



Performance Evaluation Procedures for Household Clothes Washers

AHAM HLW-1-2013



PREFACE

The Association of Home Appliance Manufacturers develops standards in accordance with AHAM's "Policy and Procedures Governing Technical Standards" which states:

"AHAM Standards shall be in the best interest, mutually, of consumers who use appliances, the industries which provide and service appliances, and other interested parties. They shall relate to actual use conditions, and be technically and scientifically sound."

Use or observance of AHAM standards is voluntary. AHAM standard procedures do not preclude other valid testing procedures, each of which should be evaluated based on its own merit.

AHAM standards are presented to the American National Standards Institute (ANSI) for recognition as American National Standards. This standard will be subjected to public scrutiny by use of the canvass method and submitted to ANSI for approval once it has been accepted as an AHAM standard. This standard contains test procedures which provide a practical means of measuring specific performance characteristics of any brand or model of automatic household electric clothes washers. When using any of the test procedures to determine performance rating status or to compare the performance of appliances, it is recommended that multiple test units (typically at least 3) be run to ensure that the results obtained are statistically valid.

With regard to safety, AHAM recommends that all appliance products--major and portable--manufactured or marketed in the United States be submitted to an appropriate Nationally Recognized Test Laboratory for inspection and listing in conformance with the safety standards and procedures followed by such laboratories. The relevant standard for clothes washers is ANSI/UL 2157, "Standard for Safety, Electric Home-Laundry Equipment".

AHAM welcomes comments and suggestions regarding this standard. Any standard may be reviewed and improved as needed. All standards must be updated or reconfirmed at least every five years. Any interested party, at any time, may request a change in an AHAM standard. Such request should be addressed to AHAM's President, and should be accompanied by a statement of reason for the request and a suggested alternate proposal.

Copyright © 2013 by the Association of Home Appliance Manufacturers (AHAM)

All rights reserved.

The hard copy print version of this document shall be for individual use only.

The electronic file version of this document shall be for storage on one computer for purposes of viewing and/or printing one copy for individual use only.

This document shall not be reproduced in whole or in part by any means, and shall not be transmitted electronically or otherwise to a third person without the prior written permission of AHAM.

Table of Contents

1.	PURPOSE	1
2.	SCOPE	1
3.	DEFINITIONS	1
3.1	BASE LOAD	1
3.2	BONE DRY	1
3.3	CONDITIONING CYCLE	1
3.4	CYCLE	1
3.5	HORIZONTAL AXIS (HA) WASHING MACHINE	1
3.6	NORMALIZATION	1
3.7	PRE-TREATMENT	1
3.8	REPLICATION	1
3.9	STUFFER LOAD	1
3.10	TEST LOAD	1
3.11	VERTICAL AXIS (VA) WASHING MACHINE	1
4.	GENERAL TEST CONDITIONS	2
4.1	EQUIPMENT	2
4.2	BASE LOADS	2
4.3	AHAM STUFFER LOAD	3
4.4	TEST LOAD PREPARATION AND MAINTENANCE	3
4.5	WATER	4
4.6	ELECTRICITY SUPPLY	4
4.7	STANDARD TEST DETERGENT (FORMULA 3).	4
4.8	CONDITIONING CYCLE	5
4.9	TECHNICAL CONSIDERATIONS	5
5.	FOLDING AND LOADING THE TEST LOAD	6
5.1	GENERAL	6
5.2	FOLDING THE ITEMS PRIOR TO LOADING THE WASHING MACHINE	6
5.3	LOADING ITEMS INTO THE WASHING MACHINE – GENERAL RULES	8
5.4	LOADING REQUIREMENTS – HORIZONTAL AXIS WASHING MACHINES	11
5.5	LOADING REQUIREMENTS – VERTICAL AXIS WASHING MACHINES	15
6	SOIL/STAIN REMOVAL TEST	22
6.1	PURPOSE	22
6.2	EQUIPMENT	22
6.3	MATERIALS	22
6.4	CALIBRATION OF SOIL/STAIN TEST STRIPS	22
6.5	PREPARATION	23
6.6	PROCEDURE	23
6.7	SCORING	26
7	MECHANICAL ACTION TEST	28
7.1	PURPOSE	28
7.2	EQUIPMENT	28
7.3	MATERIALS	28
7.4	PREPARATION	28
7.5	PROCEDURE	29
7.6	DATA COLLECTION AND SCORING	30

8	SAND REMOVAL TEST	33
8.1	PURPOSE	33
8.2	EQUIPMENT	33
8.3	MATERIALS	33
8.4	SAND PREPARATION	33
8.5	LOAD PREPARATION	34
8.6	PROCEDURE	34
8.7	REMOVAL OF SAND FROM CLOTHES	35
8.8	COMPLETING TESTS	35
8.9	DATA ANALYSIS	36
9	RINSING EFFECTIVENESS TEST	38
9.1	PURPOSE AND OVERVIEW	38
9.2	EQUIPMENT	38
9.3	MATERIALS	39
9.4	LAS CONCENTRATION CURVE	39
9.5	PROCEDURES – GENERAL	46
9.6	ACQUIRING SAMPLES	47
9.7	UV ABSORBENCY MEASUREMENTS	49
9.8	CALCULATIONS	51
10	WATER RETENTION TEST	53
10.1	PURPOSE	53
10.2	EQUIPMENT	53
10.3	MATERIALS	53
10.4	PREPARATION	53
10.5	PROCEDURE	54
10.6	DATA ANALYSIS	54
11	TANGLE-FREE ACTION TEST	57
11.1	PURPOSE	57
11.2	EQUIPMENT	57
11.3	MATERIALS	57
11.4	PROCEDURE	57
11.5	DATA ANALYSIS FOR TANGLE TEST	59
12	DATA ANALYSIS (GENERAL)	61
12.1	DEFINITIONS	61
12.2	CALCULATION FORMULA	61
13	SAFETY	62
ANNEX A.	(NORMATIVE) TEST MATERIALS AND TEST EQUIPMENT	63
A.1	BASE LOAD.	63
A.2	AHAM STUFFER LOAD	63
A.3	ENERGY CLOTH	63
A.4	SHIRTS FOR SECTION 11, TANGLE FREE ACTION TEST	63
A.5	THE AHAM STANDARD DETERGENT (FORMULA 3)	63
A.6	SOIL/STAIN REMOVAL TEST STRIPS	64
A.7	PERFORMANCE REQUIREMENTS FOR DETERGENT AND SOIL/STAIN STRIPS.	65
A.8	MECHANICAL ACTION TEST SWATCHES	66
A.9	SAND FOR SAND REMOVAL TEST.	67
A.10	TRISTIMULUS COLORIMETER/SPECTROCOLORIMETER.	67

A.11	TEST EQUIPMENT FOR SECTION 9, RINSING EFFECTIVENESS	68
A.12	TEST MATERIALS FOR SECTION 9, RINSING EFFECTIVENESS	68
ANNEX B.	(INFORMATIVE) SOURCES OF MATERIALS AND TEST EQUIPMENT	70
ANNEX C.	(INFORMATIVE) MAINTENANCE OF AGE PROFILES IN BASE LOADS.....	71
C.1	BUILDING UP LOADS	71
C.2	LOAD MAINTENANCE.....	71
ANNEX D.	(NORMATIVE) TANGLE TABLES	74
ANNEX E.	(INFORMATIVE) QUARTZ CUVETTE AND GLASSWARE CLEANING AND HANDLING FOR RINSING EFFECTIVENESS TEST	79
E.1	PURPOSE	79
E.2	CUVETTES	79
E.3	GENERAL CLEANING	79
E.4	PERIODIC GLASS CLEANING	79
ANNEX F.	(INFORMATIVE) CHECKING UV SPECTROPHOTOMETER CALIBRATION.....	81
F.1	PURPOSE	81
F.2	WAVELENGTH CALIBRATION	81
F.3	STRAY LIGHT	81
F.4	PHOTOMETRIC ACCURACY	81
F.5	INSTRUMENT SELF CHECK	81
ANNEX G.	RINSING EFFECTIVENESS SAMPLE DATA AND CALCULATION	82

1. PURPOSE

The purpose of this standard is to establish a uniform, repeatable procedure for evaluating the performance of household clothes washers.

This standard provides technical means to compare and evaluate the performance of different brands and models of household clothes washers.

This standard is not intended to inhibit improvement and innovation in product testing, design or performance.

2. SCOPE

This standard applies to automatic household clothes washers and combination washer-dryer equipment. With respect to combination washer-dryer equipment, this standard covers the washing function only.

This standard includes definitions and test methods for evaluating the performance of various cycles of household clothes washers.

3. DEFINITIONS

- 3.1 Base Load:** The textile load without any additional test strips, test pieces or test materials.
- 3.2 Bone Dry:** A condition of a load that has been dried in an automatic clothes dryer or equivalent set at the maximum temperature for a minimum of 10 minutes, removed and weighed before cool-down, and then dried for additional 10 minute periods until the final weight change of the load is 1% or less.
- 3.3 Conditioning Cycle:** The cycle used to prepare a washer for test.
- 3.4 Cycle:** A complete washing process consisting of a series of different operations (wash, rinse, spin, etc.).
- 3.5 Horizontal Axis (HA) Washing Machine:** A washing machine in which textiles are placed in a horizontal or inclined ($< 45^\circ$ from horizontal axis) drum where the spin extraction means is by rotation of the drum about its axis and the mechanical washing action being produced by rotation of the drum about its axis, the movement being either continuous or periodically reversed.
- 3.6 Normalization:** The process of removing residual detergent or other chemicals from the base load.
- 3.7 Pre-treatment:** The washing of new base load items prior to use.
- 3.8 Replication:** A repeat run of a test. For example, when three duplicate runs are required, each run is referred to as a replication.
- 3.9 Stuffer Load:** In procedures for evaluating washer performance, material used to bring the total weight of textiles to a specified amount (or weight).
- 3.10 Test Load:** The base load plus soil test strips, test pieces and/or test materials.
- 3.11 Vertical Axis (VA) Washing Machine:** A washing machine in which textiles are placed in a vertical or inclined ($>45^\circ$ from vertical axis) drum where the spin extraction means is by rotation of the drum about its axis and the mechanical

washing action being produced either by rotation of the drum about its axis (the movement being either continuous or periodically reversed) or by other devices contained within the drum and moves relative to the drum.

4. GENERAL TEST CONDITIONS

4.1 Equipment. For user convenience, the specific equipment required for any given test is listed in the Section covering that test.

Additionally, it is recommended that the pretreatment and normalization of the loads be carried out in a separate clothes washer specifically retained for that purpose.

4.2 Base Loads

4.2.1 The base load is designed to simulate consumer loads using test pieces that are reproducible and facilitate test repeatability.

4.2.2 The base load shall consist of items that simulate bed sheets, pillowcases and towels as specified in Annex A.A.1. Provision is made to test with various load sizes, and the number of items for various nominal test load weights is given in Table 2 (Section 5).

4.2.3 The stated load weight shall be the weight of the base load. The weight of added test strips and/or swatches is ignored.

4.2.4 All load sizes given in pounds (lbs.) in this standard are 'bone dry' weights (refer to 4.4.3 for description of the bone dry procedure.)

4.2.5 Load Size conversion between IEC and AHAM

- 1 kg_{IEC} test load is approximately 975 grams IEC Base Load (the stain strip is approximately 25 grams and there is 1 per kg).
- 975 grams IEC base load are approximately 907 grams bone dry (estimating the difference between climate control conditions and bone dry to be approximately 7%).
- 907 g base load bone dry are equal to 1.999 lbs (with 1 lbs being equal to 453.59237 g).
- Therefore: 1 kg_{IEC} test load translates almost exactly to 2 lbs AHAM Load.

To facilitate the usage of this standard for users of the IEC standard 60456, this standard also mentions the IEC test load mass in kg_{IEC} corresponding to the AHAM base load mass in lbs.

4.2.6 The procedure for making up a test load is as follows:

4.2.6.1 The base load is assembled using the exact number of items specified in Table 2 for the weight desired.

4.2.6.2 The assembled base load is weighed. If the measured weight differs from the nominal weight by more than 0.12 lb (50 g), final adjustment of the base load weight is made by adding or removing towels as necessary.

4.2.7 **Usage.** No item shall be used for more than 84 test cycles, not counting pre-treatment and normalization cycles.

To minimize the influence of aging of the textiles, the cotton base load shall consist of sheets, pillowcases and towels of mixed age. The weighted average age of the load should be between 29 and 51 test cycles. Examples of how to create and maintain a mixed age load, and how the average age of a load may be estimated, are given in Annex C.

4.3 AHAM Stuffer Load

An AHAM stuffer shall comply with the specification given in Annex A.A.2: No stuffer shall be used for more than 25 test cycles, excluding the extra rinse and preconditioning cycles.

4.4 Test Load Preparation and Maintenance

4.4.1 **Pre-Treatment.** New textile items shall be treated before their first use. Follow the parameters in Table 1.

4.4.2 **Normalization.** Before first use in any series of tests, and subsequently after every three cycles, the base load shall be normalized. Follow the parameters in Table 1.

Table 1

	Pre-Treatment for New Textiles	Normalization for Base Load
Cycle	The cycle recommended by the manufacturer for washing cotton or linen clothes.	The cycle recommended by the manufacturer for washing cotton or linen clothes.
Wash Temperature	Hot water	Hot water
Rinse Temperature	Cold water	Cold water
Detergent	AHAM Standard Detergent (Formula 3) 27 g + 4.0 g per pound of base load	None
Number of Cycles	5	2
Drying	Only after the fifth cycle	Bone dry

4.4.3 **Drying Procedure.** To obtain consistency in determining load sizes, the base load should be dried to “bone dry” weight by the following procedure:

If load* is damp following removal from a clothes washer or if load has been removed from storage and is nominally dry, place it in an automatic clothes dryer or equivalent set at the maximum temperature and dry for 10 to 40 minutes depending upon the load size. Remove before cool down and weigh immediately. Continue drying for ten minute periods until the final weight change between each weighing is 1% or less.

**Note: If necessary the base load may be divided into not more than two similar portions.*

4.5 Water

4.5.1 **Temperature.** Water supply temperatures as measured at the point of the hose connection at the clothes washer are to be as follows unless otherwise noted.

4.5.1.1 Hot = $130 \pm 2^{\circ}\text{F}$ ($54 \pm 1^{\circ}\text{C}$).

4.5.1.2 Cold = $60 \pm 5^{\circ}\text{F}$ ($16 \pm 3^{\circ}\text{C}$).

4.5.2 **Pressure.** The static water pressure at the hot and cold water inlet connections of the clothes washer shall be maintained at $35 (\pm 2.5)$ psig. $\{241.3 (\pm 17.2)$ kPa $\}$ during the test. The static water pressure for a single water inlet connection shall be maintained at $35 (\pm 2.5)$ psig. $\{241.3 (\pm 17.2)$ kPa $\}$ during the test.

4.5.3 **Hardness.** Water hardness is to be 0-3 grains/gal (50 parts per million of CaCO_3 or less).

4.6 **Electricity Supply.** The supply voltage shall be maintained at the rated voltage $\pm 2\%$ throughout the test. If a voltage range is indicated, then the supply voltage shall be the nominal voltage of the country in which the clothes washer is intended to be used.

The supply frequency shall be maintained at the rated frequency $\pm 1\%$ 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.

4.7 Standard Test Detergent (Formula 3).

4.7.1 The detergent used in all tests shall be AHAM Standard Test Detergent (Formula 3) as specified in Annex A.A.5.

4.7.2 **Concentration.** The detergent quantity (unless otherwise specified) shall be 27 g plus 4.0 g per pound (0.454 kg) of base load.

4.7.3 **Storage.** The detergent shall be stored in accordance with the manufacturer's instructions. It shall not be used beyond the expiration date. If no expiration date for the detergent is specified by the manufacturer, the expiration date is deemed to be one year from the date of manufacture.

4.8 Conditioning Cycle. Normalize the load twice after every three test runs using the normal cycle of a vertical-axis washer with “deep” wash and rinse fills.

The normalization washer should provide a minimum ratio of 2.5 gallons of water per pound of load in both the wash and rinse cycles. It is acceptable to divide the load to achieve this requirement. For example, use 20 gallons of water for an 8 lb. load or 10 gallons of water for a 4 lb. load.

If the load has been subjected to a condition that would result in a high level of residual detergent, then a third normalization is recommended.

4.9 Technical Considerations. It is recommended that a minimum of 3 units be tested to account for washer to washer variation. Statistical methods should be utilized to determine the number of test units and test runs to definitively compare performance of different washers or test cycles.

Conditions in the wash load can change perceptibly if there is any interruption to the test sequence. To enhance repeatability of results, once a run is started all operations should be performed sequentially with minimum delay.

In addition to testing clothes washers for various load sizes, other parameters such as water hardness, wash and rinse water temperatures, wash times and speeds, may be varied to determine their effects.

Do not compare clothes washers tested under unlike conditions unless differences are clearly stated. Comparison of test results is not valid unless identical conditions are used or variations carefully noted.

This test procedure is for clothes washer performance evaluation only. Do not use it to compare detergents and other laundry products. Other tests are designed for these purposes.

5. FOLDING AND LOADING THE TEST LOAD

5.1 General. This procedure sets out the method for folding of the test load and loading it into the test washing machine and the reference machine. The procedure has been adopted from the IEC 60456 FDIS document. Experience has shown that the way that a washing machine is loaded can influence the results obtained, especially with respect to washing performance. To achieve reproducible results it is therefore necessary to specify both the loading sequence and the position and placement of all load items in the test washing machine and the reference machine for all performance tests.

5.2 Folding the items prior to loading the washing machine: This section sets out the folding of load items before they are placed into the washing machine as specified in 5.3. This procedure is specified for the AHAM Cotton Load.

5.2.1 Cotton load

Towels with a stain test strip attached: Towels with a stain test strip attached shall be folded in accordance with Figure 1.

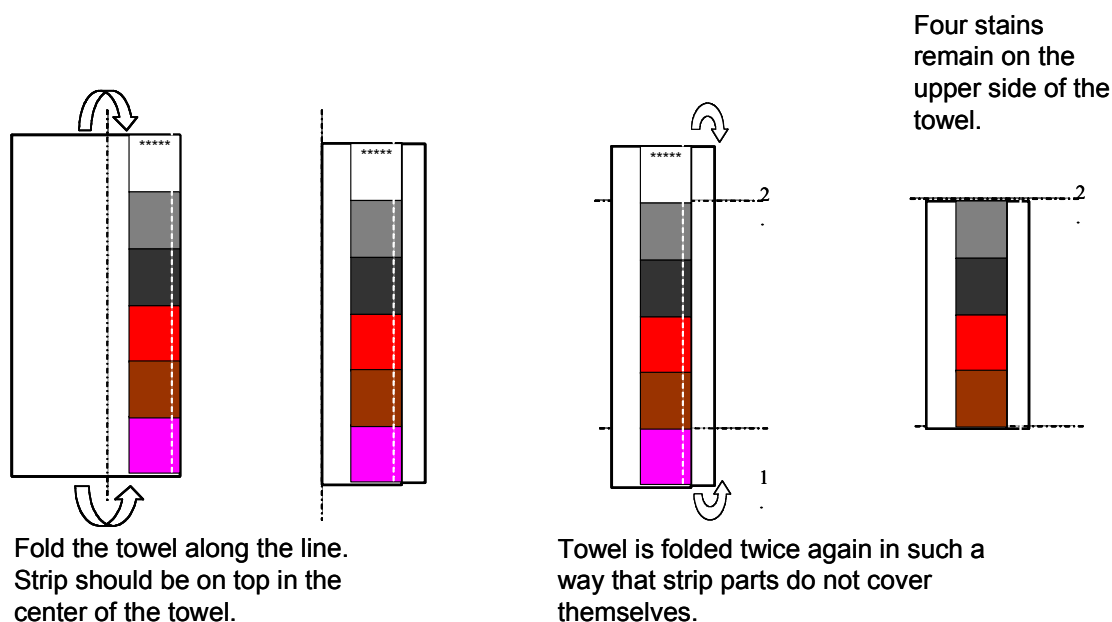
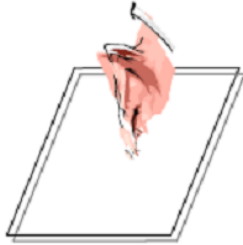


Figure 1 – Folding towel with a stain test strip attached

- 5.2.1 **Towel without a stain test strip:** Towels without a stain test strip attached shall be folded in accordance with Figure 2.

Grasp the towel in the center.



Shake the towel so that it hangs loosely.



Figure 2 – Folding towel without a stain test strip attached

- 5.2.2 **Pillowcase:** Pillowcases shall be folded in accordance with Figure 3.

Grasp the pillowcase in the center.



Shake the pillowcase so that it hangs loosely.



Figure 3 – Folding pillowcases

- 5.2.3 **Bed sheets:** Bed sheets shall be folded into thirds to form letter “Z” in accordance with Figure 4.

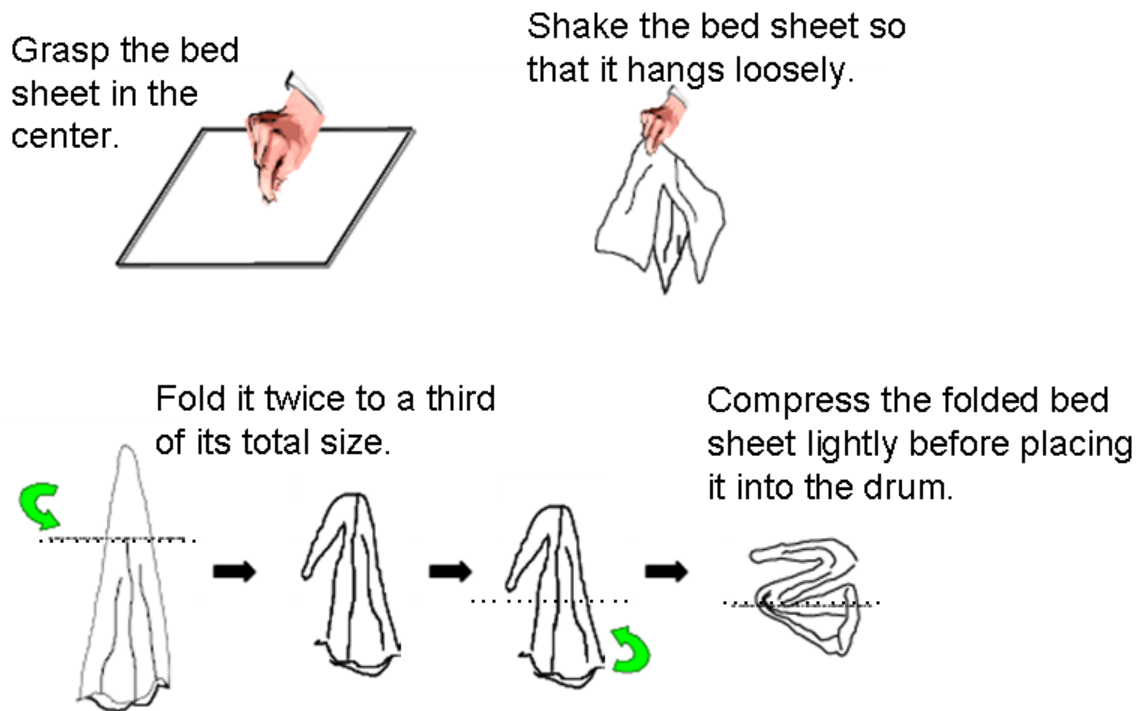


Figure 4 – Folding bed sheets

- 5.3 **Loading Items into the washing machine – general rules:** This section sets the placement of load items into the washing machine.

- 5.3.1 **Machine type:** For the purposes of loading, all washing machines shall be classified as either horizontal axis washing machine or vertical axis washing machines as specified below.

- 5.3.1.1 **Horizontal axis washing machines:** In a horizontal axis washing machine the load is placed in a drum which rotates around an axis which is usually horizontal or close to horizontal (see definition). This is illustrated in Figure 5. In most cases, the drum rotates around this axis for washing and spinning operations.

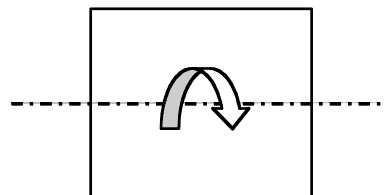


Figure 5 – Illustration of horizontal axis washing machine

5.3.1.2 Vertical axis washing machines: In a vertical axis washing machine the load is placed in a drum which rotates around an axis which is usually vertical or close to vertical (see definition). This is illustrated in Figure 6. In cases where the drum does not rotate for any operation (i.e. no spinning function available and no rotation during washing) then the washing machine is classified as a vertical axis washing machine.

Components, protrusions or mechanical devices of different style (e.g. agitator, impeller) inside the drum in a **vertical axis washing machine** may cause slight variations in the loading scheme described. These variations are covered in the loading sequence for **vertical axis washing machines**.

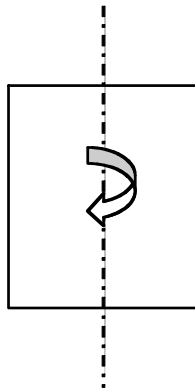


Figure 6 – Illustration of vertical axis washing machine

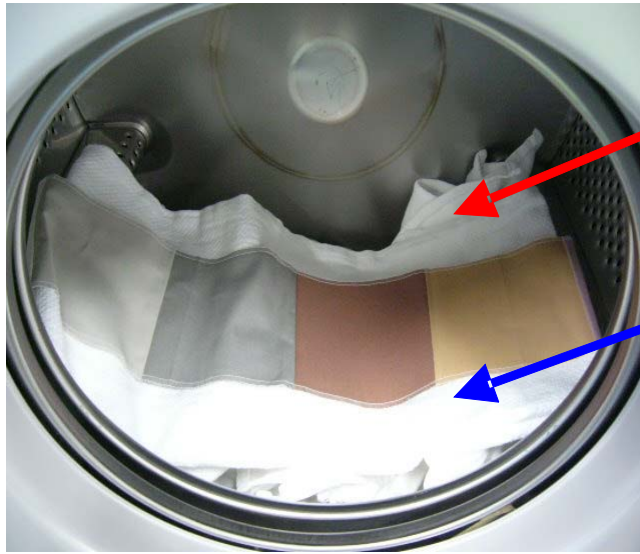
5.3.2 Loading sequences

5.3.2.1 General rules: Washing machines are always loaded item by item in layers from bottom to top. Excessive force should not be used. All items shall be placed into the drum in the orientation described below.

5.3.2.2 Items with attached strip: Load items which have stain test strips attached (e.g. towel for cotton load) are always laid flat in the washing machine with the 4 soils of the stain test strip facing upwards. Load items with stain test strips attached should not be placed on top of each other.

5.3.2.2.1 Loading for horizontal axis washing machines: Horizontal axis washing machine shall be loaded as described in this section.

The folded towel with the stain test strip is placed in the drum with the Sebum/Carbon Black/Blood/Cocoa stains facing upwards and the folded side of the towel facing to the front of the **washing machine** drum as illustrated in Figure 7.



Open side of the folded towel towards the back of the drum.

Folded side of the towel towards the front opening of the drum.

Figure 7 – Horizontal axis washing machine: placement of items in the drum

5.3.2.2.2 Loading for vertical axis washing machines: Vertical axis washing machine shall be loaded as described in this section.

The folded towel is placed in the drum with the Sebum / Carbon Black / Blood / Cocoa stains facing upwards and the folded side of the towel facing the drum wall as illustrated in Figure 8.

Folded side of the towel towards the wall of the drum.

Open side of the folded towel towards the center of the drum.



Figure 8 – Vertical axis washing machine: placement of items in the drum

5.3.2.3 **Cotton loads:** Follow the loading sequence step by step as given in section 5.4 for horizontal axis washing machines and in section 5.5 for vertical axis washing machines. The load items defined for each step are evenly distributed in a single level of the drum for horizontal axis washing machine (looking in from the front) or one quarter of the drum for a vertical axis washing machine (looking down in plain view).

5.4 Loading requirements – horizontal axis washing machines

5.4.1 **General loading directions:** A horizontal axis washing machines is loaded in steps from bottom to top. The sequence step by step is given in Table 2.

Each step consists of either:

one sheet

one towel with attached strip

one or several towels without strip

one or several pillowcases

If there are several items they shall be placed with alternating orientation as illustrated in Figure 9.

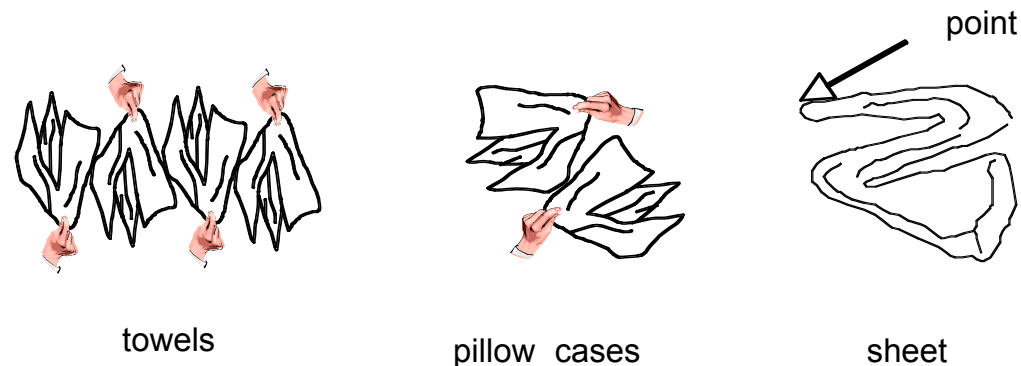


Figure 9– Horizontal axis washing machine: illustration of alternating orientation

Towels are placed into the drum from back to front parallel to the drum axis. If two or more towels are called for at the same time, they are to be laid alternately in opposite directions on the same level, side by side.

Pillowcases are placed side to side across the drum axis. If two pillowcases are required, they are laid in opposite directions on the same level.

Sheets are placed as a lying “Z” perpendicular to the **washing machine** axis with the point to the left.

Section 5.4.4 provides an example and pictures for one sequence (5 kg /10 lbs).

5.4.2 Horizontal axis washing machine: loading step by step

The sequence shall be from the bottom to top of the drum as set out in Table 2. Step 1 starts at the bottom of the drum, step 27 is at the top of the drum. An example is set out in section 5.4.4.

NOTE 1 For the example in section 5.4.4 the Table has been transposed relative to Table 2.

Horizontal Axis Loading Item Summarywith 5 Hole Swatches																			
AHAM lbs	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
IEC kg conversion (Bone Dry + 7%)	10.0	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
Towels	28	28	23	25	25	21	23	23	23	18	18	14	14	9	5	11	9	7	4
Pillowcases	16	14	14	14	12	12	12	10	8	8	6	6	4	4	4	5	4	3	2
Sheets	4	4	4	3	3	3	2	2	2	2	2	2	2	2	2	0	0	0	0
Strips	10	10	9	9	8	8	7	7	6	6	5	5	4	4	3	3	2	2	2
Five hole MA	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3	3

Table 2 – Horizontal Axis Washing Machine Loading Summary Chart

Horizontal Axis Washing Machine Loading Chart

		AHAM Loads in Pounds																		
Step	Garments / Test Strips	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1	pillowcase	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1
1a	five hole MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	towels adjust number here	4	4	4	4	4	4	4	4	4	3	3	2	3	2	1	2	2	2	1
3	towel + strip	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	pillowcase	2	2	2	2	2	2	2	1	1	1									
5	towel + strip	1	1	1	1	1	1	1	1	1	1									
6	sheet	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
7	towel + strip	1	1	1	1	1	1								1					
8	pillowcase	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
8a	five hole MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
9	towel + strip							1	1	1	1	1	1	1						
10	towels adjust number here	3	3	2	3	3	2	3	3	3	2	2	2	2	1		1	1		
11	towel + strip	1	1	1	1	1	1													
12	sheet	1	1	1	1	1	1													
13	towel + strip	1	1																	
14	pillowcase	2	1	1	1	1	1	1	1	1	1	1	1				1			
15	towel + strip			1	1			1	1			1	1			1	1			
16	towels adjust number here	4	4	2	2	3	1	2	2	3	2	3	1				2	1	1	
17	pillowcase	2	1	1	1	1	1	1	1	1	1	1	1							
18	towel + strip	1	1																	
19	sheet	1	1	1																
20	towel + strip	1	1	1	1	1	1													
21	towels adjust number here	3	3	2	3	3	2	3	3	3	2	2	2	2			1	1		
22	towel + strip							1	1	1	1	1	1	1						
23a	five hole MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
23	pillowcase	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1		
24	towel + strip	1	1	1	1	1	1								1					
25	sheet	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
26	towel + strip	1	1	1	1	1	1	1	1	1	1									
27	pillowcase	2	2	2	2	2	2	2	1	1	1									
28	towel + strip	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
29	towels adjust number here	4	4	4	4	4	4	4	4	4	3	3	2	3	2	1	2	2	2	1
30a	five hole MA	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
30	pillowcase	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1

5.4.3 Loading for load sizes above 10 kg (20 lbs)

Additional items for test loads heavier than 10 kg (20 lbs) are added to the following steps: Sheets need to be added between two steps:

- Sheet no. 5 between step 14 / 15
- Sheet no. 6 between step 16 / 17
- Sheet no. 7 between step 8 / 9
- Sheet no. 8 between step 22 / 23

Pillowcases are added to all steps one by one as needed in the order from the outer to the inner layers: step 1 – 30 – 4 – 27 – 8 – 23 – 14 – 17.

Towels are added to the steps marked for adjustment one by one as needed in the order from inner to outer layers: step 16 – 10 – 21 – 2 – 29.

Towels with strips attached needs to be distributed evenly. For **horizontal axis washing machines** holding more than 10 kg (20 lbs) it is expected that the drum is deep enough to have two towels with attached strip placed in one step next to each other as shown below in Figure 10.

Towels with strips are added to all steps one by one as needed in the order from the inner to the outer layers: step 13 – 18 – 11 – 20 – 9 – 22 – 7 – 24 – 5 – 26 – 3 – 28.

Towels with strips are only placed in step 15 when there are an odd number of towels with test strips.

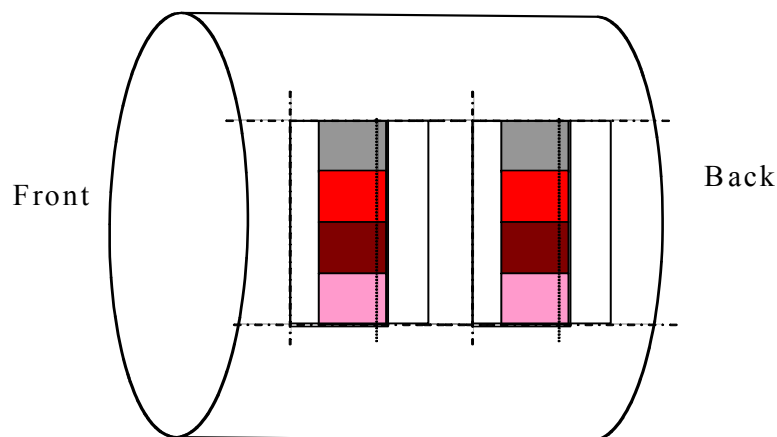


Figure 10 – Placement of 2 towels with strips in one layer for load sizes larger than 10 kg (20 lbs)

5.4.4 Example

Table 3 illustrates how to place a 4 kg (8 lbs) load into a **horizontal axis washing machine** from bottom to the top.

Table 3 – Horizontal axis washing machine washing machine, loading example (4 kg (8 lbs))

Table 3 Horizontal axis washing machine - loading example (8 lb)				
step (example only)	group.step (related to table 5.1)	item	picture	number of items
18	30	Pillowcases		1
17	30a	5 hole MA		1
16	29	Towels		3*
15	28	Towels + strip		1
14	25	Sheets		1
13	23	Pillowcases		1
12	23a	5 hole MA		1
11	22	Towels + strip		1
10	21	Towels		2*
9	10	Towels		2*
8	9	Towels + strip		1
7	8a	5 hole MA		1
6	8	Pillowcases		1
5	6	Sheets		1
4	3	Towels + strip		1
3	2	Towels		3*
2	1a	5 hole MA		1
1	1	Pillowcases		1

* adjust number of towels here

5.5 Loading requirements – Vertical axis washing machines

5.5.1 General loading directions

Vertical axis washing machines are loaded in groups from bottom to top. The sequence step by step is given in Tables 4 to 7.

The wash load is divided into five groups and placed as set out in Tables 4, 5, 6 and 7 (as applicable). The purpose of groups 1 to 4 is to ensure that the total load is in balance in a **vertical axis washing machine**. Thus as far as possible every item in each group has an equivalent item in the opposite quadrant of the drum in another group, although not at the same level in the drum. There are some exceptions to this principle due to the need to remain within the specified load weights.

Group 5 is composed of additional items to make up to the required weight and to allow for adjustment thereof.

The items are placed evenly around the axis using the 4 quadrants as shown in Figure 11. The first item of group 1 is placed in the front quadrant with other items placed in a clockwise order around the drum according to the order given in the tables. The first item of group 2 is placed in the left quadrant with remaining items placed in succession. The first item of group 3 is placed in the back quadrant and so on.

Each towel with an attached soil/stain test strip is always placed on the top of the item loaded in the preceding step.

In principle, the soil/stain test strips and mechanical action swatches are distributed evenly across the depth of the load (between layers) and distributed evenly within each group (around the circumference in the system).

The loading scheme depends on the number of sheets as follows:

Four sheets: One goes into each quadrant

Three sheets: First goes to the front, second to left-back area, third to back-right area

Two sheets: One to the right quadrant, one to the left quadrant.

In general there are four main groups, each starting in another quadrant.

The number of steps for each is no more than six but depends on load size. For smaller loads are fewer steps required.

For a **vertical axis washing machine** without a central agitator, items maybe spread to utilize the volume in the center of the basket.

If there are several items they shall be placed with alternating orientation.

Towels are placed into the drum around the drum axis. If two or more towels are called for at the same time, they are to be laid in opposite directions alongside each other in the same quadrant.

Pillowcases are placed side to side across the drum axis. If two pillowcases are called for, they are to be laid in opposite directions alongside each other in the same quadrant.

Sheets are placed in the designated quadrant with point towards clockwise direction viewed from above.

For more details see the pictures and one sequence (5 kg (10 lbs)) in section 5.5.3.

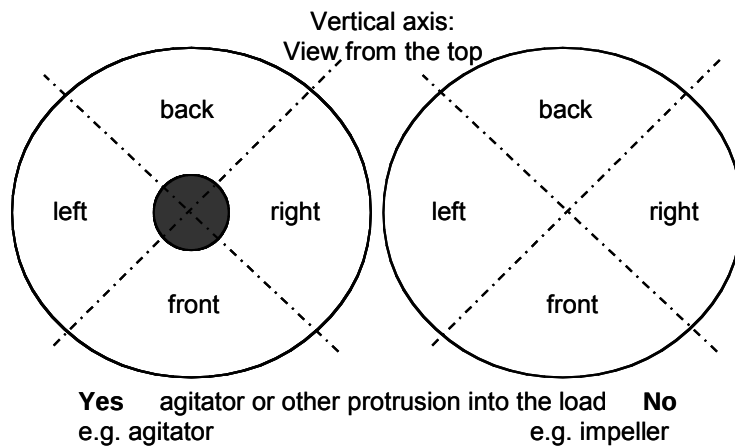


Figure 11 – Vertical axis washing machines, four quadrants (plan view)

5.5.1 Vertical axis washing machine: loading step by step

The sequence shall be from bottom to top of the drum as set out in Table 4. Group 1 is loaded first and other items go from the bottom of the drum; group 5 is the last group of items and these are placed on top.

Table 4 – Vertical axis washing machines, small loads without sheets (1,0 to 2,5 kg (2 to 5 lbs))

Step	Group	Garments / Test Strips	AHAM Loads in Pounds				Quadrant
			5	4	3	2	
1	1	Pillowcases	1	1	1	1	front
1a		5 hole MA	1	1	1	1	front
2		Towels	1	1	1	1	left
3		Towel+strip	1	1	1	1	left
4		Pillowcases					back
5		Towel+strip					back
6		Sheets					
1	2	Pillowcases	1	1			left
1a		5 hole MA	1	1			left
2		Towels	1	1			back
3		Towel+strip					back
4		Pillowcases					right
5		Towel+strip					right
6		Sheets					
1	3	Pillowcases	1	1	1	1	back
1a		5 hole MA	1	1	1	1	back
2		Towels	1	1	1	1	right
3		Towel+strip	1	1	1	1	right
4		Pillowcases					front
5		Towel+strip					front
6		Sheets					
1	4	Pillowcases	1	1			right
1a		5 hole MA	1	1			right
2		Towels	1	1			front
3		Towel+strip					front
4		Pillowcases					left
5		Towel+strip					left
6		Sheets					
1	5 add on	Pillowcases	1		1		left
1a		5 hole MA			1	1	left
2		Towels	1				front
3		Towel+strip					front
4		Pillowcases					right
5		Towel+strip	1				back
6		Towels adjust number here	3	3	3	0	spread on top

Table 5– Vertical axis washing machines, medium loads with two sheets (3,0 to 7,0 kg (6 to 14 lbs))

			AHAM Loads in Pounds									
Step	Group	Garments / Test Strips	14	13	12	11	10	9	8	7	6	Quadrant
1	1	Pillowcases	2	2	1	1	1	1	1	1	1	front
1a		5 hole MA	1	1	1	1	1	1	1	1	1	front
2		Towels	2	2	2	2	2	2	2	1	1	left
3		Towel+strip	1	1	1	1	1	1	1	1	1	left
4		Pillowcases	1	1	1	1	1	1				back
5		Towel+strip	1	1	1	1	1	1				back
6		Sheets	1	1	1	1	1	1	1	1	1	right
1	2	Pillowcases	2	1	1	1	1	1	1	1	1	left
1a		5 hole MA	1	1	1	1	1	1	1	1	1	left
2		Towels	2	2	2	2	2	2	2	1		back
3		Towel+strip	1	1	1	1	1	1	1	1		back
4		Pillowcases	1	1	1	1						right
5		Towel+strip	1	1								right
6		Sheets										
1	3	Pillowcases	2	2	1	1	1	1	1	1	1	back
1a		5 hole MA	1	1	1	1	1	1	1	1	1	back
2		Towels	2	2	2	2	2	2	2	1		right
3		Towel+strip	1	1	1	1	1	1	1	1	1	right
4		Pillowcases	1	1	1	1	1	1				front
5		Towel+strip	1	1	1	1						front
6		Sheets	1	1	1	1	1	1	1	1	1	left
1	4	Pillowcases	2	1	1	1	1	1	1	1	1	right
1a		5 hole MA	1	1	1	1	1	1	1	1	1	right
2		Towels	2	2	2	2	2	2	2	1		front
3		Towel+strip	1	1	1	1	1	1	1	1		front
4		Pillowcases	1	1	1	1						left
5		Towel+strip										
6		Sheets										
1	5 add on	Pillowcases										left
2		Towels										front
3		Towel+strip										front
4		Pillowcases										right
5		Towel+strip									1	back
6		Towels adjust number here	8	8	9	4	5	1	2	1	1	spread on top

Table 6 – Vertical axis washing machines, large loads with three sheets (7,5 to 8,5 kg (15 to 17 lbs))

Step	Group	Garments / Test Strips	AHAM Loads in Pounds			Quadrant
			17	16	15	
1	1	Pillowcases	2	2	2	front
1a		5 hole MA	1	1	1	front
2		Towels	2	2	2	left
3		Towel+strip	1	1	1	left
4		Pillowcases	1	1	1	back
5		Towel+strip	1	1	1	back
6	2	Sheets	1	1	1	right
1		Pillowcases	2	2	2	left
		5 hole MA	1	1	1	left
2		Towels	2	2	2	back
3		Towel+strip	1	1	1	back
4		Pillowcases	1	1	1	right
5		Towel+strip	1	1	1	right
6	3	Sheets	1	1	1	front-left
1		Pillowcases	2	2	2	back
		5 hole MA	1	1	1	back
2		Towels	2	2	2	right
3		Towel+strip	1	1	1	right
4		Pillowcases	1	1	1	front
5	4	Towel+strip	1	1	1	front
6		Sheets	1	1	1	left-back
1		Pillowcases	2	2	2	right
		5 hole MA	1	1	1	right
2		Towels	2	2	2	front
3		Towel+strip	1	1	1	front
4	5 add on	Pillowcases	1	1	1	left
5		Towel+strip	1	1	1	left
6		Sheets				
1		Pillowcases	1			left
2		Towels	2			front
3		Towel+strip	1			front
4	5 add on	Pillowcases	1			right
5		Towel+strip				back
6		Towels adjust number here	6	9	5	spread on top

Table 7 – Vertical axis washing machines, very large loads with four sheets (9,0 to 10,0 kg (18 to 20 lbs))

Step	Group	Garments / Test Strips	AHAM Loads in Pounds			Quadrant
			20	19	18	
1	1	Pillowcases	2	2	2	front
1a		5 hole MA	1	1	1	front
2		Towels	3	3	3	left
3		Towel+strip	1	1	1	left
4		Pillowcases	1	1	1	back
5		Towel+strip	1	1	1	back
6		Sheets	1	1	1	right
1	2	Pillowcases	2	2	2	left
1a		5 hole MA	1	1	1	left
2		Towels	3	3	3	back
3		Towel+strip	1	1	1	back
4		Pillowcases	1	1	1	right
5		Towel+strip	1	1	1	right
6		Sheets	1	1	1	front
1	3	Pillowcases	2	2	2	back
1a		5 hole MA	1	1	1	back
2		Towels	3	3	3	right
3		Towel+strip	1	1	1	right
4		Pillowcases	1	1	1	front
5		Towel+strip	1	1	1	front
6		Sheets	1	1	1	left
1	4	Pillowcases	2	2	2	right
1a		5 hole MA	1	1	1	right
2		Towels	3	3	3	front
3		Towel+strip	1	1	1	front
4		Pillowcases	1	1	1	left
5		Towel+strip	1	1	1	left
6		Sheets	1	1	1	back
1	5 add on	Pillowcases	2	1	1	left
2		Towels	3	3	1	front
3		Towel+strip	1	1	1	front
4		Pillowcases	2	1	1	right
5		Towel+strip	1	1		back
6		Towels adjust number here	3	3	1	spread on top

5.5.2 Vertical axis washing machine: load sizes above 10 kg (20 lbs)

Additional items for loads heavier than 10 kg (20 lbs) are added on top.

The sequence of the five groups is repeated.

5.5.3 Example

Table 8 illustrates how to place a 4 kg (8 lbs) load into a **vertical axis washing machine**.

Table 8 – Vertical axis washing machine – loading example (4 kg (8 lbs))

Table 8 Vertical axis washing machine - loading example (8 lb)						
step (example only)	group.step (related to table 5.4)	placement	quadrant	item	picture	number of items
19	5.6	on top		Towels		2*
18	4.3	front		Towels + strip		1
17	4.2	front		Towels		2
16	4.1a	right		5 hole MA		1
15	4.1	right		Pillowcases		1
14	3.6	left		Sheets		1
13	3.3	right		Towels + strip		1
12	3.2	right		Towels		2
11	3.1a	back		5 hole MA		1
10	3.1	back		Pillowcases		1
9	2.3	back		Towels + strip		1
8	2.2	back		Towels		2
7	2.1a	left		5 hole MA		1
6	2.1	left		Pillowcases		1
5	1.6	right		Sheets		1
4	1.3	left		Towels + strip		1
3	1.2	left		Towels		2
2	1.1a	front		5 hole MA		1
1	1.1	front		Pillowcases		1

6 SOIL/STAIN REMOVAL TEST

6.1 Purpose. To evaluate the performance of household clothes washers in removing representative soils and stains from fabric.

This procedure and the materials used in it are intended to demonstrate the cleaning effect of clothes washers under the conditions specified. They are not appropriate for other purposes such as comparing detergents.

NOTE: While the methods herein have been designed to minimize variation, it is advisable that comparative data be obtained using a single lot of stain strips.

6.2 Equipment

- a) Tristimulus Colorimeter/Spectrocolorimeter (see Annex A.A.10).
- b) Fabric drying equipment (automatic clothes dryer or equivalent).
- c) Sewing machine or stapling equipment for attaching test strips to load items.
- d) Weighing equipment, 0 to 250 gram range, accuracy $\pm 0.1\%$ of reading.
- e) Weighing equipment, calibrated in pounds, range to suit maximum intended test load weight, accuracy $\pm 0.1\%$ of reading.
- f) Equipment for monitoring water supply temperatures at machine inlet (see Section 4.5.1) and electrical supply voltage, and for confirming that the hardness of the water is within specification (see Section 4.5.3).
- g) Means for measuring bath temperature (optional)
- h) Means for recording elapsed time (optional)
- i) Means for confirming that machine is level (optional)

6.3 Materials

- a) Standard base load items as defined in Section 4.2.
- b) AHAM Soil/Stain test strips as specified in Annex A.A.6.

Note: It is strongly recommended that all strips used in a series of tests be from the same lot as produced by the manufacturer.

- c) AHAM Standard Detergent (Formula 3) as defined in Section 4.7.

6.4 Calibration of Soil/Stain Test Strips. For each soil/stain in each lot of test strips the supplier will have provided calibration data as follows:

- a) The pre-wash reflectance as determined by the supplier's laboratory.
- b) The post-wash reflectance, for the maximum reference washer treatment, as defined in Annex A.A.7.1, Treatment a).
- c) The post-wash reflectance, for the reference treatment, as defined in Annex A.A.7.1, Treatment b).