

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

Household electrical appliances – Performance – Water for testing

Appareils électrodomestiques – Aptitude à la fonction – Eau pour les essais

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INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

PRICE CODE  
CODE PRIX

N

ICS 97.060

ISBN 978-2-83220-139-8

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**HOUSEHOLD ELECTRICAL APPLIANCES –  
PERFORMANCE – WATER FOR TESTING**

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International standard IEC 60734 has been prepared by subcommittee 59D: Home laundry appliances, of IEC Technical Committee 59: Performance of household and similar electrical appliances.

This fourth edition cancels and replaces the third edition published in 2001. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) four types of standard water, from soft to very hard, are defined with specification for hardness, **alkalinity** and **conductivity**;
- b) preparation method A is no longer maintained; and
- c) method C3 is added to prepare water of specified hardness, **conductivity** and **alkalinity** starting with natural water while the natural water based methods C1 and C2 focus on **water hardness** only, without allowing control or setting of **alkalinity** and **conductivity**.

The text of this standard is based on the following documents:

FDIS	Report on voting
59/398/FDIS	59/399/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

Words in **bold** in the text are defined in Clause 3.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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## INTRODUCTION

This publication specifies water qualities with regard to hardness, **alkalinity** and **conductivity** and describes several methods to prepare water to be used for testing household appliances in cases where the water quality is important for the reproducibility of the test results. The described methods allow the preparation of water complying with all three target requirements (hardness, **alkalinity**, **conductivity**), or just hardness – depending on the requirements set out in the referring appliance test method.

Compared to the third edition of IEC 60734 (2001), method A is no longer maintained and another method, method C3, is added.

Method B is used to prepare water of the correct **total hardness**. Preparation starts with demineralised water in which hardening salts are dissolved. It will give water specified temporary as well as **permanent hardness**, whilst complying with the specifications for **alkalinity** and **conductivity**.

Method C1 starts with natural water with higher hardness than required, while method C2 starts with soft natural water, which is hardened. Depending on the composition of the natural water, several other ions might be present. Restrictions regarding the amounts are given for some ions, which may influence the cleaning results when testing washing machines and dishwashers. No specification regarding **temporary** and **permanent hardness** is given.

The development of method C3 appreciates the need for water of specified **conductivity** and **alkalinity** for testing the performance of tumble dryers. While synthetic method B meets this need, the natural water based methods C1 and C2 focus on **water hardness** only without allowing control or setting of **alkalinity** and **conductivity**. The new method C3, which starts with natural water, fills that gap.

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# HOUSEHOLD ELECTRICAL APPLIANCES – PERFORMANCE – WATER FOR TESTING

## 1 Scope

This International Standard describes the preparation of four types of water of different hardness, conductivity and alkalinity, intended to be used for testing the performance of household appliances such as washing machines, dishwashers, tumble dryers, steam irons etc.

It defines the characteristics of these waters and establishes various methods to be used for obtaining them. It also includes specifications for required measurements.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6059, *Water quality – Determination of the sum of calcium and magnesium – EDTA titrimetric method*

ISO 7888, *Water quality – Determination of electrical conductivity*

ISO 9963-1, *Water quality – Determination of alkalinity – Part 1: Determination of total and composite alkalinity*

ISO 10523, *Water quality – Determination of pH*

## 3 Terms, definitions and symbols

### 3.1 Terms and definitions

For the purposes of this document, the following definitions apply.

#### 3.1.1

##### **water hardness**

parameter indicating the quantity of alkaline earth salts (bicarbonates, sulphates, chlorides etc.) present in the water

#### 3.1.2

##### **total hardness**

sum of calcium and magnesium ions in the water

#### 3.1.3

##### **temporary hardness**

fraction of the **total hardness** equivalent to the bicarbonate content

#### 3.1.4

##### **permanent hardness**

difference between the **total hardness** and the **temporary hardness**



**3.1.5****alkalinity**

ability of a solution to neutralize acids to the equivalence point of carbonate or bicarbonate, i.e. equals the stoichiometric sum of the bases in the solution

**3.1.6****conductivity**

ability of a solution to conduct an electric current, i.e. measure of the stoichiometric sum of the ions dissolved in the solution

**3.2 Symbols**

<b>Symbol</b>	<b>Unit</b>	<b>Definition</b>
$A_0$	mmol/l	initial <b>alkalinity</b>
$A_{\text{req}}$	mmol/l	target <b>alkalinity</b>
$c_0(\text{Fe})$	mg/l	initial iron content
$c_{\text{max}}(\text{Fe})$	mg/l	maximum iron content
$c_0(\text{Cu})$	mg/l	initial copper content
$c_{\text{max}}(\text{Cu})$	mg/l	maximum copper content
$c_0(\text{Mn})$	mg/l	initial manganese content
$c_{\text{max}}(\text{Mn})$	mg/l	maximum manganese content
$c_0(\text{Cl}^-)$	mmol/l	initial chloride content
$c_{\text{max}}(\text{Cl}^-)$	mmol/l	maximum chloride content
$cond_0$	$\mu\text{S}/\text{cm}$	initial <b>conductivity</b>
$cond_{\text{req}}$	$\mu\text{S}/\text{cm}$	target <b>conductivity</b>
$dil$	–	dilution factor
$dil_{\text{min}}$	–	lowest possible dilution factor that allows the preparation of water to meet all requirements
$dil_{\text{min}}(\text{h,A,cond})$	–	lowest possible dilution factor that allows the preparation of water to meet the <b>total hardness, alkalinity and conductivity</b> requirements
$dil_{\text{min}}(\text{Fe})$	–	lowest possible dilution factor that allows the preparation of water to meet the maximum iron content requirement
$dil_{\text{min}}(\text{Cu})$	–	lowest possible dilution factor that allows the preparation of water to meet the maximum copper content requirement
$dil_{\text{min}}(\text{Mn})$	–	lowest possible dilution factor that allows the preparation of water to meet the maximum manganese content requirement
$dil_{\text{min}}(\text{Cl}^-)$	–	lowest possible dilution factor that allows the preparation of water to meet the maximum chloride content requirement
$k_A$	–	constants
$k_H$	–	constants
$h_0$		initial <b>total hardness</b>
$h_{\text{req}}$		target <b>total hardness</b>
$addition_A$	ml	quantity of solution to be added to reach required <b>alkalinity</b>
$addition_h$	ml	quantity of solution to be added to reach required <b>total hardness</b>
$addition_{\text{cond}}$	ml	quantity of solution to be added to reach required <b>conductivity</b>

#### 4 Measurements and accuracy

Measurements according to this International Standard shall comply with the following specifications in Table 1:

**Table 1 – Measurement specifications**

Parameter	Unit	Minimum accuracy	Additional requirements and remarks
<b>Total hardness</b>	mmol/l	± 2 %	See ISO 6059 for specifications of such determination.
<b>Alkalinity</b>	mmol/l	± 5 %	The <b>alkalinity</b> is measured as the concentration of (HCO <sup>3-</sup> ). If determined by titration with hydrochloric acid the endpoint shall be pH 4,5 – the stoichiometric factor then is 1. See ISO 9963-1 for specifications of such determination.
<b>Conductivity</b>	µS/cm	± 5 % at 20 °C	See ISO 7888 for specifications of such determination.
pH	-	± 0,05	The accuracy requirement shall be met over a temperature range of 15 °C to 25 °C. See ISO 10523 for specifications of such determination.
Content of iron, copper, manganese or chloride	-	-	The requirements for these parameters are maximum content requirements. The accuracy of the measurement shall be sufficient to prove compliance with these requirements.

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#### 5 Standard water

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##### 5.1 Water types <https://standards.iteh.ai/catalog/standards/sist/d59c00f0-1366-42dd-a80a-a23ca608f278/iec-60734-2012>

In Table 2, different water types are defined, which are all referred to by their level of **total hardness** and specified with specific levels of **total hardness**, **alkalinity**, **conductivity** and pH.

**Table 2 – Composition of soft, medium hard, hard and very hard water**

Property	Unit	Water type			
		Standard soft water	Standard medium hard water	Standard hard water	Standard very hard water
<b>Total hardness</b>	mmol/l (Ca <sup>2+</sup> /Mg <sup>2+</sup> )	0,50 ± 0,20	1,50 ± 0,20	2,50 ± 0,20	3,50 ± 0,20
<b>Alkalinity</b>	mmol/l (HCO <sub>3</sub> <sup>-</sup> )	0,67 ± 0,20	2,00 ± 0,20	3,35 ± 0,20	4,70 ± 0,20
<b>Conductivity</b> (at 20 °C)	µS/cm	150 ± 50	450 ± 100	750 ± 150	1050 ± 250
pH (at 20 °C)	-	8,0 to 8,5	7,5 to 7,9	7,3 to 7,7	-

Other test methods and standards referring to the water types in this International Standard may require to meet all or only selected properties given in Table 2.

NOTE With the specification of these four standard waters it is possible to select one or more standardised waters, which would approximate the local natural waters available. If any other **water hardness** is needed, it can be prepared in a similar way by interpolation of the given specifications.

## 5.2 Additional requirements

Other test methods and standards referring to the water types described in this International Standard may also require that any or all of the specifications shown in Table 3 are met.

**Table 3 – Maximum content of heavy metal ions and chloride**

Property	Unit	Water type			
		Standard soft water	Standard medium hard water	Standard hard water	Standard very hard water
Max. iron content, $c_{\max}(\text{Fe})$	mg/l	0,1			
Max. copper content, $c_{\max}(\text{Cu})$	mg/l	0,05			
Max. manganese content, $c_{\max}(\text{Mn})$	mg/l	0,05			
Max. chloride content, $c_{\max}(\text{Cl}^-)$	mmol/l	4,5			Not applicable
NOTE Iron, copper and manganese can influence bleach performance if the water is used for cleaning purposes. The chloride content may be of relevance for testing dishwashers. Standard very hard water does not meet the chloride content requirement.					

## 6 Preparation of standard water

### 6.1 Demineralisation of natural water

Natural water is demineralised so that its specific resistance is 100 000  $\Omega/\text{cm}$  or more (i.e. its **conductivity** is 10  $\mu\text{S}/\text{cm}$  at maximum). Water of this quality can be obtained e.g. using mixed cation and anion exchange resins or by reverse osmosis.

When an ion exchange resin is new, the first one or two preparations should be discarded. This is not necessary after each normal regeneration.

### 6.2 Preparation of standard water method B

#### 6.2.1 Principle

This preparation method starts with demineralised water to which salts are added to achieve the specified water properties.

#### 6.2.2 Procedure

Prepare the following solutions of salts in demineralised water:

- Solution 1             $\text{NaHCO}_3$             67,2 g/l            (800 mmol/l)
- Solution 2             $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$     38,0 g/l            (154,2 mmol/l)
- Solution 3             $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$     65,6 g/l            (446,1 mmol/l)

Add specified amounts of the three solutions as given in Table 4 to 0,7 l of demineralised water and add up to 1,0 l for preparation of the desired standard water. If large amounts of water are prepared, the addition may be performed through automatic dosage. Finally, adjust the pH to the range specified in Table 2 with HCl or NaOH before use.

**Table 4 – Amounts of salt solutions to be added to 1 l of demineralised water**

Solution	Water type			
	Standard soft water	Standard medium hard water	Standard hard water	Standard very hard water
Solution 1 (NaHCO <sub>3</sub> )	0,83 ml	2,50 ml	4,17 ml	5,84 ml
Solution 2 (MgSO <sub>4</sub> ·7H <sub>2</sub> O)	0,83 ml	2,50 ml	4,17 ml	5,84 ml
Solution 3 (CaCl <sub>2</sub> ·2H <sub>2</sub> O)	0,83 ml	2,50 ml	4,17 ml	5,84 ml

**6.2.3 Composition of standard water prepared by method B**

The **temporary hardness** component of the water consists of calcium and magnesium hydrogen carbonates Ca(HCO<sub>3</sub>)<sub>2</sub> and Mg(HCO<sub>3</sub>)<sub>2</sub>. The **permanent hardness** component consists of the chlorides and sulphates of calcium and magnesium (CaCl<sub>2</sub>, CaSO<sub>4</sub>, MgCl<sub>2</sub>, MgSO<sub>4</sub>). Composition of standard water achieved by method B is shown in Table 5.

**Table 5 – Expected composition of standard water achieved by method B**

Ions	Mol. weight	Water type			
		Standard soft water	Standard medium hard water	Standard hard water	Standard very hard water
		<b>Ion concentrations (mmol/l)</b>			
Ca <sup>2+</sup>	40,0	0,37	1,11	1,85	2,59
Mg <sup>2+</sup>	24,3	0,13	0,39	0,65	0,91
HCO <sub>3</sub>	61,0	0,67	2,00	3,35	4,68
Cl <sup>-</sup>	35,5	0,75	2,23	3,75	5,23
SO <sub>4</sub>	96,0	0,13	0,39	0,65	0,91
Na <sup>+</sup>	23,0	0,67	2,00	3,35	4,68
<b>Temporary hardness (mmol/l)</b>		0,33	1,00	1,67	2,34

**6.3 Preparation of water methods C1 and C2**

**6.3.1 Principle**

Methods C1 and C2 allow to prepare standard water of specified **total hardness** starting with natural water. Methods C1 and C2 do not adjust **alkalinity** or **conductivity**.

**6.3.2 Composition of standard water prepared by methods C1 and C2**

If the test method or standard referring to the water types in this standard also requires any or all of the specifications of Table 3 to be met (maximum content of heavy metals and chloride), the natural water shall be analyzed regarding the respective (required) properties. If the content of iron, copper, manganese or chloride in the natural water exceeds the limits specified in 5.2, first dilute the natural water with demineralised water.

No differentiation is made between **temporary hardness** and **permanent hardness**. The Ca<sup>2+</sup>/Mg<sup>2+</sup> ratio shall be 1,5 to 9.