
**Textiles and textile products —
Microplastics from textile sources —
Part 3:
Measurement of collected material
mass released from textile end
products by domestic washing method**

*Textiles et produits textiles — Microplastiques d'origines textiles —
Partie 3: Mesurage de la masse de matériaux collectés libérés par les
produits finis textiles par la méthode de lavage domestique*

STANDARDSISO.COM : Click to view the full PDF of ISO 4484-3:2023



STANDARDSISO.COM : Click to view the full PDF of ISO 4484-3:2023



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

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

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword.....	iv
Introduction.....	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	2
5 Apparatus	2
6 Reagents	3
7 Test condition	3
7.1 Standard atmosphere for preparation of test specimens and mass measurement.....	3
7.2 Test atmosphere for washing test.....	3
8 Test specimen preparation	3
9 Test procedure	3
9.1 General.....	3
9.2 Empty washing cycle before the washing test.....	3
9.3 Washing test of the test specimen.....	4
9.4 Washing of the collected material from the filter bag.....	4
9.5 Measurement of the mass of the collected materials.....	4
10 Calculation	5
10.1 Calculation for each test run.....	5
10.2 Calculation of average for 3 test runs.....	5
11 Repeatability and reproducibility	5
12 Test report	6
Annex A (informative) Filter fabric specification and filter bag construction	7
Annex B (normative) Requirements of the washing machine to be used in this test	9
Annex C (informative) Number of empty washing cycles after test washing	12
Annex D (informative) Reference detergent	13
Annex E (informative) Condition of the multiple washing cycle test and example of the test result	14
Annex F (informative) Interlaboratory trial	17
Annex G (informative) Number of test specimens	22
Annex H (informative) Collection percentage of the fibre fragments	25
Annex I (informative) Filter aperture size	26
Bibliography	28

Foreword

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

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

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO 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, ISO had received notice of a patent 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 www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 38, *Textiles*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 248, *Textiles and textile products*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 4484 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Daily washing of textile end products generates fibre fragments which are discharged from washing machine. The purpose of this test method is to collect materials including fibre fragments which are discharged from the domestic washing machine through the washing process.

Although there are many types of washing machines used at home, ISO 6330 has been developed for the domestic washing test method, which specifies the domestic washing machines and test conditions. This document utilizes one of the standard washing machines in ISO 6330.

In addition, a care label is attached to textile end products in many countries of the world and this care label specifies washing conditions to use in this document.

Due to the complicated internal structure of washing machines, the cleaning process of the machine is very important to avoid contamination. This document proposes the checking method and the requirements of the washing machine to be used in this document.

The identification and quantification of components contained in the collected materials through the washing process are determined by applying ISO 4484-2.

The information gathered from this document can be utilized by the textile industry for the development of textile end products to reduce or minimize shedding materials from textile end products through the washing process.

STANDARDSISO.COM : Click to view the full PDF of ISO 4484-3:2023

STANDARDSISO.COM : Click to view the full PDF of ISO 4484-3:2023

Textiles and textile products — Microplastics from textile sources —

Part 3: Measurement of collected material mass released from textile end products by domestic washing method

1 Scope

This document specifies a method for measuring the collected material mass released from the outlet hose of a standard washing machine, described in ISO 6330, through the washing process.

NOTE The washing condition of textile end products is indicated by the care labelling according to ISO 3758.

This document is applicable to textile end products (including consumer textile products, such as clothing made of fleece, shirts, trousers, blouse, etc.) and home textile end products (such as, blankets, rugs, curtains, etc.) which are composed of all fibres such as natural fibres, and man-made fibres, including mixture of the fibres that can be washed in a domestic washing machine.

This document is not applicable to fabrics and cut textile products. It does not cover the test for washing machines and detergents as well.

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.

ISO 139, *Textiles — Standard atmospheres for conditioning and testing*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 3758, *Textiles — Care labelling code using symbols*

ISO 6330:2021, *Textiles — Domestic washing and drying procedures for textile testing*

3 Terms and definitions

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

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

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

3.1

collected material

material collected by the filter attached at the outlet hose of a washing machine through the washing process, which include fibre fragments and non-water-soluble materials

3.2

empty washing cycle

washing cycle without test specimens by using the test washing program

4 Principle

A given mass of textile end products is washed in a domestic washing machine under certain temperature and mechanical conditions for a given number of washing cycles. The material shed through the washing cycles is collected in a filter bag which is attached at the outlet hose of the washing machine. The collected materials in filter bag are transferred to the membrane filter and the membrane filter with the collected materials are weighed in the weighing bottle. The membrane filter and weighing bottle are prepared in combination. The mass of the collected materials is calculated by the subtracting the original mass of the membrane filter and weighing bottle from the mass with the collected materials. The mass of collected materials, the ratio of the mass of the collected materials and the test specimen mass and the mass of the collected material per piece of textile end product are reported.

5 Apparatus

5.1 Domestic washing machine, specified in ISO 6330, with built-in filters removed. The domestic washing machine used in this document shall meet the requirements in [Annex B](#).

5.2 Filter bag, woven mesh, with aperture size of $(10 \pm 4) \mu\text{m}$; the specification for the materials and the construction is described in [Annex A](#). The aperture size of the filter is determined according to [Annex I](#).

5.3 Analytical balance, with a resolution of 0,1 mg or better.

5.4 Balance, with a resolution of 1 g or better.

5.5 Oven, capable of maintaining a temperature of $(105 \pm 3) ^\circ\text{C}$, without fan.

5.6 Cable ties, made of polyamide.

5.7 Polycarbonate membrane filter, approximately 47 mm in diameter with $10 \mu\text{m}$ aperture size. Stainless steel filter is also applicable.

5.8 Weighing bottle or dish, made of metal or glass, with a minimum diameter, approximately 47 mm, with a lid.

5.9 Vacuum filtration device, consisting of sintered filter platform and funnel, with vacuum pump.

5.10 Wash bottle, made of polyethylene or silicone resin, etc., squeezable and with nozzle.

5.11 Tweezers, made of stainless steel or plastics.

5.12 Glass beaker, with a minimum capacity of 1 000 ml.

5.13 Desiccator, with drying agent.

6 Reagents

6.1 **Water**, distilled or grade 3 water according to ISO 3696.

7 Test condition

7.1 Standard atmosphere for preparation of test specimens and mass measurement

The standard atmosphere for test specimen preparation and mass measurement are at the temperature of (20 ± 2) °C and the relative humidity of (65 ± 4) % in accordance with ISO 139.

7.2 Test atmosphere for washing test

The condition for the washing test is ambient condition.

8 Test specimen preparation

Only one kind of textile end products is applied in this washing test. Different kinds of textile end products shall not be mixed in the washing test. The number of the test specimens per washing test (S_n) is at least two textile end products. The maximum dry volume of all test specimens per washing test shall be not more than half of the volume of the washing tub.

The washing test is repeated for three (3) sets.

The number of the test specimens can affect the test result, which is shown in [Annex G](#) as an example.

The test specimens are conditioned in accordance with ISO 139. The total mass of the conditioned test specimens (M_p), which is measured using a balance ([5.4](#)), shall be up to 1 g and reported in the test report.

9 Test procedure

9.1 General

The washing machine used in this test shall meet the requirement described in [Annex B](#). Once met the requirement, the washing machine can be used continuously for the washing test.

For the consecutive washing test, take a procedure from [9.2](#).

The washing conditions of this test procedure is indicated by the care label attached to the textile end products in accordance with ISO 3758. The details of the washing condition are referred to ISO 6330.

If the countries use their own care label system or care instruction system, set the washing condition indicated by their system or if there is no label, run the washing program agreed among the interested parties.

9.2 Empty washing cycle before the washing test

Mount the filter bag ([5.2](#)) to the outlet hose of the domestic washing machine ([5.1](#)) and tie up by cable tie ([5.6](#)). Run one washing cycle of the washing program without test specimens. The washing program is the same as the washing test in [9.3](#). After completion of the washing cycle, remove the filter bag from outlet hose. Measure the mass of the collected materials by following the steps from [9.4](#) to [9.5](#) and [Clause 10](#) and report the mass of the collected materials from the empty washing cycle in the test report. This is an information of the test washing machine condition.

9.3 Washing test of the test specimen

Mount the filter bag (5.2) to the outlet hose of the domestic washing machine (5.1) and tie up by cable tie (5.6). Put the test specimens into the washing tub and run one test washing cycle of the washing program.

The detergent may be used for washing test and the preferable detergent is introduced in Annex D.

When the multiple numbers of the test washing cycle are required, run the number of the washing cycles as determined by the interested parties according to Annex E. An example of the results of the multiple numbers of test washing cycles is shown in Annex E.

After completion of the washing cycle, remove the test specimens from the washing tub.

Then, run 2 empty washing cycles by the same washing program.

The number of empty washing cycles (2 empty washing cycles) after test washing was determined by the results as shown in Annex C.

After completion of the empty washing cycle, remove the filter bag from outlet hose.

For the 2nd and 3rd sets of the test specimens, run the washing test in 9.3.

9.4 Washing of the collected material from the filter bag

Prepare four (4) glass beakers (5.12) containing 1 l of water (6.1) separately. Wash the filter bags of 9.2 and 9.3 in the glass beakers by turning the filter bags inside out and carefully checking that there are no fibre remnants. The solution in the beaker is the suspension solution of the collected materials.

Place the test specimen with outside side out, and with the zip up or button on if applicable, into the washing tub.

9.5 Measurement of the mass of the collected materials

Prepare four (4) polycarbonate membrane filters (5.7) and four (4) weighing bottles (5.8) in combination and separately, it is essential to keep each membrane filter/weighing bottle combination consistent throughout the duration of the test. Measure the mass of the original membrane filter (5.7) and a weighing bottle (5.8), respectively, and record them up to 0,1 mg and denoted as (M_{f1}).

Membrane filters (5.7) are handled by tweezers (5.11). The membrane filter (5.7) shall be kept in the weighing bottle (5.8) to prevent contamination from the environment.

Set the membrane filter (5.7) on a vacuum filtration device (5.9).

Filter the suspension solution of 9.4 by the membrane filters on a vacuum filtration device (5.9). Add 1 l of water (6.1) to the beaker and wash the filter bag again and filter the suspension solution by the same membrane filter. Repeat this procedure at least twice. Finally, wash the surface of the filter bag and the inside of the beaker by water (6.1) using a wash bottle (5.10), and this suspension solution is also filtered by the same membrane filter.

Place the membrane filter with collected materials into the original weighing bottle of 9.5 in combination and dry for 2 h at (105 ± 3) °C in the oven (5.5). Then place the weighing bottle with the membrane filter and collected materials in desiccator (5.13) to cool down to the room temperature.

Condition the membrane filter with the collected materials and the weighing bottle under standard atmospheres in 7.1.

Measure the mass of the conditioned membrane filter with the collected material and the weighing bottle up to 0,1 mg by the analytical balance (5.3) and record the result as (M_{f2}).

At this time, measure of the mass several times at intervals of 1 h or more. The mass is determined as the weighed value that shows a difference compared to the former and subsequent measurements within 0,1 % of the subsequent value.

10 Calculation

10.1 Calculation for each test run

The mass of the collected materials, C_m in mg is calculated by the [Formula \(1\)](#).

$$C_m = M_{f2} - M_{f1} \quad (1)$$

where

C_m is the mass of the collected materials through the test washing process in mg;

M_{f1} is the mass of the original membrane filter and weighing bottle in mg;

M_{f2} is the mass of the membrane filter with the collected materials and weighing bottle in mg.

The mass of the collected material per textile end product (C_{mp}) in mg per product is calculated by [Formula \(2\)](#).

$$C_{mp} = C_m / S_n \quad (2)$$

where

C_{mp} is the mass of the collected materials in mg/product;

C_m is the mass of the collected materials through the test washing process in mg;

S_n is the number of test specimens for one washing test.

The mass of the collected materials per the mass of the textile end products, C_{mw} in mg/kg is calculated by [Formula \(3\)](#).

$$C_{mw} = (C_m \times 1\,000) / M_p \quad (3)$$

where

C_{mw} is the mass of the collected materials per mass of textile end products in mg/kg;

C_m is the mass of the collected materials through the test washing process in mg;

M_p is the mass of test specimens in g.

10.2 Calculation of average for 3 test runs

Take averages of 3 test runs for C_m , C_{mp} and C_{mw} as the test results.

11 Repeatability and reproducibility

The interlaboratory test according to this document is given in [Annex F](#).

12 Test report

The test report shall include the following information:

- a) a reference to this document, i.e. ISO 4484-3:2023;
- b) date of the test;
- c) type of a washing machine and test conditions;
- d) test method (number of washing cycles, etc.);
- e) test environment conditions;
- f) number of test specimen put into the washing tub;
- g) total mass of the test specimens put into the washing tub;
- h) the collected mass in the empty washing cycle before test washing;
- i) the average mass of the collected materials through the test washing process;
- j) the average mass of the collected materials per a textile end product;
- k) the average mass of the collected materials per the mass of textile end products;
- l) material, fibre, product construction, etc. of specimen tested;
- m) any deviation from the procedure;
- n) any unusual features observed;
- o) if detergent is used, report the kind and amount of detergent.

STANDARDSISO.COM : Click to view the full PDF of ISO 4484-3:2023

Annex A (informative)

Filter fabric specification and filter bag construction

A.1 Fabric structure for filter bag

The image of the mesh fabric is shown in the [Figure A.1](#) as an example and the product specification by manufacturer is as follows:

- fibre material: 100 % polyamide monofilament yarn;
- weave structure: 2/2 twill weave;
- linear density (dtex): warp, 9, weft, 9;
- number of threads per centimetre (T/cm): warp, 198, weft, 184;
- mass per unit area (g/m^2): 35.

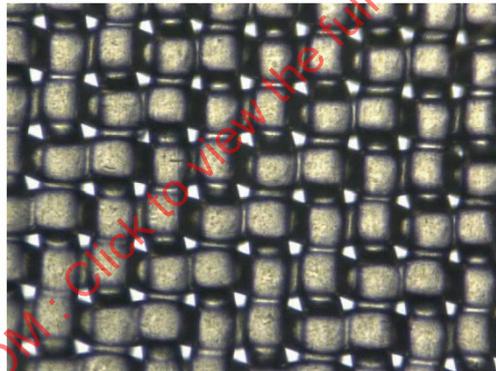


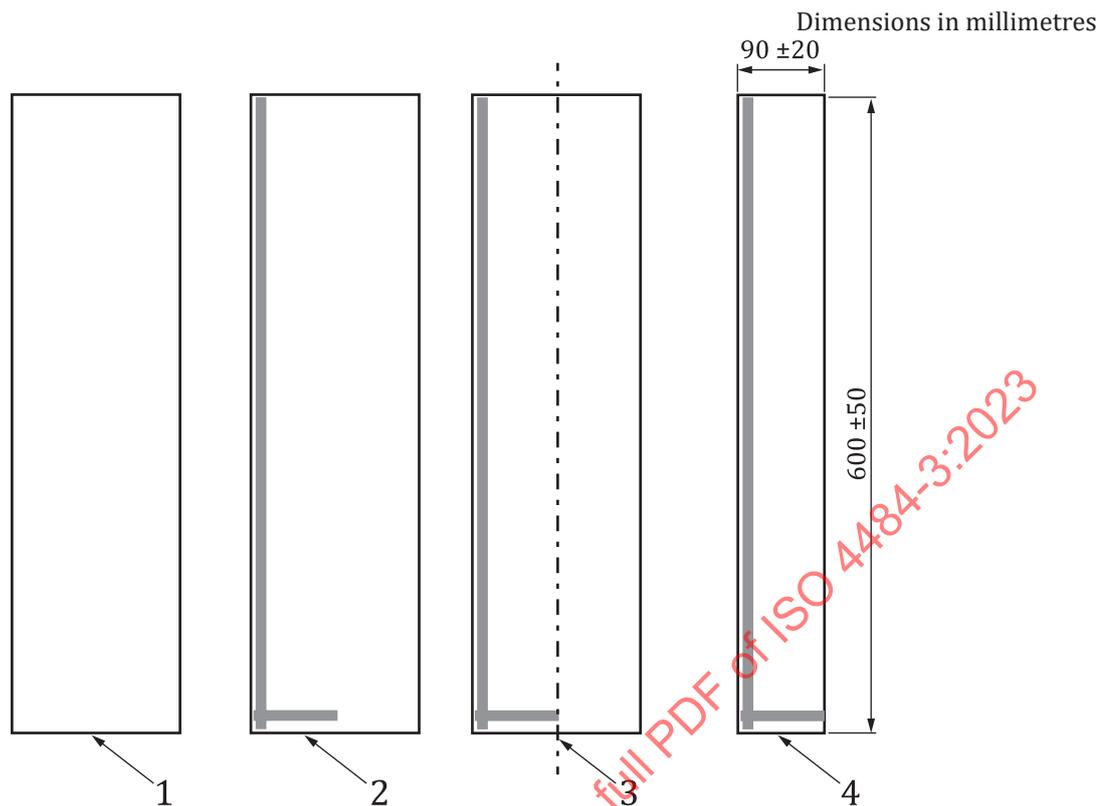
Figure A.1 — Photo of a polyamide monofilament mesh filter as an example

A.2 Filter bag construction

This is an example of the filter bag construction. The other construction of the filter bag can be applied for the purpose of the collecting the materials from the outlet hose of the washing machine.

- Shape: Rectangular form.
- Bag dimension in mm: The longer side is approximately 600 mm and the shorter side is approximately 90 mm which includes bonding allowance approximately 15 mm as shown in [Figure A.2](#) by dark thicker line.
- Bonding: The step for the formation of filter bag is shown in [Figure A.2](#). The filter fabric is heat-cut in rectangular fabric (key 1). The iron-on fusing tape with about 1 cm width is attached in two sides (key 2). The fabric is folded in two (key 3) and adhered together by iron-on fusing tape (key 4) with no gaps.

How to use the iron-on fusing tape is given by the manufacturer's instruction.



Key

- 1 fabric cut by heat-cutting
- 2 position for iron-on fusing tape with about 10 mm in width
- 3 centre line to be folded
- 4 finished filter bag shape

Figure A.2 — Example of filter bag construction

A.3 Filter checking

As for reusing the filter bag, the filter surface condition should be checked by light microscope whether there is no damage and no foreign materials. The example of inspection condition is as follows:

- 1) the magnification: x 40;
- 2) the number of inspection points: 100;
- 3) the criteria for reusable: no damage and no foreign materials comparing with new filter bag.

Annex B (normative)

Requirements of the washing machine to be used in this test

B.1 General

The domestic washing machines used for this test shall meet the requirement described in this annex.

B.2 Empty washing test procedure

B.2.1 Mount the filter bag (5.2) to the outlet hose of the washing machine (5.1) and tie up by cable tie (5.6).

B.2.2 Run one empty washing cycle of the washing program which shall be 4N according to ISO 6330:2021 or equivalent.

B.2.3 After completion of the empty washing cycle, remove the filter bag from the outlet hose.

B.2.4 Wash the collected materials from the filter bag according to 9.4. Measure and calculate the mass of collected materials (C_m) from each empty washing cycle according to 9.5 and Clause 10.

B.2.5 Repeat to run the numbers of the empty washing cycles from B.2.1 to B.2.4 by three (3) empty washing cycle or more.

B.2.6 Calculate CV (%) using the C_m values for the consecutive 3 cycles.

B.3 Requirements of the test washing machine to be used for this test

The coefficient of variation CV (%) of the mass of the collected materials is required to be 10 % or less for three consecutive empty washing cycles, or the C_m shall be 1,0 mg or less three times in a row. The flow of the procedure is shown in Figure B.1

Repeat the empty washing cycle until the requirement is achieved. If the washing machine cannot meet the requirements after numbers of the empty washing cycle, the washing machine is considered as unsuitable for this washing test.

If the washing machine is heavily soiled, it may be washed with a cleaning agent recommended by the washing machine manufacturer.

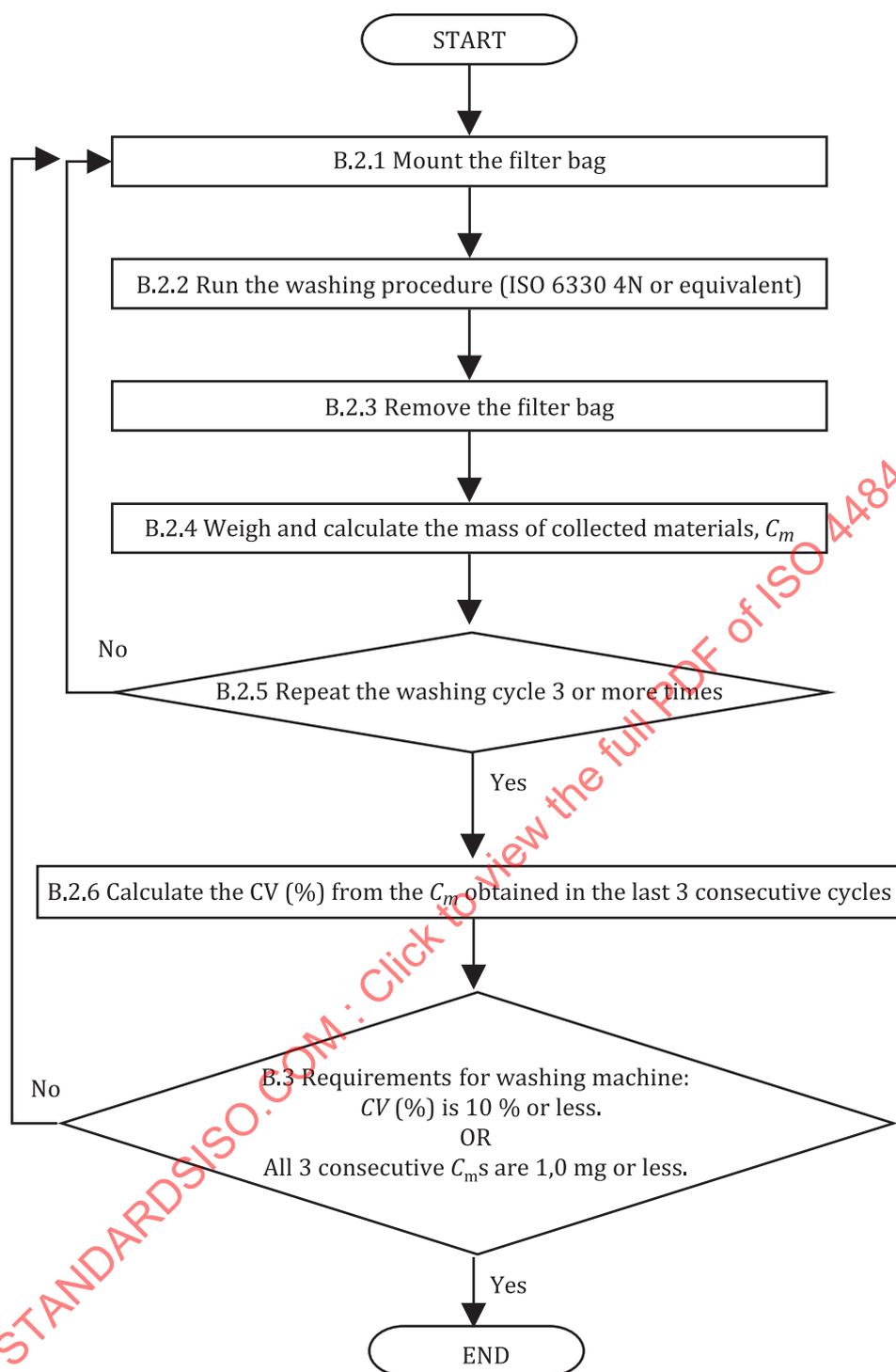


Figure B.1 — Flowchart of checking of the washing machine to be used in this test

B.4 Example of the empty washing test result

The example of the empty washing test result is shown in [Table B.1](#). As shown in [Table B.1](#), the CV (%) becomes 10 % or less after 5th cleaning washing.

Table B.1 — One example of empty washing test result

No. of cleanings	Total collected mass (mg)	Running mean	Standard deviation (<i>SD</i>)	Coefficient of variation <i>CV</i> (%)	Remarks (Data used for mean and <i>SD</i>)
1 st	1,34	—	—	—	—
2 nd	1,15	—	—	—	—
3 rd	0,75	1,080	0,301	27,9	1 st , 2 nd , 3 rd
4 th	0,84	0,913	0,210	23,0	2 nd , 3 rd , 4 th
5 th	0,75	0,780	0,052	6,7	3 rd , 4 th , 5 th

STANDARDSISO.COM : Click to view the full PDF of ISO 4484-3:2023

Annex C (informative)

Number of empty washing cycles after test washing

C.1 General

From this test, the number of the empty washing cycles after the test washing cycle of the specimens was determined. Test specimens are shown in [Table C.1](#).

Table C.1 — Details of test specimens

Specimen No.	Specimen name and structure	Composition	Mass of specimens (g)
1	Underwear A: Single knit	90 % Polyamide, 10 % Elastane	93
2	Underwear B: Single knit	47 % Acrylic, 26 % Polyester, 20 % Viscose, 7 % Elastane	344
3	Fleece fabric C	100 % Polyester	497
4	Fleece fabric D	100 % Polyester	411

C.2 Test procedure

The test washing cycle for the test specimens was performed according to the test procedure shown in [9.3](#). After the specimens were removed from the washing tub, the empty washing cycles were repeated 3 times and the mass of the collected materials was determined for each cycle.

C.3 Test result

The ratio of the mass of the collected materials by each empty washing cycle to the mass of the collected materials by the test washing of the specimens was calculated. The results are shown in [Table C.2](#).

Table C.2 — Test result for number of empty washing cycles for continuous use of washing machine

No. of empty washing cycle	Ratio of the collected mass of empty washing cycle against the mass of the collected materials for the test specimens (%)			
	No.1	No.2	No.3	No.4
1 st	2,2	6,1	-0,2	4,2
2 nd	1,3	-4,0	-0,7	2,2
3 rd	0,8	-4,1	-2,5	0,4

NOTE The negative values in the table were caused by the weighing method in this test. The mass of collected materials was measured with the polyamide mesh filter and the variation happens the measurement of the empty washing test in which the mass of collected materials are nearly zero, so the moisture content of filter bag affected to the calculation. This is why the measurement method was changed to [9.5](#), using polycarbonate filter.

Annex D (informative)

Reference detergent

In case of use of detergent, the preferable reference detergent is a non-phosphate liquid detergent both with or without optical brightener.

The nominal composition of reference detergent is given in [Table D.1](#).

Table D.1 — Reference detergent, AATCC HE detergent

Composition	Nominal content ratio (mass %)
Sodium dodecylbenzene sulfonate	20 - 25
Sodium lauryl ether sulfate	5 - 10
Ethoxylated alcohol C9-12	10 - 15
Ethanol	1 - 3
Sodium citrate	+
Amine oxide 35 %	+
Defoamer	+
Sodium tetraborate decahydrate	+
Anti-dye transfer agent	+
Water	Make up to 100
Total	100
+ trace additives	

Annex E (informative)

Condition of the multiple washing cycle test and example of the test result

E.1 General

If the multiple washing cycle test is required, take one of the following procedures with the consent of the interested parties. The test method selected should be reported in the test report.

E.2 Continuous washing method without drying

Run one washing cycle test then run the second washing cycle test without removing the test specimens from the washing tub. Continue this procedure until the number of washing cycles determined by the interested parties is reached.

E.3 Natural dry method — Line drying

Run one washing cycle test and remove the test specimens from washing tub. Dry the test specimens at the conditioned room at $(20 \pm 2) ^\circ\text{C}$, $(65 \pm 4) \% \text{RH}$ for 12 h or more. Then put the dried test specimens in washing tub and run the second washing cycle of washing test. Continue this procedure until the number of washing cycles determined by the interested parties is reached.

E.4 Tumble drying method

Run one washing cycle test and remove the test specimens from the washing tub. Dry the test specimens using a tumble dryer according to the conditions specified in ISO 6330. Remove the test specimens from the dryer, put the dried test specimens in washing tub, and run the second washing cycle of the washing test. Continue this procedure until the number of washing cycles determined by the interested parties is reached.

E.5 Example of the multiple washing cycle test

E.5.1 Test procedure

The continuous washing cycle test without drying was performed. The mass of collected materials are determined for each washing cycle for the test.

E.5.2 Test specimen

The detail of test specimens is shown in [Table E.1](#).

Table E.1 — Details of test specimens

Specimen No.	Specimen item and structure	Composition	Mass (g)
1	Underwear A: Single knit	90 % Polyamide, 10 % Elastane	100

Table E.1 (continued)

Specimen No.	Specimen item and structure	Composition	Mass (g)
2	Outerwear B: Fleece	87 % Polyester, 13 % Elastane	451

E.5.3 Test result

The test results are shown in [Tables E.2](#), [E.3](#) and [Figure E.1](#).

Table E.2 — Test results for test specimen No.1

Washing cycle	Mass of the collected materials (mg/product)				
	1st	2nd	3rd	4th	5th
n = 3 (3 test runs)	14,8	5,2	3,3	2,5	2,0
	14,9	4,6	3,2	2,3	1,8
	14,2	5,3	3,3	2,5	2,0
Mean value	14,6	5,0	3,3	2,4	1,9
Standard deviation (SD)	0,38	0,38	0,06	0,12	0,12
CV (%)	2,6	7,5	1,8	4,7	6,0
Washing cycle	Mass of the collected materials (mg/product)				
	6th	7th	8th	9th	10th
n = 3 (3 test runs)	1,4	-	-	1,6	1,6
	1,2	0,8	0,6	1,1	1,3
	1,5	1,0	0,6	1,0	1,0
Mean value	1,4	0,9	0,6	1,2	1,3
Standard deviation (SD)	0,15	0,14	0,00	0,32	0,30
CV (%)	11,2	15,7	0,0	26,1	23,1

Table E.3 — Test results for test specimen No.2

Washing cycle	Mass of the collected materials (mg/product)				
	1st	2nd	3rd	4th	5th
n = 3 (3 test runs)	51,1	19,2	11,5	9,1	8,8
	44,1	24,6	14,9	11,7	9,3
	39,9	27,8	11,6	11,7	7,6
Mean value	45,0	23,9	12,7	10,8	8,6
Standard deviation (SD)	5,66	4,35	1,93	1,50	0,87
CV (%)	12,6	18,2	15,3	13,9	10,2
Washing cycle	Mass of the collected materials (mg/product)				
	6th	7th	8th	9th	10th
n = 3 (3 test runs)	4,5	5,5	7,5	8,0	8,2
	6,5	5,2	6,6	7,3	7,0
	4,8	4,2	6,1	7,3	7,7
Mean value	5,3	5,0	6,7	7,5	7,6
Standard deviation (SD)	1,08	0,68	0,71	0,40	0,60
CV (%)	20,5	13,7	10,5	5,4	7,9

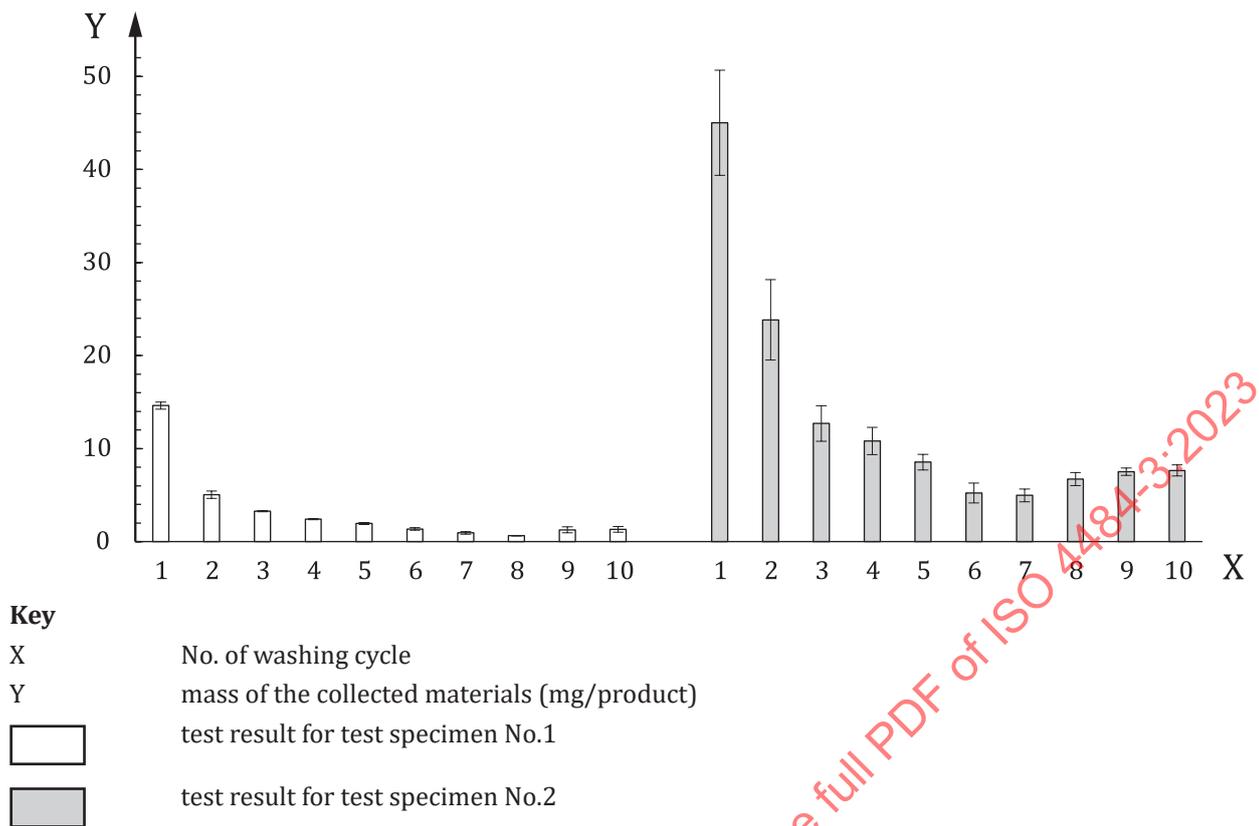


Figure E.1 — Test results of the mass of the collected material at the No. of washing cycles

Annex F (informative)

Interlaboratory trial

F.1 General

The interlaboratory trial on ISO 4484-3 was executed from September 2021 to December 2021, and September 2022 to November 2022. The result was summarized in November 2022. This trial has been organized by Japan Chemical fibres Association and Kaken Test Centre.

F.2 Participating laboratories

The following 10 laboratories has been applied for participation. The report was summarized on the results of the total 9 laboratories, except USA where the test had been delayed due to COVID 19 pandemic.

- USA: 1 laboratory
- Italy: 1 laboratory
- Spain: 1 laboratory
- Germany: 2 laboratories
- Japan: 5 laboratories

F.3 Domestic washing machine and apparatus

- Type A: front-loading washing machine (Italy, Spain, Germany 2 laboratories, Japan 2 laboratories)
- Type C: top-loading pulsator type (Japan 5 laboratories)

The lab numbers and the type of washing machine used for each are listed in [Table F.1](#).

Table F.1 — Combination of lab number and washing machine type

Lab No.	Washing machine type
2	A
3	A
4	C
5	C
6	C
7	C
8	C
10	A
11	A
12	A
13	A

F.4 Washing machine checking

The participants were requested the checking of the test washing machine to be used and confirmed to meet the requirements of Annex B as [Confirm the coefficient of variation (CV%) of the mass of the collected materials is to be 10 % or less for three consecutive operations. or the C_m is 1,0 mg or less three times in a row].

The cleaning results are shown in Table F.2 and Table F.3. It was confirmed that all test washing machines except Lab 13 met the requirements.

Table F.2 — Mass of the collected materials through the empty washing cycles on Type A washing machine

No. of washing cycles	Laboratory											
	Lab 2		Lab 3		Lab 10		Lab 11		Lab 12		Lab 13 ^a	
	C_m (mg)	CV (%)	C_m (mg)	CV (%)								
1st	2,8	N/A	1,8	N/A	5,15	N/A	5,2	N/A	9,9	N/A	0,63	N/A
2nd	2,5	N/A	2,4	N/A	3,76	N/A	2,5	N/A	6,1	N/A	3,04	N/A
3rd	2,0	17	2,0	15	2,33	38	2,0	53	15,5	45	1,81	66
4th	1,7	20	0,8	48	2,27	30	1,9	15	3,5	75	1,70	34
5th	1,4	18	1,1	48	1,51	22	1,7	8	10,8	61	N/A	N/A
6th	1,2	18	0,9	16	2,73	28	N/A	N/A	5,3	58	N/A	N/A
7th	1,0	17	0,8	16	1,98	30	N/A	N/A	3,3	60	N/A	N/A
8th	0,8	20	0,6	20	1,45	31	N/A	N/A	2,2	44	N/A	N/A
9th	0,8	13	0,6	17	0,96	35	N/A	N/A	3,6	24	N/A	N/A
10th	0,8	0	1,2	43	1,90	33	N/A	N/A	4,0	29	N/A	N/A
11th	0,6	16	0,2	75	1,75	33	N/A	N/A	3,8	5	N/A	N/A
12th	0,6	17	0,0	138	1,11	26	N/A	N/A	14,1	81	N/A	N/A
13th	0,5	10	0,2	87	1,71	24	N/A	N/A	1,5	104	N/A	N/A
14th	0,5	11	0,1	100	1,40	21	N/A	N/A	3,7	105	N/A	N/A
15th	0,5	0	0,1	43	1,65	10	N/A	N/A	5,3	55	N/A	N/A

NOTE N/A: not applicable

^a Prior to these washing cycles, 20 additional empty washing cycles were performed. Results were not recorded.

Table F.3 — Mass of collected materials through the empty washing cycles on Type C washing machine

No. of washing cycles	Laboratory									
	Lab 4		Lab 5		Lab 6		Lab 7		Lab 8	
	C_m (mg)	CV (%)								
1st	2,9	N/A	0,0	N/A	0,4	N/A	0,33	N/A	1,17	N/A
2nd	2,7	N/A	-0,3	N/A	0,5	N/A	0,48	N/A	0,60	N/A
3rd	2,2	14	-0,1	115	0,3	25	0,23	36	0,67	38
4th	1,5	28	-0,3	49	0,3	31	0,28	40	0,91	22
5th	2,0	19	-0,4	57	0,4	17	0,19	19	0,33	46
6th	1,2	26	-0,4	16	0,4	16	0,13	38	0,32	65
7th	0,4	67	0,2	173	0,3	16	0,20	22	0,28	9
8th	0,5	62	0,1	964	0,4	16	0,14	24	N/A	N/A

NOTE N/A: not applicable

Table F.3 (continued)

No. of washing cycles	Laboratory									
	Lab 4		Lab 5		Lab 6		Lab 7		Lab 8	
	C_m (mg)	CV (%)								
9th	0,8	37	-0,1	229	0,3	17	0,20	19	N/A	N/A
10th	N/A	N/A	0,1	346	0,3	17	0,17	18	N/A	N/A
11th	N/A	N/A	0,1	346	0,3	0	0,16	12	N/A	N/A
12th	N/A	N/A	0,1	0	N/A	N/A	0,14	10	N/A	N/A
13th	N/A	N/A	-0,1	346	N/A	N/A	N/A	N/A	N/A	N/A
14th	N/A	N/A	-0,1	346	N/A	N/A	N/A	N/A	N/A	N/A
15th	N/A	N/A	-0,1	0	N/A	N/A	N/A	N/A	N/A	N/A

NOTE N/A: not applicable

F.5 Interlaboratory trial

F.5.1 Test specimen details

The detail of test specimens is shown in [Table F.4](#). Two (2) textile end products are subjected to washing test.

Table F.4 — Details of test specimens

Specimen No.	Specimen item and structure	Composition	Mass of one textile end product (g)
1	Under wear: filament yarn	88 % Polyester, 12 % Elastane	110
2	Under wear: spun yarn	47 % Acrylic, 26 % Polyester, 20 % Viscose, 7 % Elastane	380
3	Fleece jacket	100 % Polyester	435

F.5.2 Test result

The test results are shown in [Table F.5](#) and [Table F.6](#).

Cochran's test was executed on the data for each washing machine type, and there were no outliers. Grubbs's test was executed on the data for each washing machine type, and test specimen No.2 in Lab 13 was 5 % outlier.

For washing machines that did not achieve cleanliness, the test results were outliers. In other words, unsatisfactory washing machines are not appropriate for ISO 4484-3. Such washing machines need to be fundamentally clean in order to perform the test. In such cases, it is helpful to observe the collected results and check for the contamination of substances other than those derived from the specimen.

Table F.5 — Mass of the collected materials per textile end product (mg/product) from washing test using Type A washing machine

Test specimen No.	Lab	The mass of collected materials (Repetition (n=3))			Mean	SD
1	Lab 2	28,6	34,5	23,8	29,0	5,36
	Lab 3	16,5	22,7	18,3	19,2	3,19
	Lab 10	18,0	23,2	31,4	24,2	6,76
	Lab 11	18,9	17,8	16,4	17,7	1,25
	Lab 12	23,2	25,7	22,2	23,7	1,78
	Lab 13	32,8	32,0	21,5	28,8	6,31
2	Lab 2	91,6	83,8	96,7	90,7	6,50
	Lab 3	114,3	85,2	94,6	98,0	14,85
	Lab 10	85,4	86,8	81,5	84,6	2,75
	Lab 11	109,5	82,5	96,1	96,0	13,50
	Lab 12	88,5	90,3	88,5	89,1	1,07
	Lab 13	66,1	77,1	41,2	61,5 ^a	18,39
3	Lab 2	17,5	20,5	15,9	18,0	2,34
	Lab 3	15,2	12,3	13,8	13,8	1,45
	Lab 10	14,7	11,8	13,5	13,3	1,46
	Lab 11	16,1	18,2	15,8	16,7	1,31
	Lab 12	16,9	19,1	16,3	17,4	1,47
	Lab 13	23,3	20,3	20,7	21,4	1,63

^a Not used for the repeatability and reproducibility calculations (F.5.3) due to 5 % outlier.

Table F.6 — Mass of the collected materials per textile end product (mg/product) from washing test using Type C washing machine

Test specimen No.	Lab	The mass of collected materials (Repetition (n=3))			Mean	SD
1	Lab 4	18,9	21,9	18,3	19,7	1,93
	Lab 5	18,3	16,0	16,3	16,9	1,25
	Lab 6	18,6	18,2	19,7	18,8	0,78
	Lab 7	23,2	22,5	23,4	23,0	0,47
	Lab 8	17,6	19,7	19,1	18,8	1,08
2	Lab 4	76,9	74,8	73,3	75,0	1,81
	Lab 5	60,8	66,2	86,2	71,1	13,38
	Lab 6	78,6	64,5	54,3	65,8	12,20
	Lab 7	80,6	57,2	78,5	72,1	12,95
	Lab 8	88,2	67,7	66,1	74,0	12,32
3	Lab 4	20,9	14,8	18,5	18,1	3,07
	Lab 5	3,3	5,4	3,3	4,0	1,21
	Lab 6	10,9	7,7	6,4	8,3	2,32
	Lab 7	10,9	3,4	4,1	6,1	2,32
	Lab 8	6,9	5,5	10,2	7,5	2,41

F.5.3 Repeatability and reproducibility

The repeatability and reproducibility are calculated according to ISO 5725-2, and the results are shown in [Table F.7](#).

Table F.7 — Repeatability and reproducibility

Washing machine Test specimen No.	Type A			Type C		
	1	2	3	1	2	3
T1	427,45	1 375,20	301,90	291,70	1 073,90	132,20
T2	10 481,34	126 431,45	5 196,90	5 733,73	77 038,56	1 518,65
T3	18	15	18	15	15	15
T4	54	45	54	45	45	45
T5	258,04	907,38	32,43	14,56	1 301,39	78,53
s _r ²	21,50	90,74	2,70	1,46	130,14	7,85
s _L ²	14,87	-0,82	7,99	4,61	-30,51	26,84
s _R ²	36,38	90,74	10,69	6,07	130,14	34,70
m [^]	23,75	91,68	16,77	19,45	71,59	8,81
s _r	4,64	9,53	1,64	1,21	11,41	2,80
s _R	6,03	9,53	3,27	2,46	11,41	5,89
Repeatability	5,27			5,14		
Reproducibility	6,28			6,59		
p _j	6	5	6	5	5	5
m [^] _j	23,75	91,68	16,77	19,45	71,59	8,81
s _{rj}	4,64	9,53	1,64	1,21	11,41	2,80
s _{Rj}	6,03	9,53	3,27	2,46	11,41	5,89

Annex G (informative)

Number of test specimens

G.1 General

As a preparatory work, the effect of the number of test specimens put in the washing tub for this test was examined and the test results are shown in this annex.

G.2 Test specimen

The detail of samples is shown in [Table G.1](#).

Table G.1 — Details of test specimen

Specimen No.	Specimen item and name	Composition	Mass (g)
1	Underwear	90 % Polyamide, 10 % Elastane	100
2	Outerwear	87 % Polyester, 13 % Elastane	451

G.3 Test procedure and the conditions

The top-loading pulsator type domestic washing machine was used. The basic procedure for the test is as shown in [9.3](#) to [9.5](#) and [Clause 10](#). However, the test was performed by using the test specimen conditions shown in [Table G.2](#).

Table G.2 — Details of test specimen condition

Test condition	Test specimen No.	Mass of total test specimens (kg): M_p	No. of test specimens (product)
1	1	2,0	20
2	1	1,0	10
3	1	0,5	5
4	1	0,2	2
5	1	0,1	1
6	2	2,0	4
7	2	1,0	2
8	2	0,5	1

G.4 Test result

The results are shown in [Table G.3](#), [Table G.4](#), [Figure G.1](#) and [Figure G.2](#).