of the test specimen, if other than specified	1.3.2
b) Low temperature T_A High temperature T_B	1.4.2
c) Number of cycles (if other than five)	1.4.3
d) Initial measurements	1.5
e) State of the specimen when introduced into the chamber	1.6.1
f) Exposure time t_1 if other than 3 h	1.6.2
g) If automatic transfer test equipment with a change-over period of less than 30 s is allowed	1.6.5
h) Duration extension	1.6.9
i) Recovery	1.7.2
j) Final measurements	1.8

2. Test Nb: Change of temperature with specified rate of change

2.1 Scope

This test determines the ability of components, equipment or other articles to withstand and/or function during changes of ambient temperature.

2.2 General description of the test

The specimen is exposed to changes of temperature in air by exposure in a chamber to prescribed temperatures varied at a controlled rate. During this exposure the performance of the specimen may be monitored.

2.3 Description of test apparatus

2.3.1 Testing chamber

2.3.1.1 The chamber for this test shall be so designed that, in any region where the specimen under test is placed, a temperature cycle can be performed in such a manner that:

- a) the low temperature required for the test can be maintained;
- b) the high temperature required for the test can be maintained;
- c) the change-over from low temperature to high temperature or vice versa can be performed at the rate of change of temperature required for the test.

2.3.1.2 The absolute humidity of the atmosphere should not exceed 20 g/m³.

2.3.1.3 During the steady-state temperature periods, the temperature of the walls of the chamber shall not differ within the periods of the high and low temperature by more than 3% and 8% respectively, of the specified ambient temperature of the test, expressed in kelvins. This requirement applies to all parts of the chamber walls and the specimens shall be unable to "see" any heating or cooling elements which do not comply with this requirement.

2.3.1.4 The air of the chamber shall be circulated. Air velocity measured close to the test specimen, shall be not less than 2 m/s.

2.3.2 Mounting or supporting of the test specimen

Unless otherwise specified in the relevant specification, the thermal conduction of the mounting or support shall be low, such that for practical purposes the specimen is thermally isolated. When testing several specimens simultaneously they shall be so placed that free circulation should be provided between specimens, and between specimens and chamber surfaces.

2.4 Severities

2.4.1 The severity of the test is defined by the combination of the two temperatures, the rate of temperature change and the number of cycles.

- 2.4.2 The lower temperature T_A shall be specified in the relevant specification and should be chosen from the test temperatures of IEC Publications 68-2-1 and 68-2-2.

The higher temperature T_B shall be specified in the relevant specification and should be chosen from the test temperatures of IEC Publications 68-2-1 and 68-2-2.

- 2.4.3 The temperature of the chamber shall be lowered or raised at a rate which averaged over a period of not more than 5 min is either 1 ± 0.2 °C/min, 3 ± 0.6 °C/min or 5 ± 1 °C/min, unless otherwise specified in the relevant specification.

An explanation concerning the relation between the temperature gradient and the mass and thermal time constant of the specimen is given in IEC Publication 68-2-33.

- 2.4.4 The number of cycles shall be two, unless otherwise specified in the relevant specification.

2.5 Initial measurements

The specimen shall be visually examined and electrically and mechanically checked, as required by the relevant specification.

2.6 Conditioning

- 2.6.1 The specimen, while being at the ambient temperature of the laboratory, shall be introduced into the test chamber, the latter also being at that temperature.

The specimen shall be either in the unpacked, switched-off, ready for use state, or as otherwise specified in the relevant specification.

- 2.6.2 If required by the relevant specification, the specimen shall be brought into operating condition.

- 2.6.3 The temperature in the chamber shall then be lowered to the specified low temperature T_A at the specified rate of cooling (see Sub-clause 2.4.3).

- 2.6.4 The exposure time t_1 to each of the two temperatures depends upon the heat capacity of the specimen. It shall be 3 h, 2 h, 1 h, 30 min or 10 min as specified in the relevant specification. Where no exposure period is prescribed in the relevant specification it is understood to be 3 h.

- 2.6.5 After temperature stability in the chamber has been reached, the specimen shall be exposed to the low-temperature condition for the specified period t_1 .

- 2.6.6 The temperature in the chamber shall then be raised to the specified high temperature T_B at the specified rate of heating (see Sub-clause 2.4.3).

- 2.6.7 After temperature stability in the chamber has been reached, the specimen shall be exposed to the high-temperature condition for the specified period t_1 .

- 2.6.8 The temperature in the chamber shall then be lowered to the value of the laboratory ambient temperature at the specified rate of cooling (see Sub-clause 2.4.3).

2.6.9 This procedure constitutes one cycle (see Figure 2).

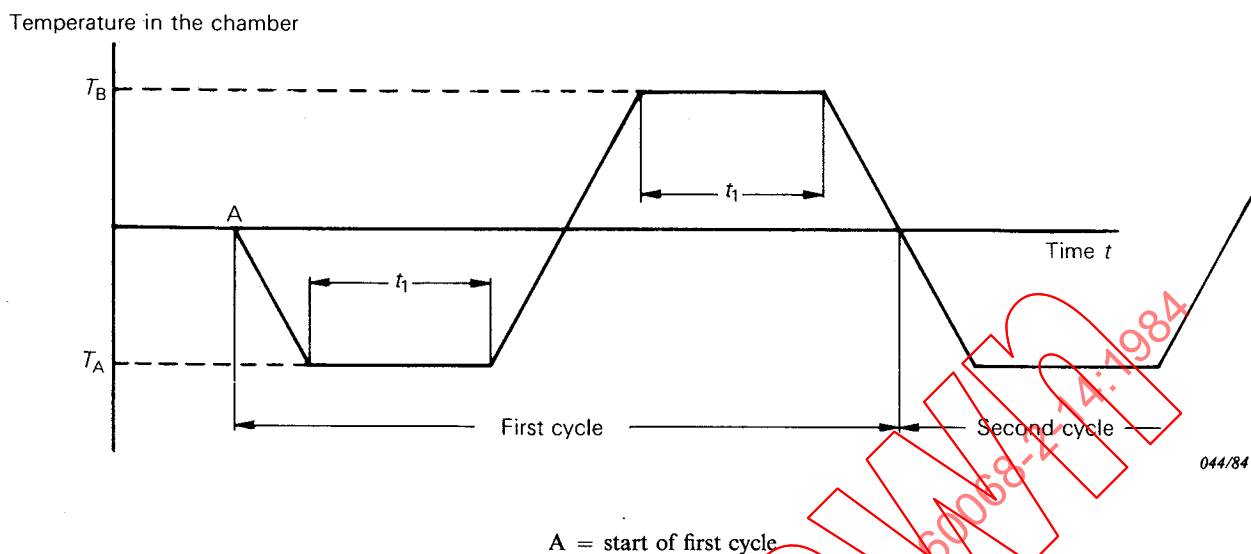


FIGURE 2

2.6.10 The specimen shall be subjected to two consecutive cycles, unless otherwise specified in the relevant specification.

2.6.11 The relevant specification shall state:

- a) the electrical and mechanical checks to be made during conditioning;
- b) the period(s) after which they are to be made.

2.6.12 Before removal from the chamber, the specimen under test shall have reached temperature stability at the laboratory ambient temperature.

2.7 Recovery

2.7.1 At the end of the conditioning period, the specimen shall remain in standard atmospheric conditions for testing for a period adequate for the attainment of temperature stability.

2.7.2 The relevant specification may prescribe a specific recovery period for a given type of specimen.

2.8 Final measurements

The specimen shall be visually examined and electrically and mechanically checked, as required by the relevant specification.

2.9 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	<i>Sub-clause</i>
a) Mounting or supporting of the test specimen, if other than prescribed	2.3.2
b) Low temperature T_A High temperature T_B	2.4.2
c) Rate of change of temperature	2.4.3
d) Number of cycles (if other than two)	2.4.4
e) Initial measurements	2.5
f) State of the specimen when introduced into the chamber	2.6.1
g) Exposure time t_1 , if other than 3 h	2.6.4
h) Electrical and mechanical checks during conditioning and the period after which they shall be carried out	2.6.11
i) Recovery	2.7.2
j) Final measurements	2.8

3. Test Nc: Rapid change of temperature, two-fluid-bath method

3.1 Scope

This test determines the ability of components, equipment or other articles to withstand rapid changes of temperature.

This test procedure results in a severe thermal shock and is applicable to glass-metal seals and similar specimens.

3.2 General description of the test

The specimen is immersed alternately in two baths, one filled with liquid at a low temperature T_A , and one filled with liquid at a high temperature T_B .

3.3 Description of test apparatus

3.3.1 Two baths, one for the low temperature and one for the high temperature, shall be provided, in such a way that the specimen under test can be easily immersed and can be quickly transferred from one bath to the other bath. The liquid shall not be stirred.

3.3.2 The bath for the low temperature shall contain liquid at the lower temperature T_A stated in the relevant specification. If no temperature is stated the liquid shall have a temperature of 0 °C.

3.3.3 The bath for the high temperature shall contain liquid at the upper temperature T_B as required by the relevant specification. If no temperature is stated the liquid shall have a temperature of 100 °C.

3.3.4 The baths shall be so constructed that at no moment during the test shall the temperature of the cold bath rise more than 2 °C above T_A or the temperature of the warm bath fall more than 5 °C below T_B .

3.3.5 The liquids used for the test shall be compatible with the materials and finishes used in the manufacture of the specimens.

Note. — The rate of heat transfer will depend upon the liquids used and will affect the severity of the test for a given temperature range. In special cases the relevant specification should specify the liquids to be used.

3.4 Severities

3.4.1 The severity of the test is defined by the specified bath temperatures, the period of transfer from one bath to the other t_2 , and the number of cycles.

3.4.2 This test has two standardized duration parameters:

- Group of parameters 1 $\left\{ \begin{array}{l} t_2 = 8 \pm 2 \text{ s with } 5 \text{ min} \leq t_1 < 20 \text{ min} \\ \text{(see Sub-clauses 3.6.3 to 3.6.5)} \end{array} \right.$
- Group of parameters 2 $\left\{ \begin{array}{l} t_2 = 2 \pm 1 \text{ s with } 15 \text{ s} \leq t_1 < 5 \text{ min} \\ \text{(see Sub-clauses 3.6.3 to 3.6.5)} \end{array} \right.$

The relevant specification shall specify the duration parameters to be used and the chosen value of t_1 .

3.4.3 The number of cycles shall be ten, unless otherwise specified in the relevant specification.

3.5 Initial measurements

The specimen shall be visually examined and electrically and mechanically checked, as required by the relevant specification.

3.6 Conditioning

3.6.1 The specimen shall be subjected to the test in the unpacked condition.

3.6.2 The specimen under test while being at the ambient temperature of the laboratory shall be immersed into the cold bath containing liquid at the temperature stated in the relevant specification.

3.6.3 The specimen shall be maintained immersed in the cold bath for the appropriate period t_1 .

3.6.4 The specimen shall then be removed from the cold bath and immersed in the hot bath containing liquid at the temperature stated in the relevant specification. The transition time t_2 shall be as stated in Sub-clause 3.4.2.

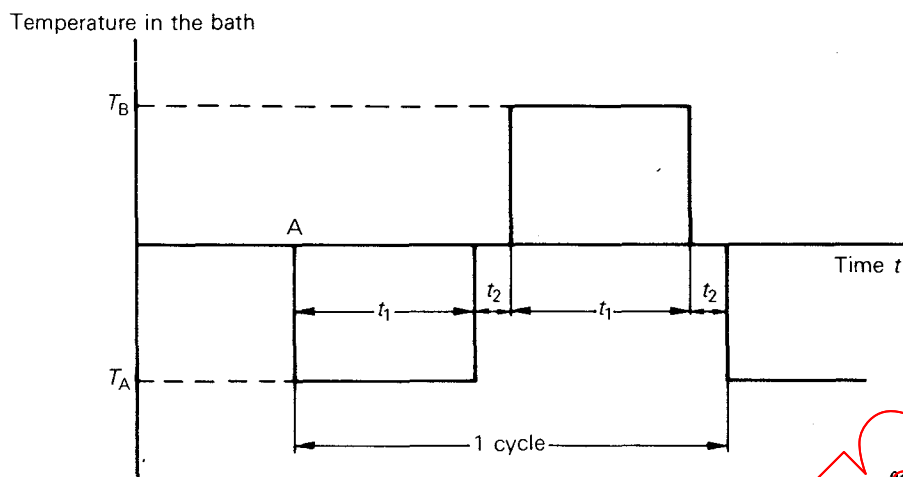
3.6.5 The specimen shall be maintained immersed in the hot bath for the appropriate period t_1 .

3.6.6 The specimen shall then be removed from the hot bath. The period t_2 between removal from the hot bath and immersion in the cold bath shall be as specified in Sub-clause 3.4.2.

3.6.7 One cycle consists of two immersion times t_1 and two transition times t_2 (see Figure 3, page 29).

3.6.8 The specimen shall be subjected to ten consecutive cycles, unless otherwise specified in the relevant specification.

3.6.9 At the end of the last cycle, the specimen shall be subjected to the recovery procedure specified in Sub-clause 3.7.



A = start of first cycle

FIGURE 3

3.7 Recovery

3.7.1 At the end of the conditioning period, the specimen shall be subjected to standard atmospheric conditions for testing for a period adequate for the attainment of temperature stability. Droplets of liquid shall be removed. Cleaning (to be defined, if necessary, by the relevant specification) is allowed to remove the deposits on the specimens of the liquids used.

3.7.2 The relevant specification may prescribe a specific recovery period for a given type of specimen.

3.8 Final measurements

The specimen shall be visually examined and electrically and mechanically checked, as required by the relevant specification.

3.9 Information to be given in the relevant specification

When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

	Sub-clause
a) Duration: groups of parameters 1 or 2, and value of t_1	3.4.2
b) Number of cycles (if other than ten)	3.4.3
c) Temperature of cold bath, if other than 0 °C	3.3.2, 3.6.2
d) Temperature of hot bath, if other than + 100 °C	3.3.3, 3.6.4
e) The liquids to be used	3.3.5
f) Initial measurements	3.5
g) Recovery	3.7
h) Final measurements	3.8