IEC 60456

Edition 6.0 2024-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Washing machines for household use – Methods for measuring the performance

Machines à laver pour usage domestique – Méthodes de mesure de l'aptitude à la fonction

IEC 60456:2024-11(en-fr)

Documents
Document Sharing Hub

Full document details: IEC 60456 2024

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC - webstore.iec.ch/advsearchform
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, …). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org
Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Documents
Document Sharing Hub

Full document details: IEC 60456 2024

IEC 60456

Edition 6.0 2024-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Washing machines for household use – Methods for measuring the performance

Machines à laver pour usage domestique – Méthodes de mesure de l'aptitude à la fonction

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 97.060

ISBN 978-2-8327-0051-8

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

CONTENTS

FOREWORD 14
1 Scope 17
2 Normative references 17
3 Terms, definitions, abbreviated terms and symbols 18
3.1 Terms and definitions 19
3.2 Abbreviated terms and symbols 27
4 Requirements 30
4.1 General 30
4.2 Rated capacity 31
4.3 Dimensions and volume 31
5 Test conditions, materials, equipment and instrumentation 32
5.1 General 32
5.2 Test conditions 32
5.2.1 Electricity supply 32
5.2.2 Water supply 32
5.2.3 Ambient temperature and humidity 34
5.3 Test materials 35
5.4 Equipment 35
5.4.1 General 35
5.4.2 Reference machine 36
5.4.3 Spectrophotometer 36
5.4.4 Equipment for conditioning the base load 37
5.4.5 Standard extractor 37
5.4.6 Iron for preparation of stain strips after washing 37
5.4.7 Alkalinity rinsing performance equipment 37
5.4.8 LAS rinsing performance equipment 38
5.4.9 Other equipment 40
6 Preparation for testing 40
6.1 General 40
6.2 Test washing machine and reference machine preparation 40
6.2.1 Test washing machine 40
6.2.2 Reference machine 41
6.3 Detergent 42
6.3.1 General 42
6.3.2 Detergent dose 42
6.3.3 Weighing and mixing of detergent 43
6.3.4 Detergent placement 43
6.4 Test loads 44
6.4.1 General 44
6.4.2 Pre-treatment of new base load items prior to use 45
6.4.3 Requirements regarding the age of base load items 45
6.4.4 Normalization of base load items 47
6.4.5 Conditioning of base load items 48
6.4.6 Test load composition 49
6.4.7 Measurement of unwashed stain strips prior to testing 55
6.4.8 Addition of tracer textiles to the base load 55

AVA Documents
Document Sharing Hub

Full document details: IEC 60456 2024

7 Performance measurements – general requirements 58
8 Tests for performance 60
8.1 General 60
8.2 Test procedure for performance tests 60
8.2.1 Test conditions, materials and preparation for testing 60
8.2.2 Test load and loading 61
8.2.3 Programme 61
8.2.4 Test procedure 61
8.2.5 Test series 61
8.2.6 Intermittently recurring functions 63
8.3 Measurements to determine water and energy consumption and programme duration 64
8.3.1 General 64
8.3.2 Measurement procedure 64
8.3.3 Assessment of data 64
8.4 Measurements to determine the standard cleaning performance 64
8.4.1 General 64
8.4.2 Materials and preparation for testing 64
8.4.3 Measurement procedure 65
8.4.4 Assessment of standard stain strips 65
8.5 Measurements to determine water extraction performance 66
8.5.1 General 66
8.5.2 Washing machines 66
8.5.3 Spin extractors 66
8.6 Measurements to determine rinsing performance 67
8.6.1 General 67
8.6.2 Alkalinity rinse test 67
8.6.3 LAS rinse test 69
8.7 Measurement to determine gentleness of action (GoA) 71
8.7.1 General 71
8.7.2 Materials and preparation for testing 72
8.7.3 Measurement procedure 76
8.7.4 Assessment of thread removal fabrics 78
8.8 Wool cleaning performance 81
8.8.1 General 81
8.8.2 Materials and preparation for testing 81
8.8.3 Measurement procedure 82
8.9 Cold water cleaning performance 82
8.9.1 General 82
8.9.2 Materials and preparation for testing 83
8.9.3 Measurement procedure 83
8.9.4 Assessment of cold water stain strips 84
9 Assessment of performance 84
9.1 General 84
9.2 Evaluation of water and energy consumption and programme duration 84
9.2.1 General 84
9.2.2 Water volumes 84
9.2.3 Programme duration 84
9.2.4 Energy consumption 85

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

9.3 Evaluation of cleaning performance 86
9.3.1 General 86
9.3.2 Cleaning evaluation per stain 86
9.3.3 Overall cleaning performance evaluation 88
9.3.4 Nomination 88
9.3.5 Batchwise use of stain strips 88
9.3.6 Example (with arbitrary values) 89
9.4 Evaluation of water extraction performance 91
9.5 Evaluation of rinsing performance 91
9.5.1 General 91
9.5.2 Alkalinity method 92
9.5.3 LAS method 93
9.6 Evaluation of gentleness of action 95
9.7 Evaluation of wool cleaning performance 96
9.8 Evaluation of cold water cleaning performance 96
9.8.1 General 96
9.8.2 Data to be reported 96
Annex A (normative) Specification of tracer textiles and ballast soil 97
A.1 General 97
A.2 Stains strips and white unsoiled fabric 98
A.2.1 Artificial soils for standard cleaning performance on cotton, synthetics/blends and polycotton 98
A.2.2 Artificial soils for wool cleaning performance 102
A.2.3 Artificial soils for cold water cleaning performance 103
A.2.4 Marking of stain strips and accompanying data 106
A.2.5 Advice for users 107
A.3 Specification of test material for wool shrinkage 107
A.4 Specification of thread removal specimen for gentleness of action measurements 107
A.4.1 General 107
A.4.2 Use for tests of wool programmes – GoA-A thread removal specimen 108
A.4.3 Use for tests of cotton and synthetics/blends programmes – GoA-B thread removal specimen 108
A.5 Specification for ballast soil 108
Annex B (normative) Detergents 110
B.1 General 110
B.2 Standard powder detergent IEC-P 110
B.2.1 General information on standard powder detergent IEC-P 110
B.2.2 Information on sodium percarbonate 111
B.2.3 Quality control measures 111
B.3 Standard wool detergent IEC-W 112
Annex C (informative) Liquid detergents 114
C.1 General 114
C.2 Composition of the standard liquid detergents 114
C.2.1 General 114
C.2.2 Standard liquid detergent IEC-L1 114
C.2.3 Standard liquid detergent IEC-L2 115
C.2.4 Quality control requirements 116
C.3 Detergent dose 117

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

C.4 Test washing machine and reference machine preparation 117
C.5 Base load 118
C.6 Gentleness of action 118
C.7 LAS rinsing performance 118
Annex D (normative) Specification for base loads 119
D.1 Cotton base load 119
D.2 Synthetics/blends base load 120
D.3 Polyester base load for wool programme 121
D.4 Polycotton base load 121
Annex E (normative) Reference machine specification 123
E.1 Specification of the reference machine and method of use 123
E.2 Further information 123
E.3 Reference machine: Method of use 123
E.3.1 Installation of the reference machine 123
E.3.2 Regular maintenance 123
E.3.3 Before test series 125
E.3.4 During a test series 125
Annex F (normative) Reference machine programme definitions and selection 126
F.1 General 126
F.2 Programming instructions 126
F.3 Tolerances 126
F.4 Start-up programme 126
F.5 Reference programmes and descriptions of comparable washing machine programmes 128
Annex G (normative) The bone-dry method of conditioning 130
G.1 General 130
G.2 Tumble dryer specifications 130
G.3 Procedure based on inlet air temperature 131
G.4 Procedure for gas dryers 131
G.5 Procedure for cotton loads based on the comparative derivation of the bone-dry factor 132
G.6 Calculation of the conditioned mass of the base load 132
Annex H (normative) Folding and loading the test load 133
H.1 General 133
H.2 Folding the items prior to loading the washing machine 133
H.2.1 General 133
H.2.2 Load items with stain strips attached 133
H.2.3 Load items without a stain strip attached 138
H.2.4 Thread removal specimen 139
H.2.5 Wool shrinkage specimen 140
H.3 Loading items into the washing machine – general rules 140
H.3.1 Machine type 140
H.3.2 Loading sequences 141
H.4 Special loading requirements for cotton loads – Horizontal axis washing machines 144
H.4.1 General loading directions 144
H.4.2 Horizontal axis washing machine: loading step by step 145
H.4.3 Loading for load sizes above 25 kg 145
H.4.4 Example 146

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

H.5 Special loading requirements for cotton loads – Vertical axis washing machines 152
H.5.1 General loading directions 152
H.5.2 Vertical axis washing machine: loading step by step 153
H.5.3 Vertical axis washing machine: load sizes above 25 kg 163
H.5.4 Example 164
H.6 Special loading requirements for synthetics/blends loads – Horizontal axis washing machines 165
H.7 Special loading requirements for synthetics/blends loads – Vertical axis washing machines 167
Annex I (normative) Calculation of weighted average age of the cotton base load, the polycotton base load and the synthetics/blends base load 169
I.1 Determination of the weighted average age 169
I.2 Determination of weighted average in case of exchange of load items for Gentleness of action measurements 169
I.3 Example of how to achieve the weighted average age requirements for a cotton base load 169
I.3.1 Overview 169
I.3.2 How to build up loads according to this example 169
I.3.3 Load maintenance according to this example 170
Annex J (normative) Rinsing 171
J.1 Alkalinity 171
J.2 LAS measurement 171
J.2.1 Preparation and checking of equipment 171
J.2.2 Detergent calibration curve 174
J.2.3 Measure the absorbance of the working standard solutions 176
J.2.4 Calculations 177
J.3 IEC-P base powder detergent sampling 177
J.3.1 Purpose 177
J.3.2 Devices and materials 177
J.3.3 Sampling procedure 178
J.4 Acquiring samples using a dispenser 181
J.4.1 General 181
J.4.2 Calibration of the dispenser 181
J.4.3 Acquiring samples (with dispenser) 182
J.5 Quartz cuvette and glassware cleaning and handling 182
J.5.1 Purpose 182
J.5.2 Cuvettes 182
J.5.3 General cleaning 182
J.5.4 Periodic glass cleaning 183
J.6 Extraction of single swatches 183
J.6.1 General 183
J.6.2 Additional materials 183
J.6.3 Single brushed extraction 183
J.7 Examples for the calculations of LAS rinsing performance 184
J.7.1 Example of checking the quality of the distilled water 184
J.7.2 Example for the calibration curve calculations 185
J.7.3 Example for calculation of LAS rinsing performance 189
Annex K (informative) Laboratory internal testing guide 190
K.1 General 190

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

K.2 Elements of an internal test protocol 190
K.2.1 General 190
K.2.2 Preparation for testing 190
K.2.3 Performing the test 191
K.2.4 Recording and checking results 191
K.3 Examples of elements from a detailed internal testing protocol 192
K.3.1 General 192
K.3.2 Initial preparation for testing 192
K.3.3 Prior to testing 193
K.3.4 During the test 193
K.3.5 Additional points to consider for test runs within a test series 194
K.3.6 Evaluation 194
K.3.7 Post-test activities 194
K.3.8 Special issues for detergent 194
K.3.9 Special considerations for alkalinity rinsing measurement 195
Annex L (normative) Measurement of energy consumption in low power modes of washing machines 196
L.1 General 196
L.2 Determination of electric power in off mode 197
L.3 Determination of electric power in standby mode 197
L.4 Determination of electric power in networked standby 197
L.5 Determination of electric power in delay start mode 198
L.6 Determination of electric power in left on mode 198
Annex M (normative) Testing procedure for manual washing machines 202
M.1 General 202
M.2 Water level 202
M.3 Programme 202
M.4 Default programme 203
Annex N (normative) Procedure to determine test load size where rated capacity is not declared 204
N.1 General 204
N.2 Determination of test load mass using table tennis balls 204
N.3 Determination of test load mass using water 205
Annex O (informative) Evaluation of washing performance 207
O.1 General 207
O.2 Edition 5 method 207
Annex P (informative) Effects on consumer relevance and measurement accuracy when deviating from standard test conditions 210
P.1 Overview 210
P.2 IEC reference machine 211
P.3 Standard detergent 212
P.4 IEC load items 212
P.5 IEC stain strips 213
P.6 Measurement of reflectance 214
P.7 Tests at rated capacity 214
P.8 Non-heated washing processes (cold water washing machines) 215
P.9 Other non-standard test conditions 215
P.10 Number of tests and evaluation of washing performance 216
P.11 Other important sources of information on testing 217

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

Annex Q (informative) Determination of test class, number of test runs in a test series and uncertainty of measurements 218
Q.1 General 218
Q.2 Purpose of test series – test class 218
Q.3 Flow chart 219
Q.4 Statistical treatment 220
Annex R (informative) Environmental aspects of washing machine usage determined in IEC 60456 224
R.1 General 224
R.2 Environmental aspects of washing machines covered by IEC 60456 224
R.2.1 General 224
R.2.2 Water consumption 224
R.2.3 Discharge of water 225
R.2.4 Energy consumption 225
R.2.5 Environmental aspects of washing machines not covered by IEC 60456 226
Annex S (normative) Test report – data to be reported 228
S.1 General 228
S.2 Rules for rounding and reporting of measured and calculated data 228
S.3 Test design and data for test washing machine 230
S.4 Reporting of materials used for the test series 236
S.5 Reporting of measured and calculated values 237
Annex T (normative) Testing intermittently recurring functions 252
T.1 Overview 252
T.2 Test series design 252
T.3 Method of evaluation 253
T.3.1 General 253
T.3.2 Energy consumption 254
T.3.3 Example 254
T.4 General test design for evaluating intermittently recurring functions 255
T.5 Ballast soil 257
T.6 Data to be reported 257
Annex U (informative) Sources of test materials and supplies 259
U.1 General 259
U.2 Suppliers for reference machine and reference programme 259
U.3 Suppliers for test materials 259
Annex V (normative) Multi-compartment washing machines 260
V.1 General 260
V.2 Measurement and evaluation of the drums of a multi-compartment washing machine 260
V.3 Rated capacity and detergent dosage for drums operated in multi-drum mode 260
V.4 Test procedure for performance tests for drums in multi-drum mode 260
V.4.1 Preparation 260
V.4.2 Test load and loading 260
V.4.3 Test procedure 261
V.5 Evaluation of the performance of drums in multi-drum mode 261
V.5.1 General 261
V.5.2 Evaluation of cleaning performance 261
V.5.3 Evaluation of water extraction performance 261

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

V.5.4 Evaluation of rinsing performance 261
V.5.5 Evaluation of gentleness of action 262
V.5.6 Evaluation of wool cleaning performance 262
V.5.7 Evaluation of cold water cleaning performance 262
V.5.8 Evaluation of combined water and energy consumption and programme duration 262
V.6 Evaluation of the performance of a multi-compartment washing machine 263
Annex W (normative) Measuring the wool shrinkage 264
W.1 General 264
W.2 Test material 264
W.2.1 Base load 264
W.2.2 Test material and additional equipment 264
W.2.3 Detergent 264
W.3 Test procedure 265
W.3.1 Determination of reference shrinkage 265
W.3.2 Preparation for testing 265
W.3.3 Washing 267
W.4 Evaluation 268
W.5 Data to be reported 269
Annex X (normative) Method for the determination of temperature inside the base load 270
X.1 General 270
X.2 Test conditions, materials, equipment and instrumentation 270
X.3 Preparation for testing 270
X.3.1 Preparation of equipment 270
X.3.2 Procedure 272
X.4 Temperature test 272
X.4.1 Data acquisition 272
X.4.2 Validity of temperature data and test runs 272
X.5 Expression of results 272
X.6 Assessment of temperature 273
X.7 Data to be reported 273
Annex Y (normative) Test instrumentation 274
Y.1 General 274
Y.2 Instruments, accuracy and precision of measurements 274
Y.3 Electrical energy consumption 274
Y.4 Water consumption 275
Y.5 Total water hardness 275
Y.6 Water pressure 275
Y.7 pH-value 276
Y.8 Humidity 276
Y.9 Length 276
Y.10 Mass 276
Y.11 Temperature 277
Y.12 Duration 277
Y.13 Voltage and frequency measurement requirements 278
Bibliography 279

Figure 1 – Overview of the different performance measures 19

AVA Documents
Document Sharing Hub

Full document details: IEC 60456 2024

Figure 2 – Load item preparation prior to a test run or series (according to test class) 45
Figure 3 – Load composition and age requirements 46
Figure 4 – Principle of attachment of cold water and standard stain strips 56
Figure 5 – Attachment of the stain strip with batch number 56
Figure 6 – Attached standard stain strip 57
Figure 7 – Attached cold water stain strip 57
Figure 8 – Principle of attachment of wool stain strip 58
Figure 9 – Attached wool stain strip 58
Figure 10 – Positions for measuring soiled test pieces 66
Figure 11 – Cutting of thread removal fabric 73
Figure 12 – Marking of thread removal fabric (GoA-A) 73
Figure 13 – Removal of end marking threads 73
Figure 14 – Preparation showing the example of a towel 74
Figure 15 – Centring of thread removal specimen, for the example of a towel 74
Figure 16 – Partial covering of a thread removal specimen, for the example of a towel 74
Figure 17 – Complete covering of thread removal specimen, for the example of a towel 75
Figure 18 – Sewing open sides, for the example of a towel (1) 75
Figure 19 – Sewing open sides, for the example of a towel (2) 75
Figure 20 – GoA-B in pillowcase (1) 76
Figure 21 – GoA-B in pillowcase (2) 76
Figure 22 – Thread removal specimen after test run 78
Figure 23 – Not remaining threads: example 79
Figure 24 – Remaining threads: example 79
Figure 25 – Remaining threads: example 79
Figure 26 – Remaining threads warp and weft direction 80
Figure 27 – Remaining threads warp and weft direction – detail 80
Figure A.1 – Test material overview 97
Figure A.2 – Thread removal specimen 108
Figure H.1 – Folding a load item with a standard stain strip attached 134
Figure H.2 – Folding a load item with a standard stain strip attached 134
Figure H.3 – Folding a load item with a standard stain strip attached 135
Figure H.4 – Folding a load item with a standard stain strip attached 135
Figure H.5 – Folding load items with cold water stain strips attached 136
Figure H.6 – Folding a load item with a cold water stain strip attached 136
Figure H.7 – Folding a load item with a cold water stain strip attached 137
Figure H.8 – Folding a load item with a cold stain strip attached 137
Figure H.9 – Folding a towel without a stain strip attached 138
Figure H.10 – Folding pillowcases without a stain strip attached 138
Figure H.11 – Folding bed sheets 139
Figure H.12 – Folding shirts 139
Figure H.13 – Folding of GoA-B specimen 140
Figure H.14 – Illustration of horizontal axis washing machine 140
Figure H.15 – Illustration of vertical axis washing machine 141

AVA Documents
Document Sharing Hub

Full document details: IEC 60456 2024

Figure H.16 – Horizontal axis washing machine: placement of items in the drum 142
Figure H.17 – Horizontal axis washing machine: placement of two load items with attached stain strip next to each other 142
Figure H.18 – Vertical axis washing machine: placement of items in the drum (plan view) 143
Figure H.19 – Horizontal axis washing machine: illustration of alternating orientation 144
Figure H.20 – Pictures HA loading 151
Figure H.21 – Vertical axis machines, four quadrants 153
Figure H.22 – Pictures VA loading agitator (order left to right) for step 1 (pillowcase), step 3 (2 towels), step 17 (sheet) and below for step 4 (attached cold water stain strip and standard stain strip) 165
Figure H.23 – Pictures VA loading impeller (order left to right) for step 1 (pillowcase), step 3 (2 towels), step 17 (sheet) and below for step 4 (attached cold water stain strip and standard stain strip) 165
Figure H.24 – Synthetics/blends loading direction pillowcase 166
Figure H.25 – Synthetics/blends loading direction shirt 166
Figure H.26 – Synthetics/blends pillowcase with strip attached 167
Figure I.1 – Example for the exchange of load items for a 5 kg cotton load 170
Figure J.1 – Folding of sheets for alkalinity measurement 171
Figure J.2 – Initial position of the bucket 178
Figure J.3 – Step 1 179
Figure J.4 – Before step 2 179
Figure J.5 – Step 2 179
Figure J.6 – Before step 3 180
Figure J.7 – Final position 180
Figure J.8 – Taking the sample 180
Figure J.9 – Example spectrum of distilled water 184
Figure J.10 – Example of a concentration curve with formula and R^2-value 187
Figure J.11 – Calibration curve for each individual sample 188
Figure J.12 – Calibration curve for all three standards 188
Figure L.1 – Phases of left on mode electric power and energy consumption measurement 199
Figure Q.1 – Test runs and test series selection flowchart 220
Figure Q.2 – Margin of error around $\overline{X}$ with selected confidence level 222
Figure Q.3 – Representation of error bar size as function of sample size 223
Figure T.1 – Flow chart showing the general test design for measuring intermittently recurring functions 256
Figure W.1 – Wool shrinkage test material, uncut 265
Figure W.2 – Wool shrinkage specimen, fraying the edges and V-cuts 266
Figure W.3 – Wool shrinkage specimen, marks 266
Figure X.1 – Placing the data logger in the centre of a pillowcase 271
Figure X.2 – Fasten the pillowcase around the data logger 271
Figure X.3 – Different examples for fastening the data logger 271

Table 1 – System of symbols consisting of variables 28

AVA Documents
Document Sharing Hub

Full document details: IEC 60456 2024

Table 2 – System of superscripts 29
Table 3 – System of subscripts 29
Table 4 – Statistical symbols 30
Table 5 – Detergent dose 42
Table 6 – Number of items in the cotton test load for various test load masses 50
Table 7 – Number of load items in the polycotton test load for various test load masses 51
Table 8 – Number of items in the synthetics/blends test load for various test load masses 53
Table 9 – Number of items in the wool test load for various test load masses 54
Table 10 – Bundle specifications for cotton loads 68
Table A.1 – Cleaning performance values and tolerances of standardized soils, reference machine CLS 101
Table A.2 – Cleaning performance values and tolerances of standardized soils, reference machine CLS 106
Table A.3 – Ingredients of ballast soil SBL 2004 109
Table B.1 – Composition of the standard powder detergent IEC-P 111
Table B.2 – Composition of the standard wool detergent IEC-W 113
Table C.1 – Composition of the standard liquid detergent IEC-L1 115
Table C.2 – Composition of the standard liquid detergent IEC-L2 116
Table C.3 – Detergent dose IEC-L1 and IEC-L2 117
Table D.1 – Specification of the cotton base load items 119
Table D.2 – Specification of the synthetics/blends base load items 121
Table D.3 – Polycotton base load specification 122
Table E.1 – Description of the reference washing machine and method of use 124
Table F.1 – Specification of reference washing programmes 127
Table F.2 – Tolerances given for some procedure parameters 128
Table F.3 – Reference programmes and descriptions of comparable washing machine programmes 129
Table H.1 – Horizontal axis washing machines, cotton loads 1 kg to 5 kg 146
Table H.2 – Horizontal axis washing machines, cotton loads 5,5 kg to 10 kg 147
Table H.3 – Horizontal axis washing machines, cotton loads 10,5 kg to 15 kg 148
Table H.4 – Horizontal axis washing machines, cotton loads 15,5 kg to 20 kg 149
Table H.5 – Horizontal axis washing machines, cotton loads 20,5 kg to 25 kg 150
Table H.6 – Horizontal axis washing machine, loading example (5 kg) 151
Table H.7 – Vertical axis washing machines, cotton loads 1 kg to 5 kg 154
Table H.8 – Vertical axis washing machines, cotton loads 5,5 kg to 10 kg 155
Table H.9 – Vertical axis washing machines, cotton loads 10,5 kg to 12 kg 156
Table H.10 – Vertical axis washing machines, cotton loads 12,5 kg to 14 kg 157
Table H.11 – Vertical axis washing machines, cotton loads 14,5 kg to 16 kg 158
Table H.12 – Vertical axis washing machines, cotton loads 16,5 kg to 18 kg 159
Table H.13 – Vertical axis washing machines, cotton loads 18,5 kg to 20 kg 160
Table H.14 – Vertical axis washing machines, cotton loads 20,5 kg to 22 kg 161
Table H.15 – Vertical axis washing machines, cotton loads 22,5 kg to 24 kg 162
Table H.16 – Vertical axis washing machines, cotton loads 24,5 kg to 25 kg 163

AVA Documents
Document Sharing Hub

Full document details: IEC 60456 2024

Table H.17 – Vertical axis washing machine – loading example (5 kg) 164
Table H.18 – Vertical axis washing machines, loading sequence example for a synthetics/blends load 168
Table J.1 – Working standard calculations 186
Table J.2 – Working standard calculation example 186
Table J.3 – Example table of the standards concentration for the complete calibration 187
Table J.4 – Example for calculation of LAS rinsing performance 189
Table L.1 – Measurement procedure for low power modes 200
Table S.1 – Example of measured and calculated parameters 229
Table S.2 – Measured and reported values 229
Table S.3 – Calculation of values 229
Table S.4 – Subsequent calculations and reporting of the result 230
Table S.5 – General test design 231
Table S.6 – Data for test washing machine 232
Table S.7 – Data for reference machine 233
Table S.8 – Data for laboratory conditions 233
Table S.9 – Standard equipment used for the test series 234
Table S.10 – Detergent and tracer textiles 236
Table S.11 – Test loads 236
Table S.12 – Common table for measured and calculated values 238
Table S.13 – Main table for measured and calculated values 239
Table S.14 – Detailed measured and calculated values, reflectance 244
Table S.15 – Detailed measured and calculated values LAS 246
Table S.16 – Measured and calculated values for calibration curve LAS 247
Table S.17 – Measured and calculated values for wool shrinkage 248
Table S.18 – Measured and calculated values for GoA 249
Table S.19 – Measured and calculated values for low power mode measurement 250
Table T.1 – Intermittently recurring function indication provided by the manufacturer/supplier – example 257
Table T.2 – Record of preparatory runs carried out before and/or between test runs 258
Table Y.1 – Requirements for electrical energy consumption measurements 275
Table Y.2 – Requirements for water measurement 275
Table Y.3 – Requirement for the total water hardness 275
Table Y.4 – Requirements for measuring the water pressure 275
Table Y.5 – Requirements for measuring the pH-Value 276
Table Y.6 – Requirements for ambient humidity measurements 276
Table Y.7 – Requirements for length measurement 276
Table Y.8 – Requirements for mass measurement 277
Table Y.9 – Requirements for temperature measurement 277
Table Y.10 – Requirements for duration measurement 277

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

WASHING MACHINES FOR HOUSEHOLD USE – METHODS FOR MEASURING THE PERFORMANCE

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60456 has been prepared by subcommittee 59D: Performance of household and similar electrical laundry appliances, of IEC technical committee 59: Performance of household and similar electrical appliances. It is an International Standard.

This sixth edition cancels and replaces the fifth edition published in 2010 and its Amendment 1:2022. This edition constitutes a technical revision.

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

a) Title changed from previous edition to more accurately describe application: "Washing machines for household use – Methods for measuring the performance".
b) Separation of the test method results from the number of test runs in a test series, with the independence of each test run or test series, allowing different test classes to be evaluated.

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

c) Introduction of a new standard powder detergent IEC-P, that substitutes the standard powder detergent IEC-A* by replacing sodium perborate with sodium percarbonate, for a better correlation with market offerings and in line with health/safety recommendations. Introduction of the new standard liquid detergents IEC-L and of the new wool standard detergent IEC-W with associated dosage instructions.

d) Introduction of new measurement and evaluation methods for:

   i) wool cleaning performance,

   ii) LAS rinsing performance,

   iii) gentleness of action,

   iv) low power mode consumption,

   v) temperature inside the washload,

   vi) intermittently recurring functions,

   vii) cold water washing machines,

   viii) replacing washing performance by cleaning performance.

e) Addition of alternative ambient conditions for conditioning of the test load with associated correction factors.

f) Extension of the description of the washing machine loading, up to and beyond 25 kg of cotton test load, and introduction of a new mixed polyester-cotton load.

g) Addition of the necessary definitions, measurement, and calculation methods for the evaluation of multi-compartment washing machines.

h) Relocation of supplementary information to the IEC free-access supporting documents dashboard: reference machine maintenance information, test materials supplier information, expanded uncertainty values and any other pertinent information for the general public.

The text of this International Standard is based on the following documents:

Draft	Report on voting
59D/518/FDIS	59D/525/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Documents
Document Sharing Hub

Full document details: IEC 60456 2024

WASHING MACHINES FOR HOUSEHOLD USE – METHODS FOR MEASURING THE PERFORMANCE

1 Scope

This document specifies methods for measuring the performance of electric **washing machines** for household use, with or without heating devices, and utilising cold and/or hot water supply, including those which specify the use of no detergent for normal use. It is also applicable to **washing machines** for communal use in blocks of flats or in launderettes and to electrical household appliances for both washing and drying textiles (household **washer-dryers**) with respect only to their washing related functions. It also deals with electrical appliances for water extraction by centrifugal force (**spin extractors**).

NOTE 1 Household **washer-dryer** combined performance is assessed to IEC 62512.

NOTE 2 Household tumble dryer performance is assessed to IEC 61121.

The object is to state and define the performance characteristics of household **washing machines**, the washing related functions of **washer-dryers** and water extraction function of **spin extractors**, and to describe the test methods for measuring these characteristics.

This document does not apply to **washing machines** for commercial use such as in commercial laundries.

NOTE 3 The preparation of methods for measuring the performance of **washing machines** for commercial use is under evaluation.

This document does not specify the acoustical noise measurement for household **washing machines**.

NOTE 4 Acoustical noise measurements and evaluation for household **washing machines** are specified in IEC 60704-1, IEC 60704-2-4 and IEC 60704-3.

This document is not intended to be used for the comparative evaluation of detergents.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60027-1:1992, *Letters symbols to be used in electrical technology – Part 1: General*

IEC 60335-2-7, *Household and similar electrical appliances – Safety – Part 2-7: Particular requirements for washing machines*

IEC 60734, *Household electrical appliances – Performance – Water for testing*

IEC 62301, *Household electrical appliances – Measurement of standby power*

IEC 63474, *Electrical and electronic household and office equipment – Measurement of networked standby power consumption of edge equipment*

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

ISO 139:2005, *Textiles – Standard atmospheres for conditioning and testing*
ISO 139:2005/AMD1:2011

ISO/CIE 11664-2, *Colorimetry – Part 2: CIE standard illuminants*

ISO 2060, *Textiles – Yarn from packages – Determination of linear density (mass per unit length) by the skein method*

ISO 2061, *Textiles – Determination of twist in yarns – Direct counting method*

ISO 3759, *Textiles − Preparation, marking and measuring of fabric specimens and garments in tests for determination of dimensional change*

ISO 7211-2, *Textiles – Woven fabrics – Construction – Methods of analysis – Part 2: Determination of number of threads per unit length*

ISO 80000-1:2022, *Quantities and units – Part 1: General*

EN ISO 648:2008, *Laboratory glassware − Single-volume pipettes*

EN 12127, *Textiles – Fabrics – Determination of mass per unit area using small samples*

CIE 015:2018, *Colorimetry*

ASTM E287-02:2019, *Standard Specification for Laboratory Glass Graduated Burets*

ASTM E288-10:2017, *Standard Specification for Laboratory Glass Volumetric Flasks*

ASTM E969-02:2012, *Standard Specification for Glass Volumetric (Transfer) Pipets*

3 Terms, definitions, abbreviated terms and symbols

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

Figure 1 shows the usage of and the relationships between definitions for performance and consumption measures.

AVA Documents
Document Sharing Hub

Full document details: IEC 60456 2024

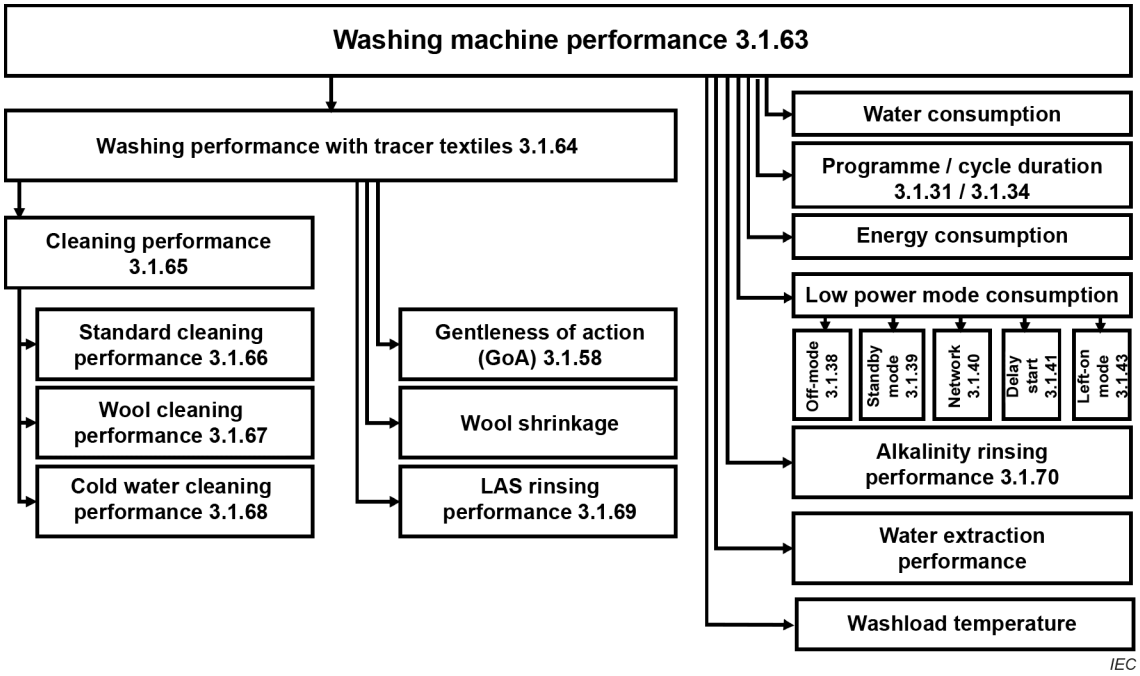


Figure 1 – Overview of the different performance measures

3.1 Terms and definitions

3.1.1
washing machine
appliance for cleaning and rinsing of textiles using water, which can also have a means of extracting excess water from the textiles

3.1.2
test washing machine
washing machine that is subjected to tests described in part or all of this document in order to determine its performance

3.1.3
reference machine
specially constructed **washing machine** of known performance, which is used to increase repeatability and reproducibility of results

Note 1 to entry: It can be used to provide a known performance level within a laboratory against which to compare selected performance parameters on **test washing machines** as defined in this document.

3.1.4
washer-dryer
washing machine that includes both a **spin extraction** function and also a means for drying the textiles, usually by heating and tumbling

Note 1 to entry: This document only covers the **operations** which relate to the **washing machine** function.

3.1.5
spin extractor
separate water-extracting appliance that removes water from textiles by centrifugal action (**spin extraction**)

3.1.6
standard extractor
spin extractor used to remove water remaining in the **base load** at the completion of the **programme** where a rinsing performance measurement is required

AVA Documents Document Sharing Hub
Full document details: IEC 60456 2024

3.1.7
vertical axis washing machine
washing machine in which the load is placed in a drum that rotates around an axis which is vertical or close to vertical

Note 1 to entry: For the purposes of this document, vertical axis is where the angle of the axis of rotation is more than 45° to horizontal. Where the drum does not rotate, the **washing machine** shall be classified as a **vertical axis washing machine**.

Note 2 to entry: The classification of vertical axis or horizontal axis in this document is used to define only the placement of the load into the drum.

3.1.8
horizontal axis washing machine
washing machine in which the load is placed in a drum that rotates around an axis which is horizontal or close to horizontal

Note 1 to entry: For the purposes of this document, horizontal axis is where the angle of the axis is less than or equal to 45° to horizontal.

Note 2 to entry: The classification of vertical axis or horizontal axis in this document is used to define only the placement of the load into the drum.

3.1.9
automatic washing machine
washing machine that has at least one **programme** where the load is fully treated by the machine without the need for user intervention at any point during the **programme** prior to its completion

3.1.10
manual washing machine
washing machine where the machine requires user intervention at one or more points during the **programme** to enable the machine to proceed to the next **operation**

Note 1 to entry: Examples of user intervention could include manual fill (non-automatic water level), transfer of the load between a washing drum and a **spin extractor** drum or manual draining.

Note 2 to entry: **Manual washing machines** have special requirements regarding the **programme** which is tested – see Annex M.

3.1.11
multi-compartment washing machine
washing machine equipped with more than one drum, whether in separate units or in the same casing

3.1.12
cold water washing machine
washing machine which does not have an internal heater to heat water or washing liquor and does not use any kind of externally pre-heated water or washing liquor and only cold water use is recommended in the manufacturer's instructions

3.1.13
test run
performance assessment of one **programme** execution with the **test washing machine** and the **reference machine** running in parallel

3.1.14
test series
group of **test runs** on a single **test washing machine** or multiples of the same model **test washing machines** which, collectively, are used to assess the performance of a **washing machine** and the statistical variability of this performance applied to the general population of the model tested

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

3.1.15
test class
type of the **test series**, to evaluate individual unit variability of multiple runs (unit class) or to evaluate production variability over multiple units (family class)

Note 1 to entry: Multiple tests on a single **test washing machine**: provide a statistical basis to assess the performance variability of a single **programme** on a single **test washing machine** when run under identical conditions.

Note 2 to entry: Single test on multiple **test washing machines** provides a statistical basis to assess the performance variability over the manufacturing process using a single **programme** when run on multiple identical **test washing machines** under identical conditions.

Note 3 to entry: Statistical independence of **test runs** and **test series** requires normalization between runs and series to minimize carryover effects. Refer to Annex O for guidance.

3.1.16
cycle
complete washing process, as defined by the **programme** selected, consisting of a series of **operations** (wash, rinse, spin, etc.) and including any **operations** that occur after the end of **programme**

Note 1 to entry: Examples of **operations** that can occur after the completion of the **programme** are pumping, monitoring and wrinkle guard (where applicable).

3.1.17
run in parallel
means on the same working day under the same testing conditions and for the same test unit(s)

Note 1 to entry: This definition refers to the running of the **reference machine** in relation to the running of the **test washing machine**.

Note 2 to entry: The intention is that the **reference machine** should be tested as far as possible under the same conditions as the **test washing machine**. If it is known that the actual test conditions vary significantly during the day, the **reference machine** and the **test washing machine** can be run at the same time to ensure that both machines are tested under the same conditions.

3.1.18
operation
each performance of a function that occurs in a **washing machine** such as pre-wash, washing, rinsing, draining or spinning

3.1.19
programme
series of **operations** that are pre-defined within the **washing machine** and which are declared by the manufacturer as suitable for washing certain textile types

3.1.20
multi-drum mode
operational mode of a **multi-compartment washing machine** where some or all of the drums are operated simultaneously with **simultaneous programmes**

Note 1 to entry: This definition applies only when two or more drums in a **multi-compartment washing machine** operate simultaneously with **simultaneous programmes**.

Note 2 to entry: A **multi-compartment washing machine** with more than one drum for the treatment of the textiles, where at least two of the drums cannot be operated simultaneously, is not regarded as having a **multi-drum mode**.

Note 3 to entry: A **multi-compartment washing machine** with at least two drums that can be operated simultaneously with **simultaneous programmes** and at least one drum that cannot be operated simultaneously, is regarded as having a **multi-drum mode** only for those drums that can be operated simultaneously.

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

3.1.21
simultaneous programme
series of **operations** which are pre-defined within the **multi-compartment washing machine** and which are declared by the manufacturer as suitable for washing certain textile types in two or more drums at the same time

Note 1 to entry: This **programme** can be also used for drums that can be operated separately.

3.1.22
intermittently recurring function
function that occurs before, during or after some but not all **cycles** of a specific **programme** (or **programmes**) and which alters water consumption, energy consumption and/or **programme duration** for the **cycle**

Note 1 to entry: Examples are water softening **operations**, water storage/reuse **operations** or similar **operations**.

3.1.23
spin extraction
water-extracting function that removes water from textiles by centrifugal action

Note 1 to entry: This is included as a function (built in **operation**) of an **automatic washing machine**, but it can also be performed by a **spin extractor**.

3.1.24
spin speed
rotational frequency of a drum during **spin extraction**

Note 1 to entry: A method for determination of **spin speed** is not defined in this document.

3.1.25
base load
textile load used for testing without **tracer textiles**

3.1.26
test load
base load used for testing including **tracer textiles**

3.1.27
test load mass
actual mass of the **base load** plus **tracer textiles**, where applicable

3.1.28
nominal test load mass
mass of dry textiles of a particular type for which the performance of the **test washing machine** is tested (**rated capacity** or partial load)

Note 1 to entry: The **nominal test load mass** is the target value for the conditioned **test load mass**.

3.1.29
rated capacity
maximum mass in kg of dry textiles of a particular type that the manufacturer declares can be treated in the **washing machine** on the **programme** selected

Note 1 to entry: When a **multi-compartment washing machine** operates in **multi-drum mode**, the **rated capacity** is considered for each individual drum.

3.1.30
combined rated capacity
sum of rated capacities of all drums operating in **multi-drum mode** with the **simultaneous programme**

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

3.1.31
programme duration
duration from the initiation of the **programme** (excluding any user programmed delay) until the **end of programme**

Note 1 to entry: If the **end of programme** is not indicated, the **programme duration** is equal to the **cycle duration**.

3.1.32
combined programme duration
duration from the simultaneous initiation of the **simultaneous programme** for two or more drums (excluding any user programmed delay) until the end of the **simultaneous programme**.

Note 1 to entry: If the **end of programme** is not indicated, the **combined programme duration** is equal to the **combined cycle duration**.

3.1.33
end of programme
when the **washing machine** indicates **programme** completion and the load is accessible to the user

Note 1 to entry: Where there is no **end of programme** indicator and the door is locked during **operation**, the **programme** is complete when the load is accessible to the user.

Note 2 to entry: Where there is no **end of programme** indicator and the door is not locked during **operation**, the **programme** is complete when the electric power of the appliance falls to a steady state condition.

Note 3 to entry: An indication of the **end of programme** can be in the form of a light (on or off), a sound, an indicator shown on a display or the release of a door or latch. Some **washing machines** can have a short delay from an **end of programme** indicator until the load is accessible to the user.

Note 4 to entry: Electronic checks of the status of safety components are not considered as function or **operation** and can occur after the end of the **programme**.

3.1.34
cycle duration
duration from the initiation of the **programme** (excluding any user programmed delay) until all activity ceases

Note 1 to entry: Activity is considered to have ceased when the electric power reverts to a steady state condition that persists indefinitely without user intervention.

Note 2 to entry: If there is no activity after the **end of programme**, the **cycle duration** is equal to the **programme duration**.

Note 3 to entry: **Cycle duration** includes any activity that occurs after the **programme** is completed. This could include any electronic activity or any additional mechanical activity that occurs for a limited period after any **end of programme** indicator. Any cyclic event that occurs indefinitely is considered to be steady state.

3.1.35
combined cycle duration
duration from the simultaneous initiation of the **simultaneous programme** for two or more drums (excluding any user programmed delay) until all activity ceases

Note 1 to entry: Activity is considered to have ceased when the electric power reverts to a steady state condition that persists indefinitely without user intervention.

Note 2 to entry: **Cycle duration** includes any activity that occurs after the **simultaneous programme** is completed. This could include any electronic activity or any additional mechanical activity that occurs for a limited period after any end of **simultaneous programme** indicator. Any cyclic event that occurs indefinitely is considered to be steady state.

Note 3 to entry: If there is no activity after the end of the **simultaneous programme**, the **combined cycle duration** is equal to the **combined programme duration**.

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

3.1.36
main wash duration
duration from the commencement of the initial water intake for the main wash until the commencement of the initial water intake for the first rinse

Note 1 to entry: The **main wash duration** includes the accompanying spin **operation** and any pause until the subsequent fill commences.

Note 2 to entry: Variations in the laboratory test conditions can affect the **main wash duration**. This definition is only applicable to **test washing machines**. The **reference machine** wash duration used for calibration of the **reference machine** is defined differently.

3.1.37
remaining moisture content
RMC
measure for the additional amount of moisture that is contained in the **base load** in relation to the equilibrium condition for **base load** items which have been conditioned in a controlled space

Note 1 to entry: This equilibrium condition is defined as 0 % **remaining moisture content** in this document. Hence it is possible for a **base load** or load items to have a negative **remaining moisture content** when treated with a tumble dryer.

3.1.38
off mode
condition in which the **test washing machine** is connected to the mains and is not providing any function

Note 1 to entry: The following shall also be considered as **off mode**:

a) conditions providing only an indication of **off mode**;

b) conditions providing only functionalities intended to ensure electromagnetic compatibility.

[SOURCE: EN 60456:2016/AMD1:2020, 3.1.28]

3.1.39
standby mode
condition where the **test washing machine** is connected to the mains and provides only the following functions, which can persist for an indefinite time:

a) reactivation function, or reactivation function and a mere indication of enabled reactivation function; and/or

b) reactivation function through a connection to a **network**; and/or

c) information or status display; and/or

d) detection function for emergency measures

[SOURCE: EN 60456:2016/AMD1:2020, 3.1.Z20]

3.1.40
network
communication infrastructure with topology of links, an architecture, including the physical components, organizational principles, communication procedures and formats protocols

[SOURCE: EN 60456:2016/AMD1:2020, 3.1.Z21]

3.1.41
delay start
condition where the user has selected a specified delay to the beginning of the **cycle** of the selected **programme**

[SOURCE: EN 60456:2016/AMD1:2020, 3.1.Z22]

AVA Documents
Document Sharing Hub

Full document details: IEC 60456 2024

3.1.42
wrinkle guard function
operation of the **test washing machine** after completion of a **programme** to prevent excessive wrinkling of the load

Note 1 to entry: It is also known as anti-crease function.

[SOURCE: EN 60456:2016/AMD1:2020, 3.1.Z23]

3.1.43
left on mode
lowest electric power mode that can persist for an indefinite time after the completion of the **programme** and unloading of the machine without any further intervention of the user

Note 1 to entry: In some products this mode can be equivalent to **off mode**.

3.1.44
unstable left on mode
condition after opening the door, at the end of the **programme** until the **test washing machine** enters **left on mode** (without any intervention by the end-user)

Note 1 to entry: **Unstable left on mode** is a limited duration mode of short duration (few seconds) up to 30 min, or longer if declared by the manufacturer. The power level during this mode can be constant or varying.

3.1.45
post programme phases
phases after the **end of programme** defined to be used for the measurement of **left on mode**

[SOURCE: EN 60456:2016, 3.1.Z8]

3.1.46
post programme phase LU
phase after the **end of programme** defined to be used for the measurement of the **unstable left on mode**

[SOURCE: EN 60456:2016, 3.1.Z9]

3.1.47
post programme phase LO
phase after the **end of programme** defined to be used for the measurement of the **left on mode**

[SOURCE: EN 60456:2016, 3.1.Z10]

3.1.48
void

3.1.49
power management system
system within the **test washing machine** which automatically reverts it to **left on mode**

3.1.50
rated voltage
voltage assigned to the appliance by the manufacturer

3.1.51
test material
material used to analyse differences in a parameter of the washing performance, including **tracer textiles**, **base load** and other **test materials**

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

3.1.52
tracer textile
textile-based **test material** such as **standard stain strip**, **wool stain strip**, **cold water stain strip**, **thread removal specimen** and **wool shrinkage specimen**, excluding the **base load**

3.1.53
stain swatch
individually soiled swatches on the same white basic cotton fabric used in a stain strip

3.1.54
standard stain strip
strip consisting of 5 different standard **stain swatches**, plus an unsoiled swatch of the same white basic cotton fabric

3.1.55
wool stain strip
strip consisting of two different wool **stain swatches** used in wool **washing machine performance** testing

3.1.56
cold water stain strip
strip consisting of 3 different cold water **stain swatches**, plus an unsoiled swatch of the same white basic cotton fabric used in **cold water cleaning performance** testing

3.1.57
ballast soil
soiled swatch intended to generate a defined soil ballast impact during a wash

3.1.58
gentleness of action
GoA
influence of the washing process of a **washing machine** on irreversible changes of textile properties

Note 1 to entry: These changes can be visible or non-visible, as for example loss of tensile and tear strengths, surface friction as abrasion or pilling, and structural disorientation.

3.1.59
thread removal specimen
woven polyamide fabrics with an open structure to all sides, allowing loosening of threads by mechanical impact – used for **gentleness of action** (**GoA**) testing

3.1.60
GoA-A
thread removal specimen without a covering item as used in the **wool cleaning performance** test

3.1.61
GoA-B
thread removal specimen in a covering item as used in all **cleaning performance** tests except **wool cleaning performance** tests

3.1.62
wool shrinkage specimen
specific wool fabric pieces intended to show the extent of wool shrinkage due to a wool wash

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

3.1.63
washing machine performance
performance of the **washing machine**, such as **standard cleaning performance**, **wool cleaning performance**, **cold water cleaning performance**, **remaining moisture content**, rinsing performance, energy consumption, water consumption, **programme duration**, **gentleness of action** (**GoA**), wool shrinkage, washload temperature

3.1.64
washing performance with tracer textiles
result of performance tests with **tracer textiles**

EXAMPLE **Standard cleaning performance**, **wool cleaning performance**, **cold water cleaning performance**, wool shrinkage and **gentleness of action** (**GoA**) or combinations of such.

3.1.65
cleaning performance
washing performance with tracer textiles of the **test washing machine** related to the **washing performance with tracer textiles** in a washing **programme** in a **reference machine**

3.1.66
standard cleaning performance
cleaning performance of cotton, polycotton and synthetics/blends **base loads**

3.1.67
wool cleaning performance
cleaning performance of wool wash **programmes** of the **test washing machine** related to the wool **washing performance with tracer textiles** in a wool washing **programme** in a **reference machine**

3.1.68
cold water cleaning performance
washing machine performance of **cold water washing machine** of the **test washing machine** related to the cold water **washing performance with tracer textiles** in a cold washing **programme** in a **reference machine**

3.1.69
LAS rinsing performance
linear alkylbenzene sulfonate surfactant rinsing performance of the **washing machine** at extracting surfactant parts of the detergent used in the washing process by rinsing with laboratory supply water

3.1.70
alkalinity rinsing performance
performance of the **washing machine** at extracting soluble parts of the detergent used in the washing process by rinsing with laboratory supply water

3.2 Abbreviated terms and symbols

Table 1 to Table 4 provide a key to symbols. Symbols are based on the SI-System and are used as specified in IEC 60027-1.

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

Table 1 – System of symbols consisting of variables

Symbol	Unit	Definition
a		weighting factor for cleaning performance
O	**cycles**	age of textile
N/n		number of items of the same type and age/number of **test runs**
u	mmol/L	alkalinity per extracted water
w	meq/kg	alkalinity concentration per kg **base load**
c	mg/L	concentration
k	S/m	conductivity
p	Pa or kPa	pressure
Y		reflectance value/Tristimulus Y value
$\overleftrightarrow{Y}$		average of the sum of the Tristimulus Y values over all stain types in a stain strip
A	Å	absorbance
E	Wh or kWh	energy consumption
C		**cleaning performance**
Q		washing performance (see Annex O)
P	W or kW	electric power
W	L	water consumption
r		rinsing index
D	s or min or h or h:min:s	time/duration
V	L or m^3	volume
m	g or kg	mass
μ	%	moisture content
b	%	shrinkage
B		shrinkage rate index
T	°C/K	temperature in ° Celsius/thermodynamic temperature
l, h	mm, cm or m	length
G	remaining threads	**gentleness of action**
GoA		**gentleness of action** ratio of results from the **test washing machine** and the **reference machine**
A		absorbance for LAS rinsing measurement
L	g/kg	mass of detergent per kg of load
e		slope of the detergent concentration curve
f		intercept of the detergent concentration curve
F		frequency of occurrence/factor
y		number of table tennis balls
α		number of **test runs** in a **test series**
β		number of stain strips in a **test run**
γ		number of **stain swatches** on a stain strip
x		defined element out of the list of sorted temperatures
X		arbitrary measured variable
U		expanded uncertainty

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

Table 2 – System of superscripts

Superscripts	Definition (or similar for other programmes/temperatures)
c60	cotton 60 °C **cycle** (can be omitted if clear from the context of use or only written as 'c')
s40	synthetics/blends 40 °C **cycle** (can be omitted if clear from the context of use or written as 's' only)
w30	wool 30 °C **cycle** (can be omitted if clear from the context of use or written as 'w' only)
cw	cold water
*	composite standard deviation (when used for σ^*)

Table 3 – System of subscripts

Subscripts	Definition
W	washing/cleaning **cycle**
mw	main wash
r1, r2, r3, r4	rinse 1, rinse 2, rinse 3, rinse 4
e	extracted water
S	laboratory supply water
s	starting/initial value
F, f	final value
tot	total (sum) value
R	running value (e.g. or each intermittently recurring function)
T	target value (e.g. for each intermittently recurring function)
0	conditioned/unwashed
p	partial load of the **base load**
m	measured value
bd	bone-dry
in	inlet
l, r	length/warp direction or width/weft/filling direction
cv	corrected value
om	**off mode**
sm	**standby mode**
ns	networked **standby mode**
ds	**delay start** mode
LU	**unstable left on mode**
LO	**left on mode**
c	cold water
h	hot water
L	load
w	water
det	detergent
Tst	**test washing machine**
Ref	**reference machine**
U	unwashed stain strip
min	minimum
max	maximum

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

Subscripts	Definition
λ, 223, 330	wavelength of photospectrometer
WSS	working standard solution
i	running number/sequence
j	index within a **test run**, e.g. soil type or age class of **test load**
k	index within an individual item, e.g. swatch/stain strip or age class number
n	index within a **test series**, e.g. **test run** number or type of bases load
base	base powder (of the standard powder detergent IEC-P)

Table 4 – Statistical symbols

Statistical values	
$\bar{}$ (bar)	average/mean (bar above the variable)
σ	standard deviation
CI	confidence interval
CL	confidence level
DoF	degrees of freedom
μ	mean value
t / $t_{\text{DoF, 1-}CL}$	test value / critical value
α	significance level (1-CL/100)

4 Requirements

4.1 General

This document describes test methods for measurement of the following performance parameters:

– **standard cleaning performance**,
– **wool cleaning performance**,
– **cold water cleaning performance**,
– **alkalinity rinsing performance** and **LAS rinsing performance**,
– water extraction performance,
– water consumption,
– energy consumption,
– low power modes (including **off mode**, **standby mode**, **delay start**, with or without **network** connection),
– **programme duration** and **cycle duration**,
– wool shrinkage,
– **gentleness of action** (**GoA**),
– washload temperature.

Any claims of performance referring to this document for these parameters shall be measured in accordance with the test methods set out in this document (refer to Clause 7 for details).

This document does not specify minimum performance requirements for clothes **washing machines**.

AVA Documents Document Sharing Hub
Full document details: IEC 60456 2024

4.2 Rated capacity

The manufacturer or supplier shall declare the **rated capacity** to the nearest 0,5 kg for each relevant textile type. Relevant textile types are cotton, polycotton, synthetics/blends and wool.

NOTE The **rated capacity** of a **washing machine** usually varies according to the textile type.

The **rated capacity** for any textile type shall not exceed the maximum mass of dry laundry, in kilograms, to be used in the **test washing machine** in accordance with IEC 60335-2-7.

When the manufacturer or supplier provides a range of values for the **rated capacity** with a particular textile type, the highest value shall be used for relevant tests.

Where information on the **rated capacity** is not available, the **nominal test load mass** shall be determined according to Annex N.

If the **rated capacity** for synthetics/blends and wool is not specified by the manufacturer or supplier, the **test load** shall be 40 % and 20 % respectively of that for cotton.

4.3 Dimensions and volume

Where a manufacturer declares dimensions and/or drum volume, these shall be in accordance with the following requirements, as applicable. The dimensions shall be given in centimetres and shall be rounded to the nearest whole centimetre. Drum volume shall be given in litres, rounded to the nearest 0,5 L.

Height: h_1	=	vertical dimension measured from the floor to a horizontal plane at the maximum height of the **washing machine**, with the door/lid closed. If adjustable levelling feet are provided, they shall be moved up and down to determine minimum and maximum possible heights.
Height: h_2	=	maximum vertical dimension measured from the floor to a horizontal plane at the maximum height of the **washing machine** with the door/lid open (generally when at right angles to the machine top). If adjustable levelling feet are provided, they shall be moved up and down to determine minimum and maximum possible heights.
Width: l_0	=	horizontal dimension, between the sides, as measured between two parallel vertical planes against the sides of the **washing machine** including all projections.
Depth: l_1	=	horizontal dimension as measured from a vertical rear plane against the back of the **washing machine** and the most prominent part of the front fascia, with the door/lid closed. For this measurement, the door thickness, knobs and handles are generally not included in the measurement.
Depth: l_2	=	horizontal dimension as measured from a vertical rear plane against the **washing machine** and the most prominent part of the front, knobs and handles also being taken into account, with the door/lid open (generally when at right angles to the machine front).
Depth: l_3	=	horizontal dimension as measured from a vertical rear plane against the **washing machine** and the most prominent part of the front, knobs and handles also being taken into account, with the door/lid closed (generally when at right angles to the machine front).
Drum volume	=	volume of the drum of a **washing machine** or **spin extractor**, where required; shall be determined in accordance with Annex N.

NOTE 1 Dimension l_1 is intended to provide an indication of the required depth for the **washing machine** where the fascia is intended to be flush with adjacent furniture or appliances.

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

NOTE 2 Dimension h_2 is generally only applicable to top loading **washing machines** while dimensions l_2 and l_3 are generally only applicable to front loading **washing machines**.

5 Test conditions, materials, equipment and instrumentation

5.1 General

The tolerances specified for parameters within this document, using the symbol "±", indicate the allowable limits of variation from the specified parameter, outside of which the test or results shall be invalid. The statement of tolerance does not permit the deliberate variation of these specified parameters.

Rounding means replacing the magnitude of a given number by another number called the rounded number, selected from the sequence of integral multiples of a chosen rounding range. Rounding shall only be applied to reported values with a rounding range as defined in Annex S, to the nearest number according to ISO 80000-1:2022, Annex B, following B.3 Rule B. If the rounding takes place to the right of the comma, the omitted places shall not be filled with zeros. Rounding in more than one stage by the application of the rules given above can lead to errors. Therefore, calculations requested within this document shall always use the precise value of a measurement (without rounding) and apply rounding according to Annex S only on the final result. An example is given in Annex S.

Unless otherwise specified, the **reference machine** shall be considered a **test washing machine** with respect to conditions, materials and equipment specified.

Guidance and recommended laboratory practice can be found in Annex K.

NOTE Justification for the selected specifications and the consequences of deviations can be found in Annex P.

5.2 Test conditions

5.2.1 Electricity supply

The supply voltage to each **test washing machine** shall be maintained at the **rated voltage** ±2 % throughout the test. If a voltage range is indicated, then the supply voltage shall be the nominal voltage of the country in which the appliance is intended to be used. The supply voltage measured during the tests shall be recorded.

The supply frequency to each **test washing machine** shall be maintained at the rated frequency ±1 % throughout the test. If a frequency range is indicated, the test frequency shall be the nominal frequency of the country in which the machine is intended to be used.

NOTE Stabilized power supply devices ensure that during normal **operation** of the **test washing machine**, the voltage wave form supplied is maintained without undue distortion.

5.2.2 Water supply

5.2.2.1 General

The measured total water hardness, water temperature and water pressure of water supplied to **test washing machines** shall comply with the following requirements and shall be reported. This water is generally referred to as laboratory supply water in this document.

5.2.2.2 Water hardness

For all treatments of the **test load** prior to a **test series** and all **washing machine test runs** in accordance with this document, either hard water or soft water can be used. If hard water is used, it shall have a total water hardness of (2,5 ± 0,2) mmol/L. If soft water is used, it shall have a total water hardness of (0,5 ± 0,2) mmol/L.

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

Normalization of a **base load** prior to use in a **test series** (refer to 6.4.4) shall always be performed using laboratory supply water with the same total water hardness as that used for the subsequent **test series**.

Total water hardness is determined and expressed in mmol/L of $CaCO_3$ equivalent.

If total water hardness needs to be adjusted, it shall be prepared according to IEC 60734, but without adjustment of pH value.

Measurements of total water hardness shall be undertaken on water that is representative of the laboratory supply water used for tests.

5.2.2.3 Water temperature

The water supply system shall be configured so that the temperature of all water entering the inlet hose of the **test washing machine** is within specified tolerance with the exception of up to 250 mL to the point of connection of each partial fill. A temperature recording system shall record inlet water temperature at intervals of no less than once per second. Laboratories should as far as possible minimize the volume of water between the temperature-controlled supply and the point of connection to the **test washing machine**.

The temperature of the laboratory supply water to each **test washing machine** shall be measured and recorded to the nearest 0,1 °C.

The cold water supply temperature shall be (15 ± 2) °C for **standard cleaning performance** tests, for wool wash **cleaning performance** tests, for **test washing machines** and for all reference **programmes**.

For cold water wash **cleaning performance** tests, the cold water supply temperature shall be within a range from 15 °C to 25 °C (refer to 8.9.1), but only for **test washing machines**.

The hot water supply temperature shall be the temperature indicated by the manufacturer ± 2 K, or (60 ± 2) °C if no value is given.

When the manufacturer specifies a hot water temperature range, which includes (60 ± 2) °C, the hot water temperature shall be set at (60 ± 2) °C. When the manufacturer specifies a hot water temperature range which does not include (60 ± 2) °C, the hot water temperature shall be set at the highest value in the temperature range which is closest to (60 ± 2) °C. When the manufacturer specifies a single temperature with a tolerance, then that temperature shall be used with the tolerance of ± 2 K.

The hot and cold water inlet supply temperatures (as applicable) shall be determined as close as possible to the point of connection of each **test washing machine** to the laboratory water supply system. It is recommended that temperature be the last parameter measured before the supply point to the **washing machine**. Clause 8 requires water temperatures and volumes to be recorded on a continuous basis (see Clause Y.1) during filling in order to determine weighted average temperature.

NOTE 1 Some countries specify a hot water temperature for regulatory purposes, in which case this water temperature is used for testing.

NOTE 2 Annex X provides a measurement and evaluation method for the determination of the representative maximum temperature reached inside the **base load** during washing.

NOTE 3 Justification for the selected specifications and the consequences of deviations can be found in Clause P.8.

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

5.2.2.4 Water pressure

The static (gauge) pressure of the laboratory supply water at the inlet to each **test washing machine** shall be maintained at (240 ± 50) kPa including during filling **operations**. The water supply to the **reference machine** shall be in accordance with E.3.1.

The hot and cold water pressures (as applicable) shall be determined as closely as practicable to the point of connection of each **test washing machine** to the laboratory water supply system. The measured pressure shall be rounded to the nearest whole 10 kPa when assessing compliance with the permitted range. Readings of the pressure should be averaged over each filling **operation** to get an accurate average weighted pressure. This normally requires the use of a data logger to record pressure data at regular intervals throughout each **operation**.

5.2.3 Ambient temperature and humidity

5.2.3.1 Ambient temperature and humidity for washing machine testing

The ambient temperature of the test room shall be maintained at (23 ± 2) °C throughout the **washing machine** test. The measured ambient temperature for **washing machine** testing shall be reported, rounded to the nearest 0,5 °C.

The ambient humidity is not specified for **washing machine** testing but its value shall be reported (Table S.12).

NOTE Justification for the selected specifications and the consequences of deviations can be found in Clause P.9.

5.2.3.2 Ambient temperature and ambient relative humidity for conditioning of base load items

Base load conditioning shall be either by the bone-dry method or by ambient-controlled room /chamber. Applicable correction factors to achieve comparable measures of the conditioned load mass are described in Annex G.

Where an ambient-controlled room/chamber is used for conditioning the **base load**, the following conditions shall be maintained:

- standard atmosphere: (20 ± 2) °C and (65 ± 5) % relative humidity (refer to ISO 139:2005 and ISO 139:2005/AMD1:2011), or
- alternative ambient conditions (23 ± 2) °C and (55 ± 5) %.

The method of applying correction factors to measured values of ambient temperature and relative humidity and for conditioning **base load** items shall be reported. The ambient temperature shall be rounded to the nearest 0,5 °C. The reported ambient relative humidity shall be rounded to the nearest whole percentage.

NOTE Specific requirements regarding conditioning of the **base load** are specified in 6.4. As an alternative to using an ambient-controlled room/chamber for conditioning the **base load**, the bone-dry method can be used as described in 6.4.5.3.

5.2.3.3 Altitude

The altitude of the laboratory shall be reported in meters above mean sea level.

Large differences in atmospheric pressure can influence the water intake of **washing machines** and hence contribute to uncertainty of measurements. To avoid one additional measured parameter, the altitude of the laboratory shall be reported to give an indication of possible variation between laboratories. Altitude data can be found in public sources such as maps or indicated by instruments or radio navigation-satellite services.

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

5.3 Test materials

This subclause sets out the specifications for textile **test materials** and the detergents required for the washing performance testing according to this document, including:

– **base loads** (load items) as specified in Annex D
  - cotton as specified in Clause D.1 as used in Clause 8,
  - synthetics/blends as specified in Clause D.2 as used in Clause 8,
  - polyester as specified in Clause D.3 as used in Clause 8,
  - polycotton as specified in Clause D.4 as used in Clause 8,

– **standard stain strips** as specified in A.2.1 as used in 8.4,
– **wool stain strips** as specified in A.2.2 as used in 8.8,
– **cold water stain strips** as specified in A.2.3 as used in 8.9,
– **wool shrinkage specimen** as specified in Clause A.3 as used in Annex W,
– **thread removal specimen** as specified in Clause A.4 as used in 8.7,
– IEC-P detergent as specified in Clause B.2 as used in Clause 8,
– IEC-W wool detergent as specified in Clause B.3 as used in 8.8 and Annex W,
– IEC-L detergents as specified in Annex C.

There are two ways to include **thread removal specimens** for testing (8.7):

GoA-A is used for **gentleness of action** evaluation in the **wool cleaning performance** test;

GoA-B is used for **gentleness of action** evaluation in all **cleaning performance** tests except **wool cleaning performance**.

NOTE 1 This differentiation is made to ensure a large enough range of measurable values for **gentleness of action** tests.

NOTE 2 Suitable sources of **test materials** are given in Clause U.3.

NOTE 3 Justification for the selected specifications and the consequences of deviations can be found in Clause P.4 and Clause P.5.

5.4 Equipment

5.4.1 General

This subclause sets out the specifications for specialized test equipment required for **washing machine** testing to this document, including:

– **reference machine**,
– spectrophotometer,
– equipment for conditioning the **base load**,
– **standard extractor**,
– iron,
– **alkalinity rinsing performance** equipment,
– **LAS**
– **rinsing performance** equipment.

A checklist of other laboratory equipment needed for **washing machine** testing is provided in 5.4.9.

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

5.4.2 Reference machine

A **reference machine** shall be **run in parallel** with the **test washing machine**, applying the same material batches and procedure to both machines to provide a measure of relative performance and reproducible results.

NOTE 1 For wool shrinkage tests, the **reference machine** is used to calibrate shrinkage of **wool shrinkage specimens** and is not necessarily **run in parallel** with the **test washing machine**.

Specifications for the **reference machine** are given in Annex E and Annex F.

NOTE 2 Justification for the selected specifications and the consequences of deviations can be found in Clause P.2.

For the purposes of this document, the **test load mass** used in the **reference machine** shall be in all cases:

– 5,0 kg for cotton **programmes**,
– 2,0 kg for synthetics/blends **programmes**,
– 1,0 kg for the wool **programme**.

NOTE 3 When the **reference machine** is used to normalize the **base load** between **test runs** and series, the maximum mass of dry **base load** which can be normalized in the **reference machine** is different from the **test load masses** above. Refer to 6.4.4.

5.4.3 Spectrophotometer

Optical measurements of each of the different stain strip pieces are performed using a spectrophotometer. The minimum instrument specification is provided below:

Measuring instrument	spectrophotometer that provides reflectance data at a minimum of 16 wavelengths spaced at 20 nm intervals or closer, in the range 400 nm and 700 nm
Parameter	Tristimulus Y value (CIE 015:2018)
Illuminant/observer	D65 / 10° – ISO/CIE 11664-2
Measuring geometry	d / 8°
UV-filter	the ultraviolet filter shall have a spectral transmittance of ≤ 0,01 at wavelengths of 400 nm and less, and a spectral transmittance of ≥ 0,80 at wavelengths in the range 450 nm to 700 nm
Measurement aperture	minimum 20 mm diameter

NOTE 1 Where a measurement aperture is not circular, an aperture area of not less than 314 mm^2 is acceptable.

Gloss/specular	excluded, i.e. measurement with open gloss/specular trap
Calibration	the calibration process shall be performed at least once a day during continuous use or after any restart of the device using: • white standard: barium sulphate tablet or certified white ceramic tile; and • black standard: black body or light trap or certified black ceramic tile; or • procedures as specified by the instrument manufacturer.

NOTE 2 Justification for the selected specifications and the consequences of deviations can be found in Clause P.6.

The spectrophotometer shall be checked for its spectral performance and measurement accuracy at least once a year.

General handling of the spectrophotometer and its use and calibration shall be in accordance with the supplier's operating instructions.

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

5.4.4 Equipment for conditioning the base load

This document requires **base load** items to be treated in a controlled manner prior to their use in performance tests, in order to determine their mass under standardized ambient conditions. The alternative methods of conditioning the **base load** items are as follows:

– leaving the **base load** items in an ambient-controlled room/chamber with a controlled ambient temperature and humidity (refer to 5.2.3.2) until their **remaining moisture content** is in equilibrium. Refer to 6.4.5.2 for details;

– treating the **base load** items in a clothes dryer of specified performance to ensure that the **base load** items are in a "bone-dry" state. Refer to 6.4.5.3 for details. Annex G sets out the method and the specifications for a tumble dryer which is used for this method.

5.4.5 Standard extractor

A **standard extractor** meeting the following specific performance requirements shall be used for **alkalinity rinsing performance** sampling (refer to 8.6.2.2).

The nominal inner drum diameter and nominal **spin speed** of the **standard extractor** used shall be reported.

The **standard extractor** shall have a g-force suitable for a water extraction performance which results in a **remaining moisture content** determined in accordance with 8.6 as follows:

– (39 ± 3) % for a cotton **base load** when operated with a spinning duration not more than 10 min; and

– (17 ± 3) % for a synthetics/blends **base load** when operated with a spinning duration not more than 5 min.

Any **spin extractor** may be used as a **standard extractor** if it can be demonstrated that it can achieve the water extraction performance requirements specified above. The extraction duration or speed shall be adjusted to achieve the **remaining moisture content** specified above for the relevant load types and sizes, but this duration shall not exceed 10 min for cotton or 5 min for synthetics/blends. As reloading of the **base load** after one **spin extraction operation** is not permitted, a pre-test to determine the appropriate spin duration is required for other **spin extractors**.

Experience has shown that use of a **standard extractor** with an inner drum diameter of between 240 mm and 250 mm and a **spin speed** of approximately 2 800 r/min, using standard bundles defined in 8.6.2.2 for a period of 10 min, will meet the specification above. A **standard extractor** should be of a design that allows the user to remove any retained water in the extractor between runs.

5.4.6 Iron for preparation of stain strips after washing

Where an iron or ironing appliance is used to prepare stain strips after washing and prior to reflectance readings, it shall have a surface temperature between 100 °C and 130 °C.

5.4.7 Alkalinity rinsing performance equipment

The following equipment is required when an **alkalinity rinsing performance** measurement is required under 8.6.2.

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

All volumetric glassware should meet all "Class A" specifications, as defined by the American Society for Testing and Materials (ASTM) Standards E 287, E 288, and E 969 unless otherwise stated (e.g. EN ISO 648:2008, "Blaubrand"[1])

pH meter: accuracy least ± 0,05 pH units (2 decimal places)

Glass beaker with stirrer: sufficient size to place the pH-electrode below the surface of the sample

Titration equipment:

– manual titration (additional): burette/burette stand, 10 mL burette calibrated in 0,01 mL divisions and stopcock; or
– automatic titration (additional): microprocessor-controlled titration device. Burette size: preferably 10 mL calibrated in 0,01 mL divisions. Minimum rate: 25 µL/min.

Reagents: all reagents used are ACS reagent grade unless otherwise stated (e.g. puriss p.a.):

– 0,1 mol/L hydrochloric acid: accurately standardized to four decimal places;
– water: wherever "water" is applicable, use reverse osmosis (RO), demineralised or distilled water.

The pH meter shall be calibrated at least once a day during continuous use or after any restart of the device.

The calibration of the pH meter shall be performed with commercially available pH buffers at pH 7,00 ± 0,5 and then at pH 4,00 ± 0,5.

Precautions should be initiated to avoid temperature differences between calibration and measurement phase (optimal: 23 °C). The stirring rate should also be kept equal for calibration and measurement phases. Calibration shall be in accordance with the supplier's operating instructions.

5.4.8 LAS rinsing performance equipment

Ultraviolet (UV) spectrophotometer:

The spectrophotometer shall be calibrated regularly according to the manufacturer's specification. The absorption of the ultraviolet light shall be measured with an ultraviolet spectrophotometer with the following specifications:

– wavelength range: 190 nm to 350 nm;
– spectral bandwidth: ≤ 2 nm;
– wavelength accuracy (at D_2 peak 656,1 nm): −0,2 nm to +0,2 nm;
– wavelength repeatability (10 measurements at 656,1 nm, bandwidth 1 nm): −0,05 nm to +0,05 nm;
– photometric range: −0,1 A to +3,0 A;
– photometric accuracy (UV with $K_2Cr_2O_7$, Ph.Eur. at 1 A): −0,02 A to +0,02 A;
– photometric repeatability (10 measurements with $K_2Cr_2O_7$, Ph.Eur. at 1 A): −0,002 nm to +0,002 nm.

[1] Blaubrand is an example of suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this brand or supplier.

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

Quartz cuvette:

– The cuvettes to be used for the measurement of the ultraviolet absorption shall be rectangular with a path length of 10 mm and be made from quartz.

Orbital shaker:

– The device for the extraction of the linear alkylbenzene sulfonate shall be an orbital shaker. The orbital shaker shall have a device for securing sample bottles on it;
– Orbit: 4 mm to 20 mm;
– Shaker speed: ≥ 350 min^{-1}.

NOTE 1 The speed of the shaker can be checked by a tachometer, either optical by light beam reflection or mechanical by a magnetic sensor. For details, refer to the manufacturer's specification.

Scale for weighing detergent and samples:

– Minimum specification: 0 g to 150 g range;
– Minimum resolution: 0,001 g;
– Accuracy: ± 0,002 g.

Scale for weighing items with higher mass:

– Minimum specification: 0 g to 600 g range;
– Minimum resolution: 0,05 g;
– Accuracy: ± 0,1 g.

Volumetric flasks:

– Volumetric flasks with a volume of 100 mL and 1 000 mL shall be used for the preparation of the working standards for calibration.
– All volumetric glassware should meet all "Class A" specifications, as defined by the American Society for Testing and Materials (ASTM) Standards E 287, E 288, and E 969 unless otherwise stated (e.g. EN ISO 648:2008, "Blaubrand").

Magnetic stirrer:

– Minimum speed ≥ 350 min^{-1}.

Magnetic stir bars:

– Small, medium and large stir bars shall be used.

Pipettes:

– Pipettes of volume 1 mL, 2 mL, 5 mL, 10 mL, and 25 mL shall be used.

Disposable glass pipettes (e.g. Pasteur pipettes[2]):

– Disposable glass pipettes without cotton stoppers, non-sterile and with a volume of 2 mL or greater shall be used for transferring the extract to the cuvettes.

NOTE 2 A transfer pipette with disposable plastic tips can be used in place of glass pipettes after correlation tests.

Sample bottle with cap (for test swatch extraction):

– Plastic bottles with caps made from high-density polyethylene with a volume of 500 mL and a diameter of (73 ± 3) mm.

[2] Pasteur is an example of suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this brand or supplier.

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

All distilled water used for extractions, dilutions and the preparation of calibration standards shall meet the following criteria:

– Conductivity (k) at 25 °C: ≤ 1 µS/cm;
– Absorbance curve spectrum 200 nm to 350 nm: no relative peak absorbance greater than ± 0,002 A in the range between 223 nm to 330 nm;
– The procedure for calculating these values is given in Clause J.2.

NOTE 3 Water prepared by methods other than distillation having equivalent specifications can be used instead of distilled water.

5.4.9 Other equipment

Testing of **washing machines** according to this document requires equipment for the measurement of a range of parameters including the following:

– mass;
– volume of water and other liquids;
– length and dimensions;
– electrical parameters (voltage, energy, frequency);
– temperature of water and air and humidity of air;
– water pressure supplied to the **washing machine**;
– total water hardness of the laboratory supply water supplied to the **washing machine**;
– pH of the laboratory supply water and various liquors extracted from the **washing machine** and the **test load** during the test;
– time;
– data loggers for temperature measurement (see Clause X.2).

For some of the above measurements, the specifications of instruments used to take these measurements are not explicitly defined in this document, except that the accuracy of measurement as specified in Annex Y shall be achieved.

NOTE Several different instruments for the measurement of mass are likely to be required for determining mass of load items and the whole **base load**, mass of titration liquids and mass of detergent (refer to Clause Y.10). Equipment for determination of wool shrinkage is described in Annex W.

6 Preparation for testing

6.1 General

This clause sets out the requirements for the preparation of the **test washing machine** and **reference machine** prior to testing. It also specifies the requirements for the preparation of **test loads** for the **test washing machine** and the **reference machine**.

6.2 Test washing machine and reference machine preparation

6.2.1 Test washing machine

6.2.1.1 General

The measurements shall generally be carried out on a **washing machine** which is installed and used in accordance with the manufacturer's instructions, except as required by this document. Manufacturer's instructions which aim at achieving more favourable results for the tested products may be disregarded if not explicitly specified in this document. Where there is more than one option for installation, the option chosen for testing shall be documented in the test report.

AVA Documents Document Sharing Hub

Full document details: IEC 60456 2024

NOTE 1 Manufacturer's instructions are provided with the product in the form of a user manual, installation guide, instruction sheet, information affixed to the product itself, or information that is available on a public website.

NOTE 2 Performance of an aged and/or used machine can differ from a new and / or unused machine.

6.2.1.2 Preparation of the test washing machine after installation

After installation, the **test washing machine** shall be run for two complete cleaning runs on a **programme** for cotton textiles with maximum wash temperature and maximum main wash water level settings if applicable, the first run without load and with 50 g of the standard powder detergent IEC-P and the second run without load and without detergent.

NOTE Detergent is used to remove any residue from the manufacturing process.

6.2.1.3 Preparation of the test washing machine for a test series

Before a **test series** is commenced, the **test washing machine** shall be checked to confirm that it has no operating defects that can affect the **operation** of the unit. Where separate inlets are supplied for both hot and cold water, they shall each be connected to an appropriate laboratory water supply system for testing (refer to 5.2.2).

All filters shall be thoroughly cleaned before each **test series**.

After cleaning the filters, a cleaning run shall be undertaken on a **programme** set to the maximum wash temperature and maximum main wash water level, if applicable, without load and without detergent. The cleaning run shall be carried out not less than one day in advance but not more than two weeks in advance and without any other run before the **test series** is started. After the cleaning run, the **test washing machine** shall be allowed to cool down to the ambient temperature of the test room. It shall be accepted that this requirement has been met if the internal surface temperature of the **test washing machine** drum is at ambient air temperature of the test room (within ±2 K), or if the **test washing machine** has been left standing at stable laboratory ambient temperature with the door or lid left open at maximum angle for not less than 16 h. The **test washing machine** shall remain in the test room at ambient temperature for the duration of the **test series**. No additional runs or **cycles** of any type (loaded or empty) shall be undertaken on the **test washing machine** between **test runs** within a **test series** (refer to Clauses 7, 8 and Annex Q).

6.2.1.4 Preparation of the test washing machine for a test run

Before each **test run**, any detergent dispenser shall be clean and dry prior to the addition of detergent.

The **test washing machine** shall be at laboratory ambient temperature at the beginning of each **test run**. It shall be accepted that this requirement has been met if the internal surface temperature of the **test washing machine** drum is at ambient air temperature of the test room (within ±2 K), or if the **test washing machine** has been left open and standing at the stable laboratory ambient temperature for not less than 2 h.

NOTE Large variations in time intervals between **test runs** can increase uncertainty.

Where the **test washing machine** is equipped with a temperature sensor to determine the water temperature in the sump during the wash **operation**, the temperature measured by this sensor may be taken as an alternative to the drum temperature to assess whether the **test washing machine** is at ambient temperature.

6.2.2 Reference machine

The **reference machine** shall be checked in accordance with the requirements of E.3.3 prior to a **test series**. The **reference machine** start-up **programme** shall be run immediately (not more than 30 min) prior to the commencement of any **test run** (refer to Clause F.4).

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

The **reference machine** shall meet the requirements of 6.2.1.4 before the start-up **programme** is started prior to the commencement of each **test run**.

6.3 Detergent

6.3.1 General

The detergent used for all **test runs** shall be as specified in Annex B. The **reference machine** and all **test washing machines run in parallel** shall use detergent from the same batch for every **test run** in the **test series**.

This document may also be used for assessment of all performance measures (except rinsing) on **test washing machines** where the manufacturer recommends the use of no detergent and where no other consumable material is added by the user during normal use. In such cases, tests on the **test washing machine** shall be performed without the addition of any consumable material (e.g. detergent) and with a connection to an electricity supply (refer to 5.2.1) and a standard laboratory water supply system (refer to 5.2.2).

NOTE 1 In all cases the **reference machine** is tested using the detergent dose specified in 6.3.2 irrespective of whether detergent is used in the **test washing machine** or not.

NOTE 2 In Annex C, standard liquid detergent IEC-L is specified and its application described.

NOTE 3 Justification for the selected specifications and the consequences of deviations can be found in Clause P.3.

6.3.2 Detergent dose

The detergent dose for the **reference machine** and the **test washing machine** shall be determined from the selected reference **programme** and the **test load** as set out in Table 5:

Table 5 – Detergent dose

Load type and reference programme	Detergent	Test washing machine		Reference machine	
		Dose hard water (refer to 5.2.2.2)	Dose soft water (refer to 5.2.2.2)	Dose hard water (refer to 5.2.2.2)	Dose soft water (refer to 5.2.2.2)
Cotton – all reference **programmes** except cotton 20 °C and cotton 30 °C	IEC-P	37,6 g + 11,3 g/kg	25,4 g + 7,5 g/kg	103,4 g	68,9 g
Cotton – Cotton 20 °C and cotton 30 °C only		37,6 g + 5,6 g/kg	25,4 g + 3,8 g/kg	54,5 g	36,7 g
Synthetics/blends		37,6 g + 11,3 g/kg	25,4 g + 7,5 g/kg	103,4 g	68,9 g
Wool	IEC-W	54,0 g + 8,0 g/kg	36,0 g + 5,3 g/kg	70,0 g	46,7 g

NOTE 1 For wool shrinkage performance test (refer to Annex W), IEC-W is used and not the standard IEC-A* base as in the former edition of this document.

NOTE 2 "g/kg" means grams of detergent per kg of **nominal test load mass**. Dosage for **reference machine** is fixed by **programme** and load type and differs from the **test washing machine**. The **reference machine** is always operated at a fixed load size, refer to 5.4.2.

NOTE 3 The quantity of detergent specified in this document is fixed by the **nominal test load mass** and water hardness. The standard detergent and the quantity specified may not be reflective of some commercial detergents.

NOTE 4 In order to take into account the use of detergents in practice, the dosage for cold washing is already lower in the 5th edition of this document compared to the dosage for the **programmes** with higher temperatures. This applies to both the **reference machine** and the **test washing machine**. In the case of the **test washing machine**, the dosage per gram of load is lower. For this edition, the total dosage has now been adjusted in accordance with the procedure for the other **programmes**.

AVA Documents
Document Sharing Hub

Full document details: IEC 60456 2024

If an alternative composition of detergent components is used, according to B.2.2, dosing shall be adjusted according to the supplier's instruction (see Clause U.3).

6.3.3 Weighing and mixing of detergent

6.3.3.1 Standard powder detergent IEC-P

Weigh the quantity of detergent components specified in Annex B to make up the detergent dose required for each single **test run**. The components shall be thoroughly mixed prior to use. Mixed standard powder detergent shall be stored at ambient temperature in a sealed container if not used immediately. The maximum storage time prior to use of standard powder detergent is fourteen days after mixing of detergent components. All detergent components shall be within their expiry date at the time of use.

6.3.3.2 Standard wool detergent IEC-W

The standard liquid detergent shall be stored at ambient temperature. It shall be mixed immediately before dosing by turning the container slowly upside down twice.

Standard liquid detergent shall be weighed in an appropriate way to ensure an accuracy of ±0,5 g.

– Use a glass beaker with an empty syringe, place it on the scale and tare it. The syringe is filled with the standard liquid detergent with a greater quantity than is specified in 6.3.2. The initial mass is recorded. Standard liquid detergent is added to the **test washing machine** as outlined in 6.3.4.2. The mass of the syringe is checked on the scale, and dosing is continued until the amount specified in 6.3.2 is added to the **test washing machine**; or
– Use the dosing device of the **test washing machine**. Place the dosing device on the scale, tare it, and add the specified quantity of the standard liquid detergent directly to the dosing device.

NOTE 1 Ensure that the standard liquid detergent does not run out of the dosing device.

– For the **reference machine**, only the dosing device provided with the **reference machine** and no alternative dosing method shall be used. Place the dosing device on the scale, tare it, and add the specified quantity of the standard liquid detergent directly to the dosing device. Then place the dosing device in the main wash detergent compartment of the **reference machine**, lift the device so that the lip of the device protrudes between the wall and the water inlet flange of the detergent compartment, and lock it in place using the mechanism on the device.

NOTE 2 Dosing device and instructions for its use are available from the manufacturer of the **reference machine**. For suppliers, see Annex U.

6.3.4 Detergent placement

6.3.4.1 Standard powder detergent IEC-P

Where a detergent dispenser is present, the detergent dose specified in 6.3.2 shall be placed as follows:

– where dispenser is large enough to hold the whole dose, place all detergent in the dispenser; or
– where the dispenser is not large enough to hold the whole dose, fill the dispenser to the maximum level indicated and place any excess detergent for the **test run** into the base of the drum before the load is added.

In the case of **vertical axis washing machines** only, where the manufacturer user guide recommends that the detergent dispenser be used only when using a **delay start** option on the machine (e.g. to avoid damage to fabrics which are in contact with the detergent), then the detergent shall be placed in the base of the drum as if the dispenser were not present.

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

Where there is no detergent dispenser, follow the manufacturer's instructions for detergent placement. If no instructions are given, all of the detergent is added to the base of the drum before the load is added.

6.3.4.2 Standard wool detergent IEC-W

Where a detergent dispenser is present, the detergent dose specified in 6.3.2 shall be placed as follows:

– where the dispenser is large enough to hold the whole dose, place all detergent in the dispenser by applying it with the syringe; or

– where the dispenser is not large enough to hold the whole dose, fill the dispenser to the maximum level indicated and place any excess detergent for the **test run** into the base of the drum before the load is added.

For the **reference machine**, place the dosing device with the liquid detergent into the dispenser.

NOTE Dosing device is available from the manufacturer of the **reference machine**. For suppliers, see Annex U.

In the case of **vertical axis washing machines** only, where the manufacturer user guide recommends that the detergent dispenser be used only when using a **delay start** option on the machine (e.g. to avoid damage to fabrics which are in contact with the detergent), then the detergent shall be placed by using the syringe in the base of the drum as if the dispenser is not present.

Where there is no detergent dispenser, follow the manufacturer's instructions for detergent placement. If no instructions are given, all of the detergent is added by using the syringe to the base of the drum before the load is added.

6.4 Test loads

6.4.1 General

This subclause sets out requirements for the preparation of the **test loads** used in the **test washing machine** and the **reference machine** including the following:

– the pre-treatment of new **base load** items prior to use in testing (6.4.2),

– the average age requirements for **base load** items used in a **test load** (6.4.3)**,**

– the determination of **test load mass** (6.4.6.1),

– the normalization of the **base load** items between **test runs** (6.4.4),

– the conditioning of **base load** items to determine the **base load** mass at a known **remaining moisture content** (6.4.5),

– the composition of the **test load** (6.4.6),

– the measurement of unwashed stain strips prior to testing (6.4.7),

– the attachment of stain strips to the **base load** to make up the appropriate **test load** prior to each **test run** (6.4.8.1 and 6.4.8.2).

Depending on the **test class** (refer to Annex Q), the **base load** is normalized between each **test run** or **test series**, except for the polyester **base load** (for use with wool **programmes**) which does not require any normalization. After normalization, the **base load** is dried in a tumble dryer.

NOTE Previous editions of this document specified no normalization runs between **test runs** in a **test series**. Extensive testing has confirmed that each run without prior normalization is not statistically independent, as detergent residues amongst other contaminants accumulate at each run. For sake of continuity with IEC 60456 5th edition, a **test series** of dependent **test runs** could need to be evaluated. Therefore, a **test series** of multiple **test runs** can be reproduced without normalization between **test runs**, on a single **test washing machine**. See Annex P and Annex Q for more details.

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

A schematic flow diagram showing the necessary preparation of load items prior to a **test run** is shown in Figure 2. A schematic flow diagram showing the selection of load items to meet age requirements for a **test run** is shown in Figure 3.

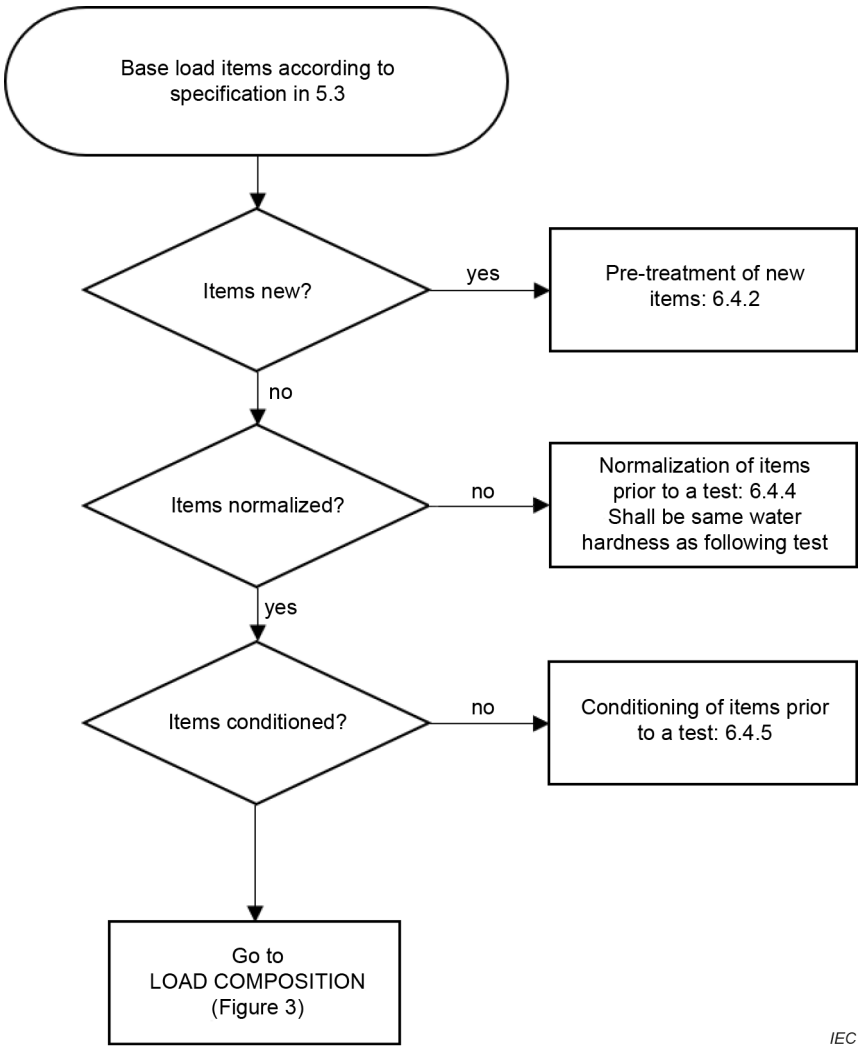


Figure 2 – Load item preparation prior to a test run or series (according to test class)

6.4.2 Pre-treatment of new base load items prior to use

New **base load** items shall be treated before their first use by undergoing a normalization wash process five times, as defined in 6.4.4 but without intermediate drying, and using 15 g/kg of the standard powder detergent IEC-P. This is followed by normalization according to 6.4.4 and by conditioning according to 6.4.5.

6.4.3 Requirements regarding the age of base load items

6.4.3.1 General

Any individual cotton, polycotton or synthetics/blends **base load** item shall not be used for more than 80 **test runs**, excluding pre-treatment runs prior to initial use (refer to 6.4.2) and normalization runs between **test runs** or **test series**.

For the purposes of meeting the age requirements specified, a **base load** item is considered to have undergone a **test run** if it has been subjected to any mechanical action or exposure to detergent and/or water other than pre-treatment runs (refer to 6.4.2) or normalization runs (refer to 6.4.4).

AVA Documents Document Sharing Hub
Full document details: IEC 60456 2024

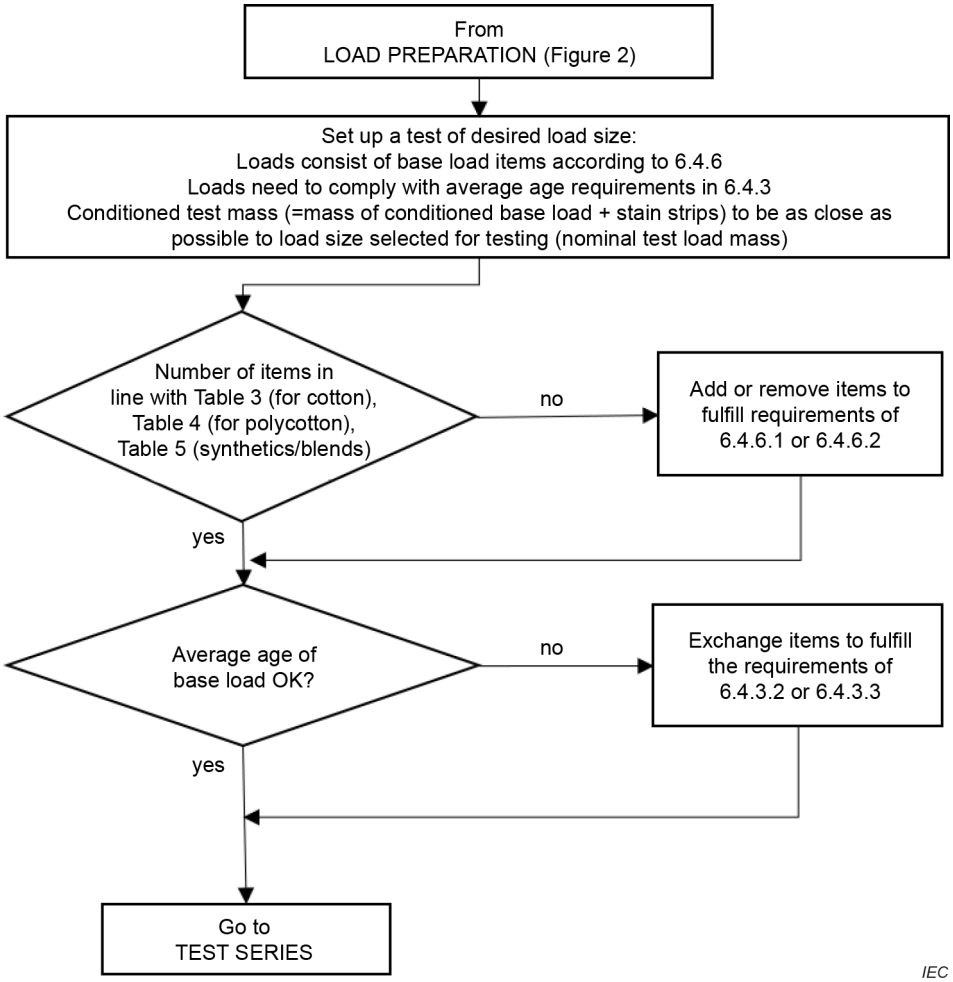


Figure 3 – Load composition and age requirements

To meet the age requirements specified in this document, a system of tracking the number of **test runs** for each load item is required. Electronic systems such as RFID technology may be used. RFID chip/s should be attached to the load in such a way that mechanical action is not influenced.

6.4.3.2 Average age requirements for cotton base load items

To minimize the influence of changes in the characteristics of the **base load** items with increasing age, the cotton **base load** for each **test run** shall consist of load items that are well distributed in age for each different item type to give a weighted average age of the **base load** between 20 **test runs** and 60 **test runs**.

The weighted average age of the **test load** is calculated according to Annex I.

6.4.3.3 Average age requirements for polycotton or synthetics/blends base load items

To minimize the influence of changes in the characteristics of the **base load** items with increasing age, half of the polycotton or the synthetics/blends **base load** shall consist of items used in 40 or fewer **test runs** and the other half in more than 40 **test runs**. The polycotton **base load** shall consist of load items that are well distributed in age to give a weighted average age of the **base load** between 20 **test runs** and 60 **test runs**. The synthetics/blends **base load** shall consist of shirts and pillowcases that are well distributed in age to give a weighted average age of the **base load** between 20 **test runs** and 60 **test runs**.

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024

6.4.3.4 Average age requirements for polyester base load items for wool programmes

There are no weighted average age requirements for polyester **base load** items for wool **programmes**.

6.4.4 Normalization of base load items

6.4.4.1 General

Normalization is the process of washing the **base load** using a specified **programme**, in order to bring the **base load** back into a standardized state prior to testing.

The **base load** shall be normalized as specified below for each load type. Normalization of the **base load** is followed by conditioning according to 6.4.5, in order to determine the load item mass in a standardized state. Normalization of a **base load** prior to use shall always be done using a laboratory supply water with the same total water hardness (refer to 5.2.2.2) as that to be used for the subsequent **test run**.

NOTE Typical laboratory practice would be to normalize the **base load** at the completion of a test and then dry the **base load** as specified and place it in a conditioning room/chamber until the next test. However, knowledge of the water hardness for the next likely test would be useful.

6.4.4.2 Normalization of cotton and polycotton base load items

6.4.4.2.1 General

All cotton and polycotton **base load** items shall be treated once in the **reference machine** or suitable alternative **washing machine**, without detergent and using the 60 °C cotton reference **programme** or equivalent alternative **washing machine programme**. On completion of the **programme**, the **base load** items shall then be dried in a tumble dryer.

If the **base load** is to be conditioned in a room/chamber in accordance with 6.4.5.2 after normalization, then the **remaining moisture content** on removal from the dryer shall be less than 0 %.

6.4.4.2.2 Normalization of base load items in reference machine

For normalization purposes, up to 6,5 kg can be washed in the **reference machine**. Where the **base load** to be normalized is more than 6,5 kg, the **base load** shall be split into two or more even parts (as far as is possible, with a mix of items in each part) for the normalization process.

6.4.4.2.3 Normalization of cotton base load items in alternative washing machines

For normalization in alternative **washing machines**, the same level of rinsing performance as normally achieved in the **reference machine** using the 60 °C cotton reference **programme** shall be ensured. To confirm this, the **LAS rinsing performance** or **alkalinity rinsing performance** achieved in the alternative **washing machine** with a 60 °C cotton **programme** shall be within ± 30 % of the **LAS rinsing performance** or **alkalinity rinsing performance** achieved in the **reference machine** when used as a **test washing machine** with 6,5 kg load and corresponding amount of detergent. Where the **base load** to be normalized is more than the **rated capacity** of the alternative machine, the **base load** shall be split into two or more even parts (as far as is possible, with a mix of items in each part) for the normalization process.

NOTE 1 The maximum load used in the alternative **washing machine** can be different from the maximum load in the **reference machine**.

NOTE 2 Detergent is used only for confirmation of the rinsing performance of the alternative **washing machine.**

NOTE 3 Refer to Supplementary Documentation on IEC website of SC59D: as LAS expanded uncertainty is in the order of 30 %, the tolerance range is set at ± 30 %.

Documents
Document Sharing Hub
Full document details: IEC 60456 2024

Alternatively, all **base load** items shall be treated once without detergent in a **washing machine** with a loading capacity that is equal to or larger than the **test load** and using a 60 °C **programme** with a normal mechanical action similar to a cotton **programme** (see Table F.1) and with one main wash and 4 rinses. The water quantity in the process shall be approximately 5 L/kg load in main wash and 5 L/kg load in each rinse. The normalization **programme** shall contain a final spin using a g-force of at least 339 g for at least 5 min or reach a final moisture content of less than 50 % for the cotton **base load**.

NOTE 4 The g-force is a measurement of the acceleration that causes a perception of weight, with a g-force of 1 g equal to the conventional value of gravitational acceleration on Earth. It is common to use this measure in commercial **washing machines**.

NOTE 5 The g-force of the **reference machine**'s final spin at 1 100 rpm in 60 °C cotton reference **programme** is (352 ± 13) g.

6.4.4.3 Normalization of synthetics/blends base load items

All synthetics/blends **base load** items shall be treated in a **reference machine** or suitable alternative **washing machine** without detergent and using the 60 °C synthetics/blends reference **programme**. On completion of the **programme** the **base load** items shall then be dried in a tumble dryer.

If the **base load** is to be conditioned in an ambient-controlled room/chamber in accordance with 6.4.5.2 after normalization, then the **remaining moisture content** on removal from the dryer shall be less than 0 %.

For normalization purposes, up to 4 kg can be washed in the **reference machine**. Where the **base load** to be normalized is more than 4 kg, the **base load** shall be split into two or more even parts (as far as is possible, with a mix of items in each part) for the normalization process.

6.4.4.4 Normalization of polyester base load items for wool programmes

The polyester **base load** is not required to be normalized after a **test run**, but the **base load** items shall be dried in a tumble dryer.

6.4.5 Conditioning of base load items

6.4.5.1 General

Conditioning is the process of bringing the **base load** to reach a known **remaining moisture content**, after normalization plus drying at the completion of a **test run** or **test series**, and in order to check the standardized mass of each load item.

Conditioning of a **base load** shall be performed after selecting load items, to set up a **base load** of required mass and required age prior to a **test run** and a **test series**. Conditioning shall be performed when items are exchanged, to meet age requirements or, in case of **gentleness of action** tests, when items are replaced by new items to form the required cover for **thread removal specimen** and at least again after every 6th run with a **base load** consisting of the same items.

Conditioning shall be done in an ambient-controlled room/chamber or using the bone-dry method. The method used shall be reported.

AVA Documents
Document Sharing Hub
Full document details: IEC 60456 2024