भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS

| Doc. No. : PRTD/AR/PF:03 | Issue No. : 2 | Issue Date 30 Sept. 2020 | **Report of Action Research** |
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| **1.** | **Action Research Project No.** *(as assigned by PRTD)* | AR/0147 |
| **2.** | **Title of the Action Research Project** | Method of testing Endurance of Domestic Electric Food Mixers (Grinders and Liquidizers) & Centrifugal Juicers |
| **3.** | **Name & Designation of Officer** | Aurosmita Kabiraj, Scientist-C & Tushar Sharma, Scientist-C |
| **4.** | **Employee No.** | 66095, 65935 |
| **5.** | **Deptt./BO/RO & Place of Posting** | CMD-III, HQ and MUBO-I, WRO |
| **6.** | **Date of Approval of the Project** | 19 Jan 2021 |
| **7.** | **Objective of the Project** | To develop a test method for testing the endurance (longevity) of Food mixers, a commonly used kitchen appliance in Indian households |
| **8.** | **Report of Action Research Activities** | Report enclosed |
| **9.** | **Conclusion & Recommendations** | An alternate Test method to assess the endurance of Domestic Electric Food Mixers (Grinders and Liquidizers) & Centrifugal Juicers of various ratings which may be deliberated upon by the technical committee. |
| **10.** | **Any other relevantinformation** | No funding has been availed. However, insight has been drawn from the discussions in the technical committee meetings of ET 32 and discussions with manufacturers. |

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31.3.2021

**REPORT OF ACTION RESEARCH**

ON

# METHOD OF TESTING ENDURANCE OF DOMESTIC ELECTRIC FOOD MIXERS (GRINDERS AND LIQUIDIZERS) & CENTRIFUGAL JUICERS

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## Executive summary

The present report focuses on the analysis of longevity of Food mixers (grinders and liquidizers) and centrifugal juicers. In particular the main objective was to propose an endurance test method to test performance of Food mixers (grinders and liquidizers) and centrifugal juicers, and highlight potentials for future improvements.

## Background

Durability and Longevity plays a key role in market demand for consumer appliances in India. Although not often highlighted, this is the key to enhance resource conservation and to contribute to waste minimization.

When BIS certification for Food mixers (grinders and liquidizers) and centrifugal juicers for domestic use as per IS 4250 was made mandatory in 2018, lot of instances came to light where frequent failures were observed by BIS testing laboratories. We identified that the failures were mainly attributable to Endurance test, where damage to coupler, blades, brushes and lid due to heating, vibration and mechanical stress during use represent main sources of stress for the whole food mixer. Especially low-quality couplers, blades, brushes and ball bearings can fail, and this represent a relevant issue, as further testing could not be carried out i.e. test could not be completed on account of these failures. In actual usage however, since the cost of repair or replacement of couplers, blades, brushes or such parts is not generally high, and such spare parts are easily accessible or available in the market, users may choose to continue using the appliance after suitably repairing or replacing it. If, however, a failure is attributable to the malfunctioning or damage of the motor, which constitutes the most important part in the functioning of the appliance, the cost of its repair or replacement may the induce the user to discard the appliance. Hence the proposed Endurance test has been devised keeping in mind these factors.

## Proposed endurance test (Summary)

A possible endurance test is here proposed considering the whole product tested under stressed conditions. The test has been conceived to have results in a relatively short amount of efforts and time, in order to be easily implemented and verified, with minimum manual intervention and subjectivity.

The endurance test is based on a series of actions:

- **Pre-conditioning**: the appliance is installed in the test rig according to the instructions of the manufacturer, if any;
- **Initial examination**: the appliance undergoes an initial visual inspection, to verify whether the machine is intact and undamaged, and fit for the test;
- **Testing**: the test consists of 48 hours of operation at 1.06 times rated voltage automatic artificial load (electrical load), spaced out by 30 minutes of normal operation (with physical load in the grinding/ liquidizing/ juicing jar) every 5.5 hours. The test is repeated for another 48 hours at 0.94 times the rated voltage. The normal operation cycles are run without the artificial load, which is substituted by a Base load;
- **Final examination**: after the final operation, the appliance is subjected to the electric strength test as per Clause 16.3 of IS 302-1 and then it undergoes a visual inspection.

# 1 Introduction

IS 4250: 1980 standard covers general, safety and performance requirements of domestic electric food-mixers used for mixing liquids, making slurries or pulps of food and for pulverizing dry food stuffs. It also contains requirements of Centrifugal juicers for extracting juices from fruits based on centrifugal action.

The main objective of this action research consists of outlining a test procedure which is an improvement on the IS 4250 test procedure for Endurance testing of electric Food mixers (grinders and liquidizers) and centrifugal juicers for household use which has been kept in abeyance due to various reasons.

The target of this work is to introduce a draft procedure for testing durability of Food mixers (grinders and liquidizers) and centrifugal juicers, with the following features:

- Reliability: the test should be applicable to the broad selection of Food mixers (grinders and liquidizers) and centrifugal juicers currently on the market, or under development;
- Repeatability: the test should not be affected by test–retest variability, in other words the variation in measurements taken by a different person or instrument on the same item, under the same conditions, and in a short period of time;
- Duration: the duration of the test should not exceed a reasonable timing (e.g. few months maximum) from the first operation to the last measurement; accelerated life testing can serve this purpose;

- Cost: as a consequence of the previous bullet point, the cost of this test should be reduced as much as possible, especially if compared to conventional long lasting tests.

The Endurance test which is carried out to check the longevity of the Appliance (motor, coupler, blades etc.) when run continuously as per its rated duty for a given number of cycles/ given number of hours.
It is given to understand from various manufacturers that while a good quality motor will sustain the requirements of Endurance test, the other parts like coupler, blades, brushes etc. will invariably not be able to sustain the test conditions. Besides, the test as laid down in the Standard required a lot of manual intervention making the results prone to error. Thirdly, the test requires substantial quantity of paper-pulp, a slurry of paper and water, which is not environment friendly or a sustainable way of carrying out testing.

From the analysis presented by Central Laboratory, BIS in one of the technical committee meetings of Electrical Appliances Sectional Committee (ET 32), it is possible to conclude that the most common failures occurring are as follows:

- Mechanical coupler damage
- Jar seal damage
- Carbon brushes wearing out
- Slurry leakage

The actual test duration of 96 hours could never be completed owing to failure in one of the above parts. Hence, the endurance of the motor has not been determined so far. In addition, the Standard in its present form does not allow for replacement of these parts or categorically specify any minimum requirement for these parts.

From an engineering point of view, Food mixers (grinders and liquidizers) and centrifugal juicers are subject to several types of stress, including thermal, vibration, and mechanical stress during use. Thus, appropriate design for strength and use of appropriate materials are considered key aspects to provide reliability to the product. It is essential that machines are designed to withstand these stresses for a defined number of years of use.

Low quality components can fail if exposed to high spin speeds for sustained durations and therefore reduce the lifespan of Food mixers (grinders and liquidizers) and centrifugal juicers; However, as in most cases, the replacement of these components is not an elaborate or expensive affair, and can be easily carried out in service centres, a reasonable relaxation may be provided.

# 2 Endurance test: procedure proposal

## 2.1 Introduction

According to the information collected from Industry Associations, an Endurance test focused primarily on the Motor is considered as relevant, the motor being the most important component of the machine, functionally as well as cost-wise. As the motor can be loaded through a motor- generator coupling arrangement, the proposal has been derived in line with this principle, instead of actual physical loading. Actual physical loading subjects the motor as well as other components like coupler, blades etc to equal degrees of stress which is not warranted. However, as actual grinding/ liquidizing/ juicing action is also important, the generator load

cycles have been interspersed with Base load cycles. Besides, additional criteria for some of the components has been recommended.

## 2.2 Procedure proposal

The following sections aim at defining the procedure proposal for an Endurance test of electric Food mixers (grinders and liquidizers) and centrifugal juicers for household use based on 96 hours of operation.

### 2.2.1 Terms and definitions

As per IS 4250:1980.

Following are the additions:

**Base Load:** The load necessary to obtain the rated input (including tolerances).

### 2.2.2 General procedure and conditions

The procedure is applicable to electric Food mixers (grinders and liquidizers) and centrifugal juicers for household use as per IS 4250.

The following conditions shall be verified during the test:

- The supply voltage should be maintained throughout the test at rated voltage.
- For base load, paper pulp slurry or any seasonal fruit or vegetable, or parboiled rice may be used.
- For making paper pulp slurry to be used as base load, paper of weight 35gsm to 55gsm (newspaper like) shall be used.
- The temperature of water shall be 25 ± 2 °C;
- The ambient temperature of the test room shall be maintained at (25 ± 2) °C
- The artificial electrical load shall be applied through a test rig in which the motor of the mixer is coupled with the shaft of a generator as shown in Figure 1. The load should be such that rated input of the appliance is achieved.
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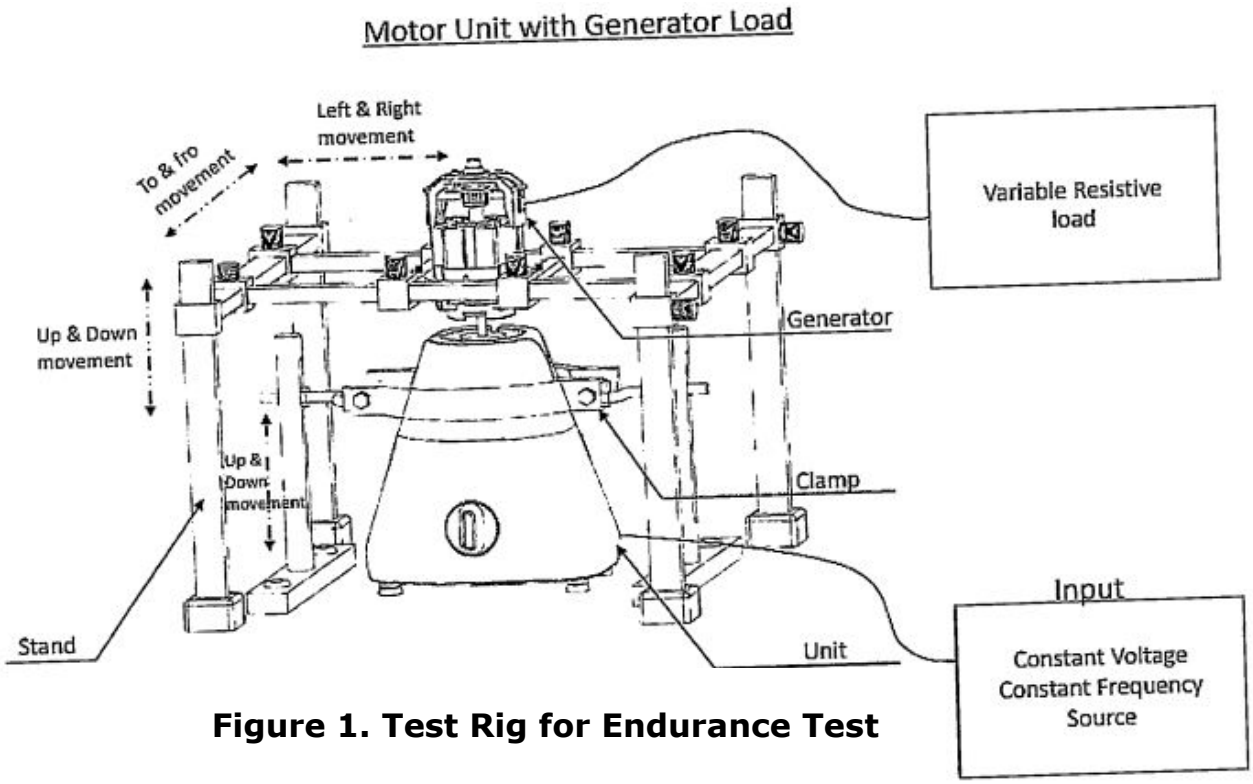


**Figure 1. Test Rig for Endurance Test**

### 2.2.3 Pre-conditioning

The appliance shall be installed in the test rig shown in Figure 1 according to the instruction of the manufacturer if any.

The appliance shall be supplied at the rated voltage i.e. voltage assigned to the appliance by the manufacturer and shall be equipped with an artificial load as described in section 2.2.2.

### 2.2.4 Initial examination

The appliance shall undergo an initial visual inspection, in order to verify whether the machine is intact and undamaged, and the appliance is fit for the test use. The status of the machine may be documented by pictures, especially of the motor, brushes, coupler, ball bearings, and blades of the jar.

### 2.2.5 Testing

The test is applied to the appliance taking into account its robustness and the capability to perform grinding/ liquidizing/ juicing operations after a series of stressed cycles.

The test is composed of four phases:

1. **Phase I:** 5.5 hours of operation at 1.06 times rated voltage with artificial generator load (electrical load) in cycles of rated ON and OFF

periods. The period is further sub-divided into 5 min ON, 2 min OFF repeated for 6 cycles before adequate rest period of not more than 45 min.

2. **Phase II:** 30 minutes (0.5 hours) of normal operation (with base load in the grinding/ liquidizing/ juicing jar) at 1.06 times rated voltage in cycles of rated ON and OFF periods. The period is further sub-divided into 5 min ON, 2 min OFF repeated for 6 cycles before adequate rest period of not more than 45 min.

   Phase I and II are repeated 8 times alternately so as to achieve 48 [(5.5+0.5) X 8] hours of operation at 1.06 times rated voltage.

3. **Phase III:** 5.5 hours of operation at 0.94 times rated voltage with artificial generator load (electrical load) in cycles of rated ON and OFF periods. The period is further sub-divided into 5 min ON, 2 min OFF repeated for 6 cycles before adequate rest period of not more than 45 min.

4. **Phase IV:** 30 minutes (0.5 hours) of normal operation (with base load in the grinding/ liquidizing/ juicing jar) at 0.94 times rated voltage in cycles of rated ON and OFF periods. The period is further sub-divided into 5 min ON, 2 min OFF repeated for 6 cycles before adequate rest period of not more than 45 min.

   Phase III and IV are repeated 8 times alternately so as to achieve 48 [(5.5+0.5) X 8] hours of operation at 0.94 times rated voltage.

The test consists of 96 hours of operation, spaced out by 30 minutes of operation with base load for every 5.5 hours of operation with artificial generator load. The appliance shall successfully perform the test and failures shall not occur.

After every 5.5 hours of operation, the artificial generator load is removed in order to execute Phase II/ Phase IV of the test with base load.

The appliance shall successfully perform all operations with base load. A visual inspection should follow these operations to detect leakages.

NOTE -During the test, the couplers shall be inspected and only one replacement if necessary) by spare coupler supplied by the manufacturer is allowed.

### 2.2.6 Final examination

After this test the appliance shall withstand the electric strength test as per Clause 16.3 of IS 302-1.

After the testing of the performance parameters, the test appliance

shall be disconnected from the power. A visual inspection shall be carried out consisting of the examination of the appliance, in order to check whether the following components are undamaged after the test:

- Motor including motor brushes
- Jar
- Coupler
- Mechanical bearings
- Blades

In particular, the following problems shall not occur:

- Leakage from jar
- Jar not properly fixed into the housing
- Unexpected noise from bearings
- Broken wires or damages of insulation
- Loss of connectivity of wires and clamps
- Cracks on printed circuit boards if any

### 2.2.7 Summary and estimated duration

Assuming a rated duty of 5 Min ON and 2 Min OFF, the estimated duration of each test phase is:

Pre-conditioning and initial examination: 30 minutes
Phase I: 957 minutes including OFF and maximum rest period
Phase II: 87 minutes including OFF and maximum rest period
Phase III: 957 minutes including OFF and maximum rest period
Phase IV: 87 minutes including OFF and maximum rest period
Final examination: 30 minutes.

Therefore, the total time to run the test is estimated in approximately 280 hours, divided as follows:

Pre-conditioning and initial examination: 30 minutes
8 Iterations of Phase I: 7656 minutes
8 Iterations of Phase II: 696 minutes
8 Iterations of Phase III: 7656 minutes
8 Iterations of Phase IV: 696 minutes
Final examination: 30 minutes.

The Phase I and Phase III operations can be performed manually or, when possible, automatically. This implies that the duration of the test can last from 20 to 35 working days, depending on the level of automation (Assuming working hours of 14 to 8 hours per day). A graphical representation of the overall test is represented by means of a Chart, in Figure 2.

## 2.3 Other requirements

The blades shall be made of Stainless steel of Grade N1 conforming to IS 15997.

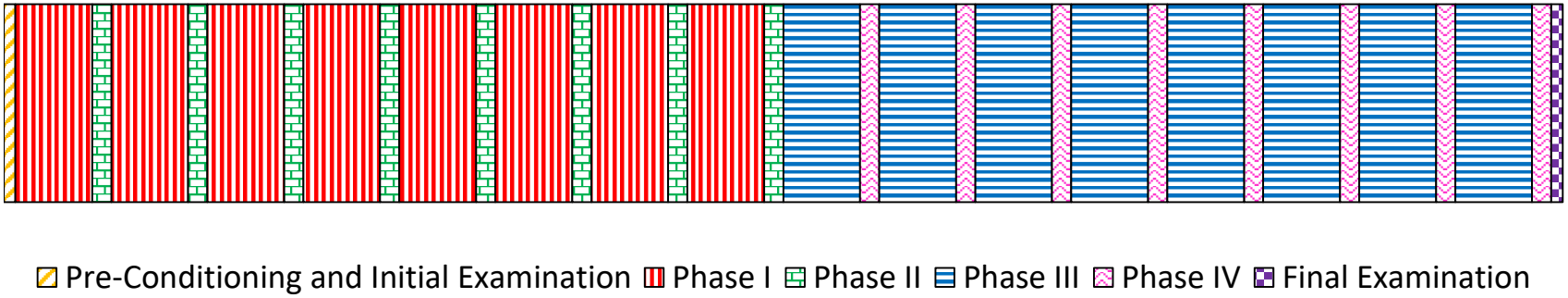


**Figure 2. Representation of the Endurance test procedure**

# 3 Conclusions and perspectives

Endurance testing can refer to different aspects of the durability, as the assessment of the lifetime of the machine (e.g. in terms of number of cycles that the machine can achieve) or to the evolution of the performance (in terms of the variation over time of e.g. the energy consumption, grinding cycle duration). Furthermore, the effective performance (e.g. fineness of grinding/ liquidizing/ juicing, grinding/ liquidizing time, efficiency) may be deteriorated (or altered by the machine) already after some initial cycles of the testing. These considerations lead us to understand that an endurance test could simultaneously introduce a certain level of stress, for a certain amount of time, and introduce a limit on the performance decline of the mixer grinder. Endurance test may not be devoted to the 'measurement' of the average lifetime, but could aim at ensuring that an appliance that is able to fulfil what is declared on the product even after significant use. Further, the life expectancy of different parts that comprise the machine should be commensurate with their cost and replaceability.

Further work is needed to define a manageable and relevant testing method, but the testing of Endurance needs to consider the whole product and the way it is specifically used. Future developments may complement or replace operating cycles with loads and cycles closer to the average user behaviour. In this case, the machine would also be more systematically subject to the possible combination of the impact of heating and mechanical stress with the impact due to the use of actual food ingredients. Nonetheless, such changes in the testing procedure may lead to potentially more expensive tests.

This project also aimed at further stimulating the discussions between industry and policy-makers about industrial practices. Promotion of endurance at the whole product level is needed and promoted by standardisation. Nonetheless, implementing a stringent stress test would encourage appliance manufacturers to design products with better mechanical properties, establishing therefore a minimum mechanical robustness, independent of usage by real customers.

As a concluding remark, the presented research only represents an alternative point to develop procedures to test endurance of Food mixers (grinders and liquidizers) and centrifugal juicers. Testing endurance of kitchen appliances can be successful only if these are based on affordable and reproducible test procedures. This project had the objective to contribute in this sense and to highlight the need of development of such testing conditions.

## References


1. IS 4250:1980 - Specification for Domestic Electric Food-Mixers (Liquidizers and Grinders) and Centrifugal Juicers
2. IS 302-1:2008 - Safety of Household and Similar Electrical Appliances Part 1 General Requirements
3. Test report data from WROL on failure of samples
4. IEC 60335-2-14: 2016 - Household and similar electrical appliances – Safety – Part 2-14: Particular requirements for kitchen machines
5. Inputs from M/s Philips India Ltd.

APPENDIX - V

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| Doc. No. : PRTD/AR/**PF:04** | Issue No. : 1 | Issue Date 28 Apr 2020 | **DECLARATION OF ORIGINAL WORK** |
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## DECLARATION OF ORIGINAL WORK

We, **Aurosmita Kabiraj, Sc C** and **Tushar Sharma, Sc C** (indicate official's Name & Designation), Employee No. **66095 & 65935** respectively hereby declare that the Action Research Projecttitled "**Method of testing Endurance of Domestic Electric Food Mixers (Grinders and Liquidizers) & Centrifugal Juicers**" is the original research work done by us. We have not copied from any other Action Research Project or any other work of similar nature and topic done by any person/institution/body either published or yet to be published. Data and information from other sources, used if any, have been with prior permission, wherever required and is duly acknowledged appropriately in the project report submitted by us.

This declaration is made on the 31st day of March 2021.

**Aurosmita Kabiraj**
**Sc C**

**Tushar Sharma**
**Sc C**

*Note:* Project has been undertaken jointly