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BSH Home Appliances Group

EEDAL'24 Session 2 Circular Economy

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Measuring the reliability of washing machines - leveraging the untapped potentials of embodied energy to further improve energy efficiency beyond direct energy use

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Jens Giegerich, Vorwerk, Germany | **Christian Dworak, BSH Hausgeräte, Germany**
Rainer, Stamminger, University of Bonn, Germany

1 Scope & 2 Normative references

- The method is based on EN 45552 (General method for the assessment of the durability of energy-related products) and takes into account EN 45554 (General methods for the assessment of the ability to repair, reuse and upgrade energy-related products).

- This document is not intended to be used to assess the reliability of:
  - Washing machines, intended for commercial or industrial use;
  - Washer-dryers.

- EN 45552:2020, General method for the assessment of the durability of energy-related products

- EN 60456:2023, Clothes washing machines for household use - Methods for measuring the performance

3 Terms and definitions

3.1
durability < of a part or a product >
ability to function as required, under defined conditions of use, maintenance and repair, until a limiting state is reached

Note 1 to entry: The degree to which maintenance and repair are within the scope of durability will vary by product or product-group.

Note 2 to entry: Durability can be expressed in units appropriate to the part or product concerned, e.g. calendar time, operating cycles, distance run, etc. The units should always be clearly stated.

[SOURCE: EN 45552:2020; 3.1.1.1, Note 2 to entry deleted]

3.2
reliability
probability that a product functions as required under given conditions, including maintenance, for a given duration without a limiting event

Note 1 to entry: The intended function(s) and given conditions are described in the information for use provided with the product.

Note 2 to entry: Duration can be expressed in units appropriate to the part or product concerned, e.g. calendar time, operating cycles, distance run, etc. The units should always be clearly stated.

[SOURCE: EN 45552:2020; 3.1.1.2]

5 Specification of a washing machine

- The **primary function** of a washing machine, fulfilling its main purpose, is to provide cleaned, rinsed and spin-dried laundry.
  - The functional analysis in accordance with the FAST method in EN 12973 has been conducted to identify (see Annex A):
    - **secondary functions** needed to fulfil primary functions;
    - parts involved in providing secondary functions;
    - technical parameters characterizing each secondary function and limiting states

Ambient conditions

Parameter	Value
Room temperature	(23 ± 4) °C
Power supply	230 V with a tolerance of ± 7 V 50 Hz with a tolerance of ± 0,5 Hz
Floor/pedestal below	Flat hard floor with scratches and other irregularities of the surface (roughness below 0,5 mm)
Distance to wall	Wooden cabinet for built in appliances Free standing (follow manufacturers instruction on machine setup)
Water supply – Temperature	(15 ± 5) °C
Water supply – pressure	(2,5 ± 1,0) bar
Water – hardness	(2,5 ± 1,0) mmol/l
Height of drainage system	Average height according to operating instructions of the manufacturer

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6 Reliability Test Procedure

- The testing procedure as used in has been put together to reflect the **critical use conditions found in consumer studies**.
- They consider especially:
  - Reflection of **programs used by consumers** and
  - **Putting thermal and mechanical stress** on the machine

Part	Details of test part	No. of executions of part
Initial part	The initial part consists of the initial inspection (see 6.2.1), the preparation for testing (see 6.2.3) and the reference testing procedure (see 6.2.4). All of them shall be carried out only once within a test scheme.	1
Main part	The main part of the test procedure consists of repeated series of 80 washing cycles (see 6.2.5) alternating with 140 rinse and spin cycles (see 6.2.6) run with different load quantities. One series of 220 cycles (washing cycle and rinse and spin cycles) of the main part are considered to represent the use of the washing machine in an average household for one year. The series of washing cycles and rinse and spin cycles (220 cycles) shall be repeated up to the number of cycles, which are declared by the manufacturer or the equivalent number of cycles according to the declared lifetime or until a failure occurs or otherwise end-of-test criteria are met. Within these 220 cycles the order maybe chosen arbitrarily. Machine parameters as described in subclause 6.2.8 will be monitored over these cycles.	Repeated as often as needed for the validation of the declared value
Test of residual moisture content	Testing the remaining moisture content of the laundry with one wash programme and a rinse-spin programme according to the specifications (see 6.2.9).	1
Final inspection	After finishing the reliability test, the machine shall be finally inspected to detect damages that have not led to failure but are still existent (see 6.2.10).	1

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Preparation of the washing machine for testing / Reference testing procedure

During the washing cycles and the rinse and spin cycles specific machine parameters shall be permanently monitored:

- energy consumption in kWh including time tracking;
- spin speed in rpm including time tracking;
- remaining moisture content in weight %;
- cycle counter;
- time to complete cycle;
- water usage in l (optional).

Table 3 Initial reference testing procedure

Programme	Load (fraction of nominal load)	Number of test runs
Eco 40-60	0.75	3
Eco 40-60	0.25	3
Cotton 60	0.75	3
Cotton 60	0.25	3
Cotton 85	0.75	3
Cotton 85	0.25	3
Rinse and Spin	0.75	3
Rinse and Spin	0.25	3

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Test procedure program requirements for washing cycles & rins and spin cycles

Table 4 Programme requirements for washing cycles

Programme	Load (fraction of nominal load)	Number of test runs
Eco 40-60	0,75	12
Eco 40-60	0,25	12
Cotton 60	0,75	22
Cotton 60	0,25	22
Cotton 85	0,75	6
Cotton 85	0,25	6

Table 5 Program requirements for rinse and spin cycles

Number of test runs	Programme	Factor of nominal load
70	Rinse & Spin	0,75
70	Rinse & Spin	0,25

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Measurement tolerances and end of test criteria

- The test for the machine under consideration shall end with a negative result if at least one of the following conditions is met:
  - At least one of the primary functions is no longer fulfilled.
  - NOTE Every no longer fulfilled secondary function leads to a non-fulfilled primary function.

  - More than 20 % of runs in a test sequence do not reach the maximum spin speed and duration (within the limits below) on either the wash cycles or the rinse and spin cycles.
  - Deviations of the accompanying energy measurements with ±10 % of the reference value.
  - Deviation of the maximum spin speed measurements with ±10 % of the reference value.
  - Displacement of the machine of more than 20 cm.
  - Leakage of the machine reported either by its own fault detection and or by leaking water.
  - Endangering the user in any way (e.g. uncomfortable noise) or triggering the electrical protection devices of the test station.

Additional Parts Tests / Door Test

Part	Relevant Loads Covered by Testing Procedure	Additional Test Needed
Buttons / Touchscreen (Program Selection)	Covered, if machine is switched on and off in between cycles and by selecting programmes	no
Detergent Dispenser	Covered by all washing cycles by using detergent	no, the part is hardly prone to failure
Door and door lock	The door does not need to be opened in between cycles, in particular in case of automated testing.	yes
Drive	Covered by all test cycles	no
Electronics/PCB	Covered by the operation of the machine; the physical integrity of the PCB is not bound to specific programme choices.	no
Gasket	Covered by all test cycles	no
Heater	Covered by the washing cycles. The programme profiles prescribed in 6.2 compensates for the lower load in the rinse and spin cycles.	no
Drum Bearing System	Covered by all test cycles	no
Filter or particle trap	Covered by all test cycles	no
Suspension System (Damper and Springs)	Covered by all test cycles	no
Power Switch	Covered, if machine is switched on and off in between cycles. Depending on the product design this can be covered by operating the programme selector knob or display	no
Pump	Covered by all test cycles	no

The described test procedure should be executed with the same appliances, which are used in 6.1 and repeated after each sequence of 220 cycles in accordance with 6.2.

The **door shall be opened and closed manually 280 times** at the end of the test sequence. This corresponds to the number of use cycles plus a safety reserve in case users add laundry or operate the door more than once per wash cycle for other reasons. By switching on the machine, the door lock will be activated and does not require additional tests.

The test is considered passed, if the door is still able to be locked and a program can be started.

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7 Statistics

- The evaluation of the test result follows a statistical approach. A **certain level of reliability (R) and confidence interval (C) should be met**. For further information on statistics and realistic scenarios of testing see Annex C, especially Table C.1.

- A level of R = 70 % and C = 70 % is advised for verification purposes of a declared number of cycles.

NOTE R = 70 % and C=70% means that 4 out of 4 samples have to successfully pass the reliability test with the number of cycles equally to the declared value. Less samples can be used if testing is extended beyond the number of cycles to be verified.

Table C. 1: Connection of number of failures, reliability, mission cycles, beta value, confidence level, available test cycles, characteristic life, number of samples and minimum testing cycles

# of failures	R%	Mission cycles	Beta	C%	Available test cycles	Characteristic life no of cycles	# of samples	Minimum testing cycles
0	60%	1000	2	60%	1500	1399	1	1339
0	60%	1000	2	60%	1000	1399	2	947
1	60%	1000	2	60%	1500	1399	2	1708
0	70%	1000	2	70%	1500	1674	2	1299
0	70%	1000	2	70%	1000	1674	4	919
2	60%	1000	2	60%	1500	1399	4	1475
0	80%	1000	2	80%	1500	2117	4	1343
1	70%	1000	2	70%	1500	1674	4	1411
1	60%	1000	2	60%	1000	1399	5	943
2	70%	1000	2	70%	1500	1674	5	1625
2	60%	1000	2	60%	1000	1399	7	1015
1	80%	1000	2	80%	1500	2117	7	1441
0	80%	1000	2	80%	1000	2117	8	950
1	70%	1000	2	70%	1000	1674	8	957
2	80%	1000	2	80%	1500	2117	10	1466
2	70%	1000	2	70%	1000	1674	11	1010
1	80%	1000	2	80%	1000	2117	14	998
2	80%	1000	2	80%	1000	2117	14	1006

10 Durability – Measurement method for the assessment of the reliability

Reparability

- While the reliability of a product describes the probable useful life of a product until the first failure occurs, reparability starts exactly at this point. **A defective product that is repairable can theoretically continue to be used after successful repair until another defect occurs and again and again**. Reparability is therefore an essential element in the context of durability.

- However, it is **not the aim of this standard to establish criteria for assessing reparability.**

Upgradeability

- According to EN 45552 upgradeability can positively influence the durability of a product. While this is obvious for IT products for both hardware and software, there are no known examples for washing machines

Durability

…. to develop such a durability assessment, a reparability assessment should first be defined.

11 Validation Test based on prEN50731:2023

- Organized and coordinated by **APPLiA and Rainer Stamminger (Start in Oct 2024)**
- Goal is to assess whether the **accelerated test according to prEN 50731** yields results equivalent to those obtained through **'real-life' testing**.
- **Manufactures and independent labs** will be requested to conduct the tests on one model of a washing machine. - One, according to EN 50731, the other conducting the 'real-life' test on the same model.
- It is estimated (assuming an average life-time of 10 years, equivalent to 2400 wash cycles) that the accelerated testing process will span **approximately 9 months**, while the 'real-life' testing will require approximately **one and a half years**.
- The testing has to continue in both tiers unless more than half of the washing machine have shown (fatal) failures. This because the assessment of both tiers needs to be based on the occurrence of **systematic failures**.
- Accidental failures need to be repaired (if possible) and the testing be continued

Thank you! Q&A

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Jens Giegerich, Vorwerk, Germany | **Christian Dworak, BSH Hausgeräte, Germany**
Rainer, Stamminger, University of Bonn, Germany