REGULATORY TESTING

OF

HOME APPLIANCES

A Dissertation submitted in fulfillment of the requirements for the Degree of

MASTER OF ENGINEERING

in

Power Systems

Submitted by

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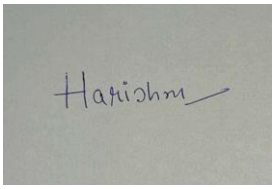
DECLARATION

I hereby certify that the work which is presented in dissertation entitled, "**REGULATORY TESTING OF HOME APPLIANCES**", in partial fulfillment of the requirements for the award of the degree of Master of Engineering in Power Systems, submitted to Electrical & Instrumentation Engineering Department of Thapar Institute of Engineering & Technology, Patiala is as authenticrecord of my own work carried under the supervision of Dr. Surya Prakash. It refers others researcher's work which are duly listed in the reference section. The matter contained in this dissertation has not been submitted, neither in part nor in full to any other degree to any other university or institute except as reported in text and references.



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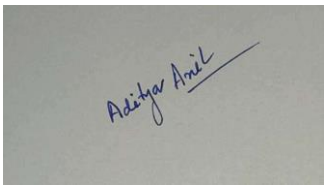

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NOMENCLATURE

LGEIL	LG Electronics India Pvt Ltd
EHF	Extremely High Frequency (Microwaves)
SHF	Super High Frequency (Microwaves)
UHF	Ultra-High Frequency
VHF	Very High Frequency
HF	High Frequency
MF	Medium Frequency
LF	Low Frequency
VLF	Very Low Frequency
VF	Voice Frequency
ELF	Extremely Low Frequency
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
DQA	Development Quality Assurance
MWO	Microwave Oven
DBT	Dry Bulb Test
WBT	Wet Bulb Test

ABSTRACT

LG Electronics provides a great platform for the budding engineers to gain a valuable experience in such a large industry and that too in a friendly cultured way. Although the enormous amount of work done and experience gained in the past one-year can't be just listed in a few lines but here is an overview of the training.

The objective of the project is "REGULATORY TESTING OF HOME APPLIANCES" which gives the reader an overview of the MWO technology, Refrigerator & Room Air Conditioner. At R&D (Development Planning) LGEIL, my work mainly consisted of product testing & certification according to international industry standards specified by Government of India.

The report is divided into different sections emphasizing on every field. It tells the reader about the profile and portfolio of LG Electronics. Further, the history, working, nomenclature, major parts etc. of Microwave Oven are discussed in detail. Then the testing and procedure of product certification (MWO, REF & RAC) according to BEE (Bureau of Energy Efficiency) are detailed. The report is wound up discussing about the Indian & International Standards and their importance & relevance.

Symbols

Symbol	Unit	Terms
mw	g	Mass
mc	g	Mass of the container
To	℃	Initial temperature of water
T_{low}	℃	Final temperature of water for the low temperature
T_{high}	℃	Final temperature of water for the high temperature
W_{high}	J	Energy reading from meter during Thigh test
W_{low}	J	Energy reading from meter during Tlow test
Q	-	Quotient of energy consumption
W_{final}	J	Final energy consumption
P	W	Power Output
Ta	℃	Ambient temperature
T	℃	Heating time

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Chapter 1

Introduction

LG Organization, originally Lucky-GoldStar, is a holding company for LG Electronics, a South Korean global conglomerate corporation. LG Electronics (formerly Goldstar) was formed in 1958, 60 years ago, and now employs over 200 thousand people around the world. LG is South Korea's fourth-largest multinational conglomerate and the world's third-largest appliance manufacturer. The LG Twin Towers building in Yeouido-dong, Yeongdeungpo-gu, Seoul, serves as the company's headquarters. In 1958, Goldstar entered the electronics industry and produced Korea's first telephone, refrigerator, and black-and-white television. The corporation expanded into oil refining, construction biotechnology, semiconductors, and banking in the next years. From the company's two previous brands, Lucky and Goldstar, Goldstar selected LG as its new name and corporate identity in 1995. The current motto "LIFE IS GOOD" is an acronym.LG Electronics was founded in 1958 and has since led the way in the digital age thanks to the technological know-how gained by producing many home appliances such as radios and TVs.

LG Electronics introduced many new products, utilized new technologies in the 21st century digital media and TV and continues to strengthen its position as a global company.

Fig. 1.1 LG Headquarters

1.1 MANAGEMENT PHILOSOPHY

The LG Way, which represents LG's distinct corporate culture, expresses our view that we can achieve our ambition of being "LG - No. 1" by focusing on "Customer-Value Creation" and "People-Oriented Management" while adhering to the principles of "Jeong-Do Management" in our daily operations.

Jeong-Do Management demonstrates our dedication to consistently improving basics and competing fairly by basing our methods on ethical management, which produces tangible outcomes. LG Electronics' management concepts are put into action through implementing Jeong-Do Management. LG's unique application of ethics is called "Jeong-Do Management." LG achieves success by employing ethical management methods and continuously improving business abilities. LG's management ideals of providing value for customers and protecting human dignity are at the heart of LG Way. Management by Principle emphasizes not just open and fair competition, but also the development of the skills necessary for LG employees to add significant value to consumers and earn their trust

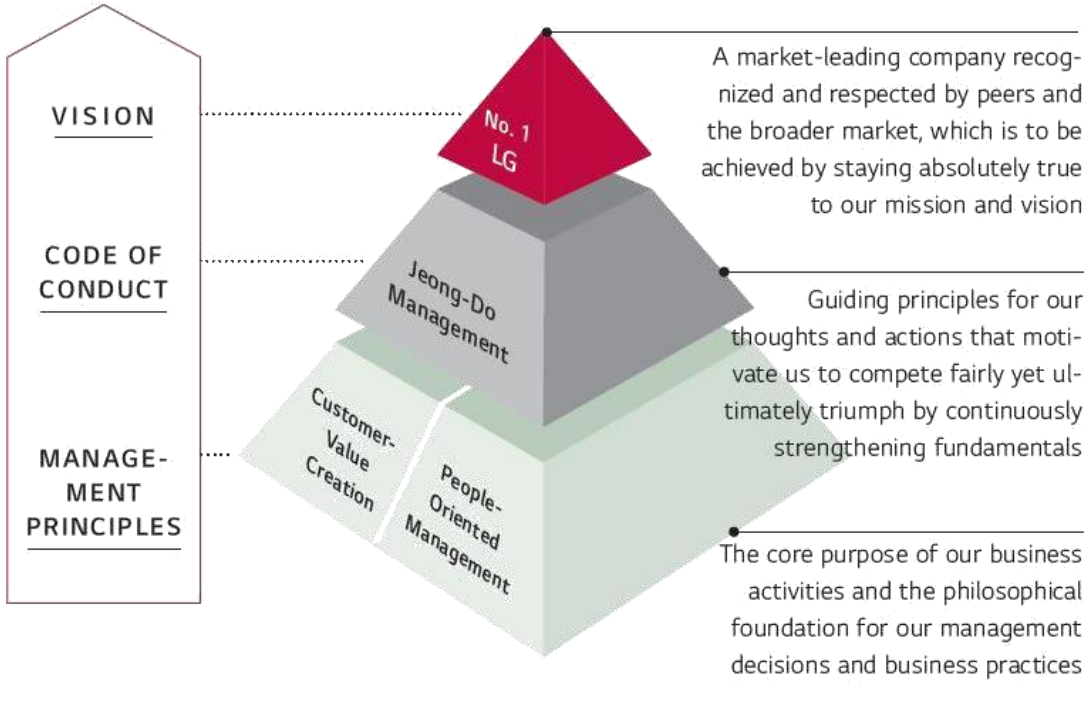


Fig. 1.2 LG Philosophy

Chapter 2

MICROWAVES AND MICROWAVE OVENS– A LOOK THROUGH

2.1 Introduction

Microwave ovens, or microwaves, are kitchen appliances that heat food by bombarding it with microwave radiation, which causes polarized molecules in the food to rotate and build up thermal energy in a process known as dielectric heating. Microwave ovens heat food rapidly and efficiently because excitation is relatively uniform; food is cooked more evenly throughout than in other cooking methods. Microwave ovens are widely used for reheating and cooking previously cooked dishes. They're also excellent for quickly heating products like hot butter, fats, and chocolate that would otherwise take a long time to prepare.

. Fig. 2.1 Microwave Oven

Advantages:-

- Cooking through use of microwaves is healthier because no external agents such asoil, ghee etc. are used to facilitate the process of cooking.
- Microwave cooking is highly time-saving because a microwave oven can cook dishes in much lesser time than the conventional oven or stove.
- Microwave oven saves power consumption as compared to conventional cooking equipment's.
- Microwave oven makes cooking more easily because of the various Auto Cook functions available.

Disadvantages: -

- Aside from the fact that microwaves can't reach the bottom of big pieces of food, wave interference also causes hot spots and cold areas to appear.

2.2 What are Microwaves and How Do They Work?

Microwaves are a type of electromagnetic radiation with wavelengths ranging from one metre to one millimeter, or, to put it another way, frequencies ranging from 0.3 GHz to 300 GHz.
The prefix "micro" in the word "microwave" does not imply a wavelength in the micrometer range. Microwaves are "small" relative to the waves utilised in traditional radio broadcasting because their wavelengths are shorter. On the following page, there is a diagram.
So, Atomic transitions, as well as electron and nuclear spins, frequently produce microwaves. By introducing cross magnetic and electric fields, electron spins can be created.
The most frequent wave frequency utilized in microwave ovens is around 2.45 GHz (2,450 MHz). Water, lipids, and carbohydrates absorb waves in this frequency range, which is an interesting feature. They are promptly transformed into atomic motion – heat – once absorbed. Most polymers, glass, and ceramics do not absorb them. Microwaves are reflected by metal, which is why the devices have metal walls.

Microwaves:

EHF = Extremely high frequency (Microwaves)	**MF** = Medium frequency
SHF = Super high frequency (Microwaves)	LF = Low frequency
UHF = Ultrahigh frequency	VLF = Very low frequency
VHF = Very high frequency	VF = Voice frequency
HF = High frequency	ELF = Extremely low frequency

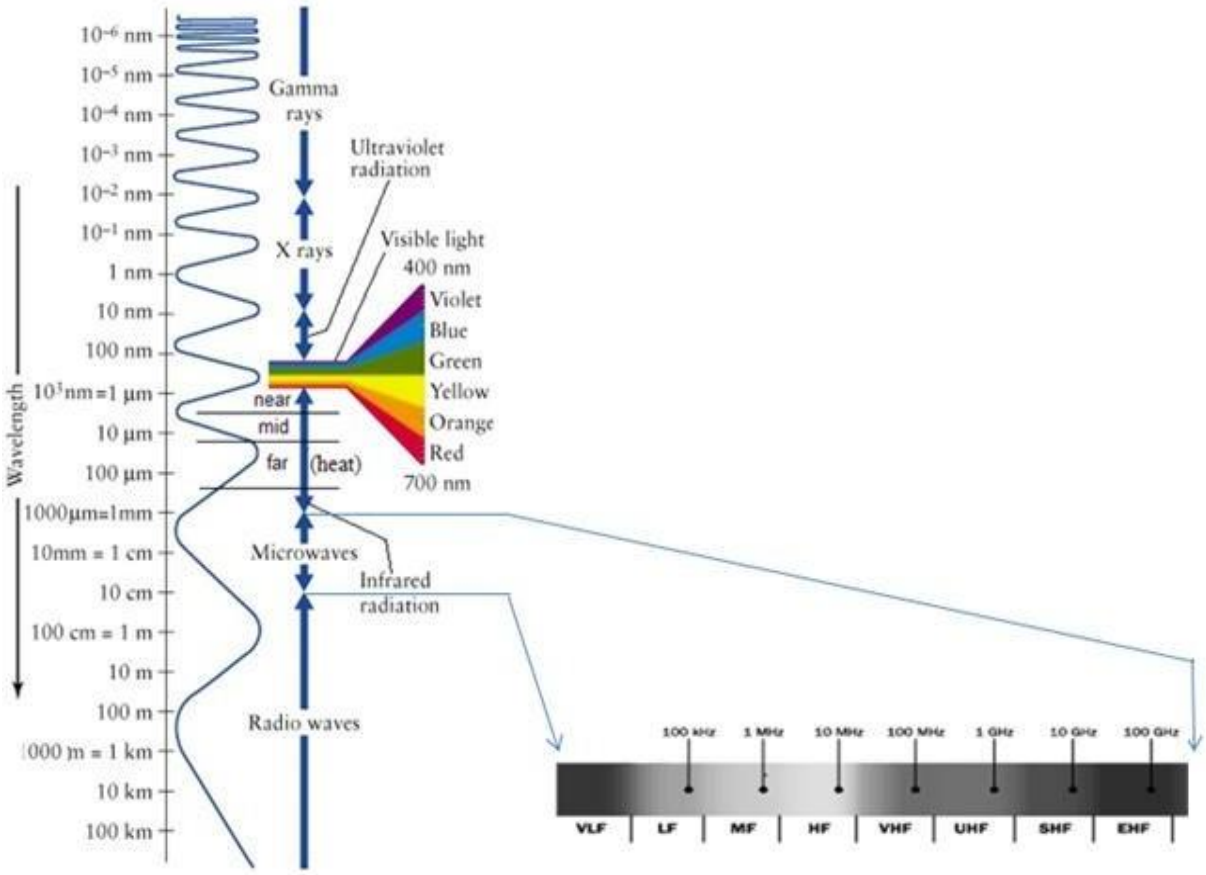


Fig. 2.2 Electromagnetic Spectrum

2.3 Microwave Oven Nomenclature

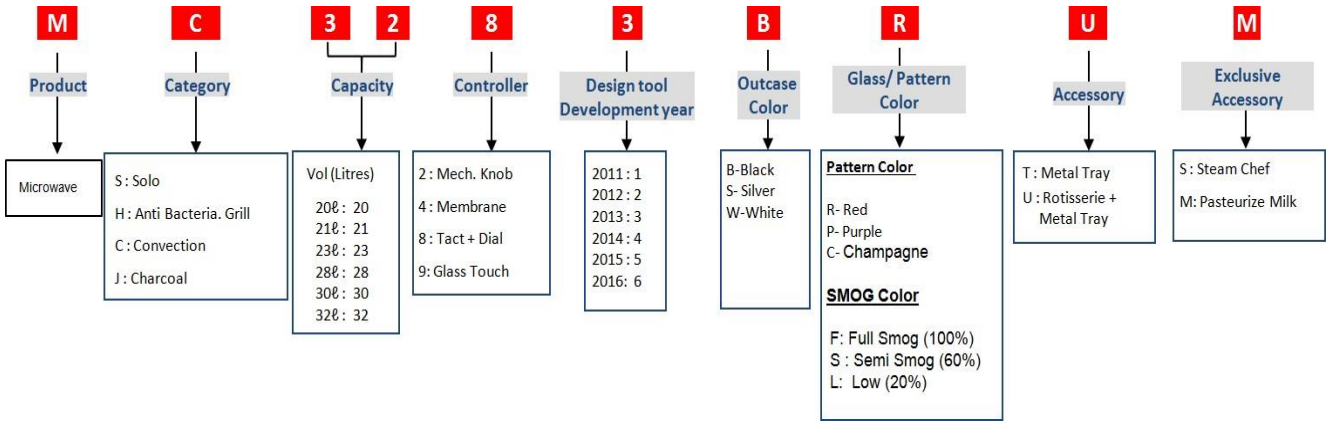


Fig. 2.3 Nomenclature of Microwave Oven

Some examples of running models are: -

Table1.1 Examples of Microwave oven models

S.No.	Category	Capacity	Existing Model Name	New Model Name
1	Conv.	32L	MJ3283BCG	MJ3286BRUS
2		28L	MC2841SPS	MC2846BLT
3		21L	MC2143BPG	MC2145BPG
4	Grill	23L	MH2344DB	MH2344DB
5		20L	MH2044DB	MH2044DB
6	Solo	20L	MS2043DB	MS2043DB

2.4 Types of Microwave Ovens

There are three main categories of Microwave Oven:

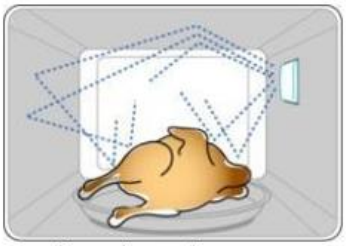
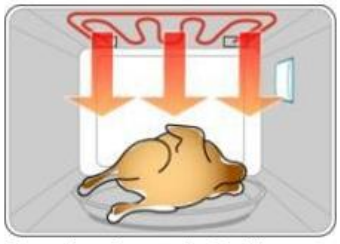
SOLO	GRILL	CONVECTION
❖ Used for Re-Heating, Cooking, Steaming and De-Frosting	❖ Used for Roasting, Toasting & Browning.	❖ Used for Baking, Barbeque, Frying & Crisping.
❖ The Solo Models have only Magnetron to produce microwaves.	❖ Browning of the food can be done with radiant heat induced from the Grill heater located at top.	❖ Along with the Micro & Grill functions, an additional heater at the rear side with a fan is there.
❖ This is the most basic model of Microwave Ovens.	❖ Heaters can be of Quartz or Sheath type.	❖ The heaters control the cavity temperature with range 100°C to 230°C.
 Heating Through Magnetron	 Heating through Grill at top	 Heating Through Convection Fan & Heater

Fig. 2.4 Types of microwave oven

2.5 Components

2.5.1 Door

The microwave oven is a box-like metal construction with a front aperture and a door. The door has hinges on one side and a latch on the other (consists of a few mini switches to provide extra security). It's normally a glass panel for easy viewing, but it's shielded by a layer of conductive mesh.

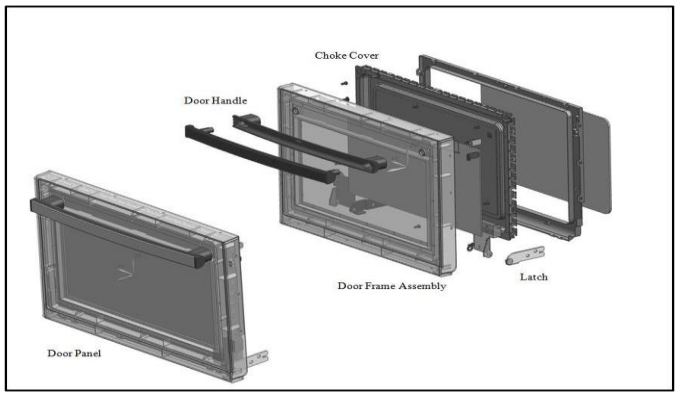


Fig. 2.5 Door

2.5.2 Latch Door

The function of these interlock switches is to provide safety in the operation of the oven. The oven stops working as soon as the door is opened to ensure the safety of the userfrom the exposure of radiation. The lamp glows in the microwave oven as soon as the door is closed in order to provide better view while the food is being closed.

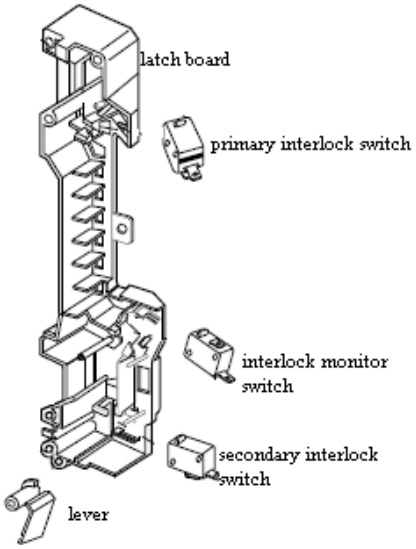


Fig. 2.6 Latch Door Parts

2.5.3 Oven Cavity Parts

Oven cavity is the enclosure which confines the microwaves in it. Food is kept in the cavity when the microwave is in operation.

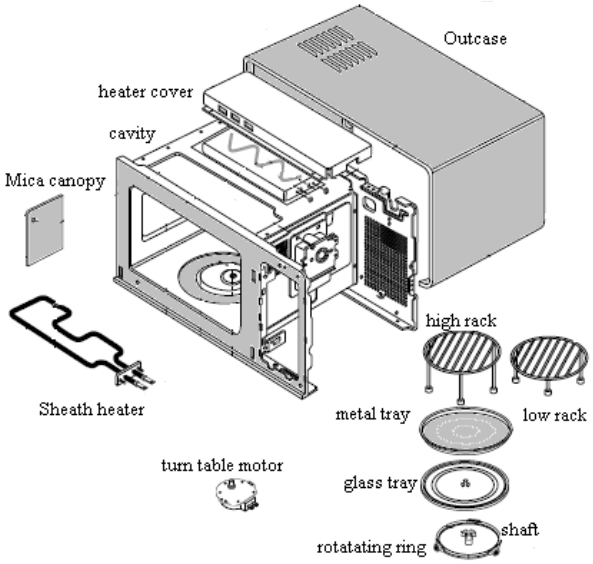


Fig. 2.7 Oven Cavity parts

2.5.4 Control Panel Parts

The outside of the oven has a display and a control panel that provide information about what has to be done. A circuit board sits underneath this control panel, which controls the microwave oven and aids in the display of instructions.

The operation of modern microwave ovens is controlled by either an analogue dial-type timer or a digital control panel. They have an LED, liquid crystal, or vacuum fluorescent display, as well as numeric buttons and additional features depending on the model.

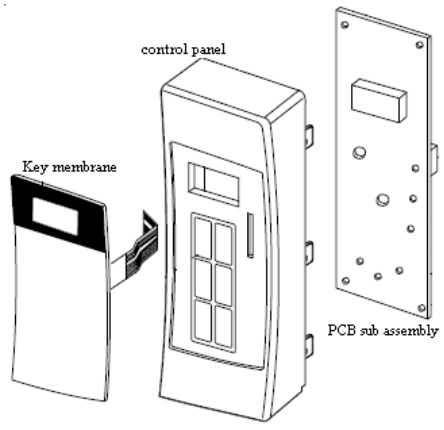


Fig. 2.8 Control Panel Parts

2.5.5 Suction Guide

Suction guide assembly has the function of removing the heat from the magnetron and giving it out.

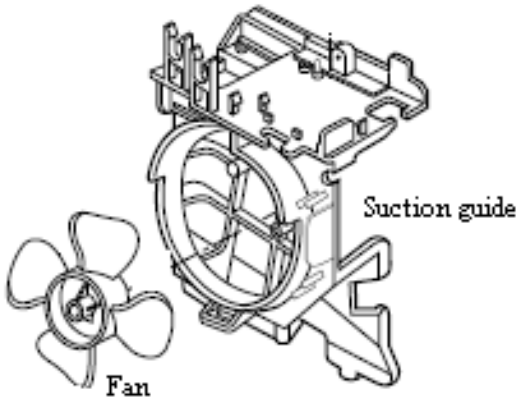


Fig. 2.9 Suction Guide

2.5.6 Harness

Harness is the bundle of various connecting wires. They connect the controller to various electrical parts of the microwave oven. At the back of the microwave cavity is another sheath heater as well as the convection motor and fan. This fan operates during the convection function. This assembly is covered with a back plate. The high voltage transformer is fixed on a base plate.

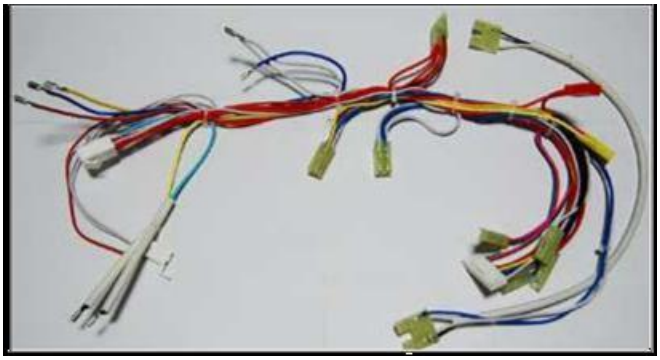


Fig. 2.10 Harness

Chapter 3

Microwave Oven Testing

Before the testing begin, the samples must be thoroughly inspected and checked for any evident physical flaws in the structure, installation, mechanical risks, markings, appropriate terminals for supply connections, grounding, and the strength of bolts and connections. The finish on the exterior surface must be uniform and free from finishing flaws.

3.1 Power Output Test: -

- **Test Condition**

- Ambient Temp: 23±2ºC
- Water Initial Temp: 10ºC±0.5
- Input Supply: 230V

- **Test Procedure**

  - Connect MWO and Power Meter.
  - Measure ambient temperature of Bowl.
  - Measure 1L (1000g) water and note initial temperature.
  - Start the test.
  - Note the test time by stop watch.
  - Note down the value of current and power by power meter.

3.2 Input Power & Current Test: -

- **Test Condition:**
  - Ambient Temp: 23 ± 2 ºC
  - Water Initial Temp.: 27 ± 2 ºC
  - Input Supply: 230V (Rated)
- **Test Procedure:**
  - Note the initial Power at which the Oven starts.
  - Run the test for 10 minutes
  - Take the readings after 1 minute with the help of power meter
  - Note the final value of power after the test is over.

- **Judgment Criteria:**

  The final power should not be within the 20% range of the rated power.

3.3 Microwave Oven Leakage Test: -

- **Test Method:**
  1. Cavity load: 275 ± 15 cc of tap water containing in beaker.
  2. Cavity load location: The center of the cavity.
  3. Power output: The appliance shall be operated at full power.
  4. Place the beaker in the microwave and start the microwave oven.
  5. We will measure leakage with the help of microwave leakage detector.
- **Judgment Criteria:**

  The microwave oven leakage should be less than 5 mw/cm^2

3.4 Door Endurance Test: -

- **Test Condition:**
  - Ambient Temp: 23 ± 2 ºC
  - Water Initial Temp.: 27 ± 2 ºC
  - Input Supply: 230V (Rated)
- **Test Procedure:**
  - Put Microwave Oven on Door Endurance Tester Jig
  - Input Supply 230V for Microwave Oven
  - Door Endurance Tester Jig Cycle:
  - 5 Sec On ~ 5 Sec Off for 1 Cycle
  - Total Test Cycle: 100000 Nos.
- **Judgment Criteria:**

  The Microwave door latch must be functional ok.

Fig. 3.1 Microwave Door Open Jig

Chapter 4

BEE- Bureau of Energy Efficiency

4.1 INTRODUCTION

In accordance with the guidelines of the country's 2001 Energy Conservation Act, the Government of India established the BEE in March 2002 under the Ministry of Power. The agency's job is to create initiatives that would improve energy efficiency and conservation in India. Beginning in January 2010, the government has suggested making BEE ratings a requirement for all appliances sold in India. The BEE's goals are to "institutionalize" energy efficiency services, enable national delivery systems, and act as a national resource for energy efficiency in all spheres of national life. The main goal would be to lower the economy's energy intensity.

4.2 Objectives

1. To exercise leadership, make policy recommendations, and give national energy conservation and efficiency initiatives guidance.
2. To coordinate policies and initiatives relating to energy efficiency and conservation and present them to the relevant parties.
3. Creating methods and practises to assess, track, and confirm energy efficiency results both at the macro level and in terms of specific industries. To make advantage of multilateral, bilateral, and private sector support for the Energy Conservation Act's implementation and effective use of energy and its conservation initiatives.

Fig. 4.1 BEE Label

4.3 Sampling

The samples will be selected up by BEE or its nominated agency for testing as per given sampling plan which is discussed below:

1. Two samples will be considered. One sample will be selected randomly from the warehouse or where the sample is manufactured.
2. Other sample will be randomly selected from the retail outlet.

4.4 BEE Testing

The bureau will follow a process which consists of three levels. The initial stage of testing will take place at the business's testing facility. The rivals' lab will host the second tests. The govt national testing laboratory will conduct the final tests. To avoid any rating disparity, this was agreed.

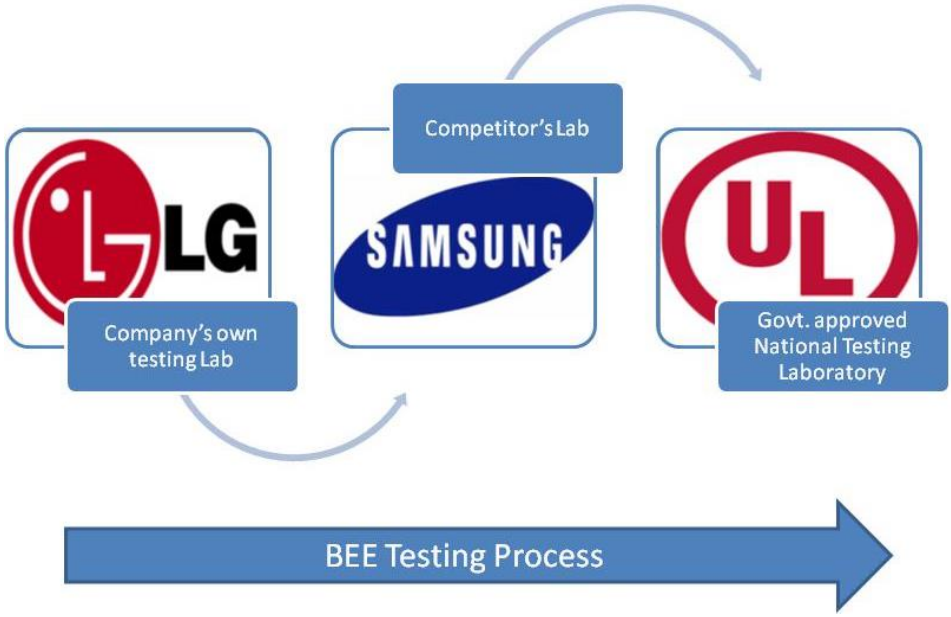


Fig. 4.2 BEE Testing Process

4.5 BEE Testing for Microwave Oven

The following tests are performed to ensure the utmost quality of the LG Microwave ovens. As from 2018, BEE Energy Star Ratings is mandatory for Microwave Ovens too. When R&D develops a new model of oven it has to be tested before mass production and also for standard certifications from govt. (BEE Star label etc.) are required before selling in market, therefore these tests are performed. Before commencement, the samples are visually examined and then connected to the test setup. Every test has a different setup and different test conditions. These tests are performed in DQA lab in LG.

4.5.1 Energy Consumption Test: -

This test's objective is to gauge the appliance's energy usage based on a defined load and temperature rise, which is representative of the energy used throughout a cooking cycle. Therefore, three different water loads in glass containers which have different sizes and shapes are used.

Table1.2 Amount of water to be filled according to the loads

Load	Glass container, cylindrical made of borosilicate glass	Nominal water amount (m_w) pure tape water
Small (s)	External diameter *d* Ø 90 mm ± 1 mm external height *h* 125 mm ± 1 mm capacity 600 ml Maximum weight 200 g	275 g ± 1 g
Middle (m)	External diameter *d* Ø 140 mm ± 1 mm external height *h* 76 mm ± 1 mm capacity 900 ml Maximum weight 250 g	350 g ± 1 g
Large (l)	External diameter *d* Ø 190 mm ± 1 mm external height *h* 90 mm ± 1 mm capacity 2000 ml Maximum weight 450 g	1 000 g ± 1 g

- **Standard Detail**: IEC 60705 Edition 4.1 2014-06
- **General Condition**:
  - The supply voltage at the main terminal must be kept at rated voltage ±1 %.
  - The ambient temperature must be 23 °C ± 2 °C.
  - The test is conducted using potable water at a starting temperature of 10 °C ± 0.5 °C.
  - Appliances are placed with their back against a wall and positioned away from sidewalls, unless otherwise specified in the instructions.

Fig. 4.3 Test Setup

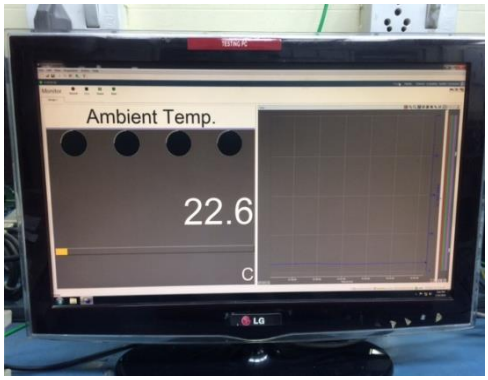


Fig. 4.4 Temperature Screen

- **Test Method**:
  - Actual mass of container and Ambient temp. is measured and noted down.
  - Power meter timer should be set equal to the oven run time.
  - Nominal amount of water (as per table) at 10 °c ± 0.5 °c should be added to small(s) container and water temperature is measured immediately

$$\Delta T_{high} = T_{high} - T_0$$

$$\Delta T_{low} = T_{low} - T_0$$

$$\Delta T_{high,total} = \frac{0{,}55 \times m_c \times \Delta T_{high}}{4{,}187 \times m_w} + \Delta T_{high}$$

$$\Delta T_{low,total} = \frac{0{,}55 \times m_c \times \Delta T_{low}}{4{,}187 \times m_w} + \Delta T_{low}$$

$$\Delta T_{high,\,norm} = \text{total}\Delta T_{high} \times \frac{m_w}{m_{w,n}}$$

$$\Delta T_{low,\,norm} = \text{total}\Delta T_{low} \times \frac{m_w}{m_{w,n}}$$

$$Q = \frac{(W_{high} - W_{low})}{(\Delta T_{high,\,norm} - \Delta T_{low,\,norm})}$$

$$W_{50} = W_{low} + Q \cdot (50 - \Delta T_{low,\,norm})$$

$$W_{final,\,cooking\ cycle} = \frac{3 \cdot W_{50,s} + 6 \cdot W_{50,m} + 2 \cdot W_{50,l}}{11}$$

m_w is actual mass of the water (g)

$m_{w,n}$ is nominal mass of water (275 g, 350 g, 1000 g)

m_c is the actual mass of the container (g)

T_0 is initial temperature of the water (°C)

T_{low} is final temperature of the water for the low temperature range (°C)

T_{high} is final temperature of the water for the high temperature range (°C)

W_{high} is energy reading from meter during Thigh test

W_{low} is energy reading from meter during Tlow test

Q is quotient of energy consumption

W_{final} is final energy consumption of MWO

4.5.2 Power Output & Efficiency Test: -

This test aims to evaluate the microwave oven's effectiveness and power output.

- **Standard Detail**: IEC 60705 Edition 4.1 2014-06
- **General Condition**:
  - The supply voltage at the main terminal must be kept at rated voltage ±1 %.

- The ambient temperature must be 23 °C ± 2 °C
- The test is conducted using potable water at a starting temperature of 10 °C ± 1 °C

➢ **Test Method**:

1. Mass and temperature of container is measured and noted.
2. Power meter timer should be set equal to the oven run time.
3. 1000 g ± 5 g of water at 10 °C ± 1 °C is added to container and temperature is measured and noted immediately.
4. The container is positioned at the centre of the oven tray.
5. The Oven and Power meter timer should be started at the same time.
6. The time for water to attain temperature of 20 °C ± 2 °C should be noted.

$$P = \frac{4{,}187 \cdot m_w (T_1 - T_0) + 0{,}55 \cdot m_c (T_1 - T_A)}{t}$$

P is microwave power output (W)

mw is the mass of water (g)

mc is the mass of container (g)

Ta is the ambient temperature (°C)

T0 is the initial temperature (°C)

T1is the final temperature (°C)

t is the heating time, excluding magnetron heating-up time

NOTE: - The wattage of the microwave output is rounded to nearby 50 W.

Clause 8's test is measuring the energy used. Based on the below equation, oven's efficiency is determined.

$$\eta = 100 \frac{Pt}{W_{in}}$$

***P** is microwave power output (W)*

***t** is heating time, excluding magnetron heating-up time (s)*

***η** is the efficiency (%)*

***Win** is including the magnetron heating-up energy consumption*

4.5.3 Standby Power Test: -

In this test we check that how much power does a microwave oven consumes when in a stand-by mode i.e., not in use but plugged into power. This seems like a simple test but maintaining the test conditions is a key factor which requires high precision as IEC Standards are very strict. The following are the nominal voltages and frequency of different countries i.e., we need to supply voltage as per required country. Maintaining a temperature of 23 °C ± 2 °C is mandatory. Placement of the oven is also very important and should be kept at given distances from the side walls. The power is noted from the power meter. The oven runs for a specific amount of time as given in standard i.e. 30 mins.

Table1.3 Nominal Voltages and Frequency of different countries

Country/Region	Nominal voltage and frequency [a]
Europe	230 V, 50 Hz
North America	115 V, 60 Hz
Japan [b]	100 V, 50/60 Hz
China	220 V, 50 Hz
Australia and New Zealand	230 V, 50 Hz

- **Standard Detail**: IEC 62301 Edition 2.0 2011-01
- **General Condition**:
  - The supply voltage shall be maintained at the main terminal at rated voltage ±1 %.
  - The ambient temperature must be 23 °C ± 2 °C.
  - Appliances are placed with their back against a wall and positioned away from sidewalls, unless otherwise specified in the instructions.
- **Test Method**:
  1. Power meter timer should be set as same as oven run time.
  2. Power meter timer and Oven should start at the same time.
  3. The oven and timer should run for a specific amount of time i.e., 30 mins
  4. The energy consumption (in mwh) should be noted from Power meter.
  5. Energy consumption is converted into Power using the below formula.

Fig. 4.5 Power Meter

$$P = \frac{Energy}{1000} \times \frac{60}{t}$$

P *is power output, in Watts*

Energy *is energy noted from power meter, in mWh*

t *is oven run time, in minute*

- **Power Meter Setting**:

1. Press Shift + Reset both at the same time.
2. Press down key for timer display.
3. Then press enter button to set the time.
4. Set the time using up and down key.
5. First set the hours and then press enter.
6. Then set minutes and then seconds and press enter.
7. Press shift + down key to change the second digit of minutes or seconds

Fig. 4.6 Timer Display in Main Menu

Fig. 4.7 Time set to 30min.

4.6 BEE Testing for Room Air Conditioner

According to the Energy Conservation Act, 2001, each item or class of appliances being made, sold, bought, or imported for sale should specify the specifics on the energy label, as determined by the government in conjunction with the BEE.

So, below mentioned tests are performed to get certification from BEE for energy label on Room Air Conditioner.

4.6.1 Cooling Capacity Test: -

- **Test Purpose**:

  These tests' aim is to assess the magnitude of the net cooling effect.

  a) Net Total Cooling Effect
  b) Power Consumption (Watt Ratio)
  c) Running Current (Current Ratio)
  d) Coefficient of Performance (COP) / Energy Efficiency Ratio(EER)
  e) ISEER & Cooling Seasonal Energy Consumption

- **Test Standards**:

  1. Temperature Conditions:

Table1.4 Temperature Conditions for indoor & Outdoor

Location	Temperature	Value
Indoor	DBT(°c)	27°c $\pm$ 0.3°c
	WBT(°c)	19°c $\pm$ 0.2°c
Outdoor	DBT(°c)	35°c $\pm$ 0.3°c
	WBT(°c)	24°c $\pm$ 0.2°c

DBT - Dry Bulb Temperature

WBT - Wet Bulb Temperatur

  2. Test Voltage: Rated voltage 230V $\pm$ 1%
  3. Test Frequency: Rated Frequency 50Hz $\pm$ 1%
  4. Front Grill & Air Filter properly fixed
  5. Damper fully closed
  6. Temperature setting: Maximum Cool
  7. Fan speed: High

- **Testing Procedure**:

  After room conditions stabilize, check RPM of fan motor in fan mode without compressor running at rated voltage of motor specifications. The evaporator coil should dry when RPM is checked.

  Test condition is to be maintained in the chamber for not less than one hour before recording the data for capacity test.

  After the steady state is attained, the data shall be recorded for every 10 minutes and 7 sets of reading shall be taken

Fig. 4.8 Indoor Unit

- **Precautions**:
  1. Vertical louvers should be parallel to the air flow & should be in OFF condition so as to offer minimum resistance to the air flow.
  2. There should be no air leakage between the indoor & the outdoor side and there should be proper sealing on the window openings.
  3. The thermocouples should be properly fixed on copper tubing where required so as to sense the pipe temperature correctly.

Fig. 4.9 Outdoor Unit

- **Data to be recorded**:

  Given below are the data which need to be recorded in the cooling capacity test.

  1. Outdoor entering air D.B.T
  2. Outdoor entering air W.B.T
  3. Indoor entering air D.B.T
  4. Indoor entering air W.B.T
  5. Indoor leaving air D.B.T
  6. Indoor leaving air W.B.T
  7. Running current
  8. Input voltage
  9. Power consumption
  10. Motor RPM

- **Judgement Criteria**:
  1. Cooling Capacity Should be More than 90% of Rated Capacity.
  2. Running Ampere Should be As per Product std.
  3. Fan Motor RPM as per Product Standard.
  4. Sensible heat ratio should be between 70% to 80%.

4.6.2 Cooling Overload Test: -

- **Test Purpose**:

  The aim of this test is to confirm the following:

  a) The air conditioner is capable of operating satisfactorily under overload operating conditions.

  b) Check the safety of control parts, running parts and the successive operation performances under the outdoor unit's maximum overloads on the cooling mode.

- **Test Conditions**:
  1. Temperature Conditions:

Table1.5 Temperature conditions for different locations

Location	Temperature	Value
Indoor	DBT(°c)	35°c ± 0.5°c
	WBT(°c)	24°c ± 0.3°c
Outdoor	DBT(°c)	46°c ± 0.5°c
	WBT(°c)	27°c ± 0.3°c

DBT - Dry Bulb Temperature

WBT - Wet Bulb Temperature

  2. Test Voltage: Low Voltage ~ 187V, High Voltage ~265V
     (For test as per BIS Ref. IS 1391 Part1 & Part2, Low voltage -10% of rated voltage & High Voltage +10% of rated voltage.
  3. Test Frequency: Rated Frequency
  4. Front Grill & Air Filter properly fixed
  5. Damper fully closed
  6. Temperature setting: Maximum Cool
  7. Fan speed: High
  8. Vertical Louvers set to cause min. obstruction to air flow.

- **Testing Procedure**:
  1. Stabilize the conditions in the chamber for not less than one hour

2. The electrical conditions should be such that the voltage should not rise more than 3% of the rated voltage when the test unit is switched off.
3. Run the test unit at low voltage for 2 Hrs at high speed at above mentioned conditions.
4. After 2Hrs, switch off the compressor for 3min. so that compressor restart after 3mins.

- **Judgment Criteria**:
  1. During the first two hours of running, the compressor and fan motor should run continuously, without tripping of the overload protecting device.
  2. The overload protective devices should trip only during 1st five minutes after the shut off period of 3min. During the remainder one hour test period, no overload protective device should trip.
  3. For the models so designed, the unit should be off for no more than 60 minutes if the restart of operation does not happen after the initial trip within the first 5 minutes. Following that, it should run nonstop for an hour.

4.7 BEE Testing for Refrigerator

Before the testing begin, the samples must be thoroughly inspected and checked for any evident physical flaws in the structure, installation, mechanical risks, markings, appropriate terminals for supply connections, grounding, and the strength of bolts and connections. The finish on the exterior surface must be uniform and free from finishing flaws.

4.7.1 Energy Consumption Test: -

- **Test Purpose**

  To find out energy units consumed by refrigerator per year (kWH/YR)

- **Test Conditions**

  a) Ambient Temperature - 32± 0.5°c
  b) Relative Humidity - 65% ± 3%
  c) Appliance shall be installed in no load conditions.
  d) Location of thermocouples:

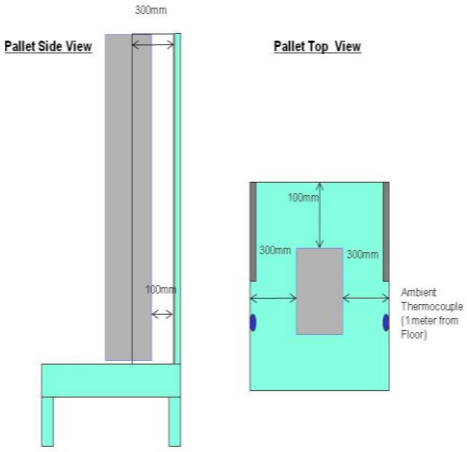


Fig. 4.10 Pallet Side View

- **Test Method**

  a) Put Refrigerator on Energy Pallet as per figure.
  b) Five thermocouples are located in frozen and three are located in unfrozen food storage compartments.

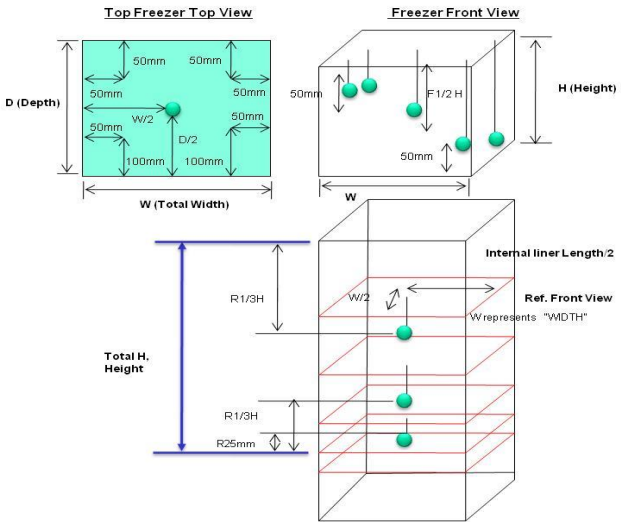


Fig. 4.11 Freezer Top and Front View

c) Stabilize product with freezer and ref knob settings in NORMAL position.

d) Note freezer and ref temperature after stabilization.

e) Measure energy consumption for both cold setting and hot setting.

Table1.6 Temperature for cold and hot settings

Setting	**Freezer**	**Ref**
Cold	-15°c to -17°c	3°c to 1°c
Hot	-15°c to -13°c	3°c to 5°c

f) Temperature measurement is done with cold & warm setting and average is calculated as follows.

F_{avg} = (T1+T2+T3+T4)/4 (Excluding coldest sensor among all 5 sensor)

R_{avg} = (T1+T2+T3)/3

- **Testing Period**

The test period must begin following stabilization and at the commencement of an operating cycle; it must last for at least 24 hours and must include an entire operational cycle. The test must go on until the end of the operating cycle if it begins but is not finished within a 24-hour period.

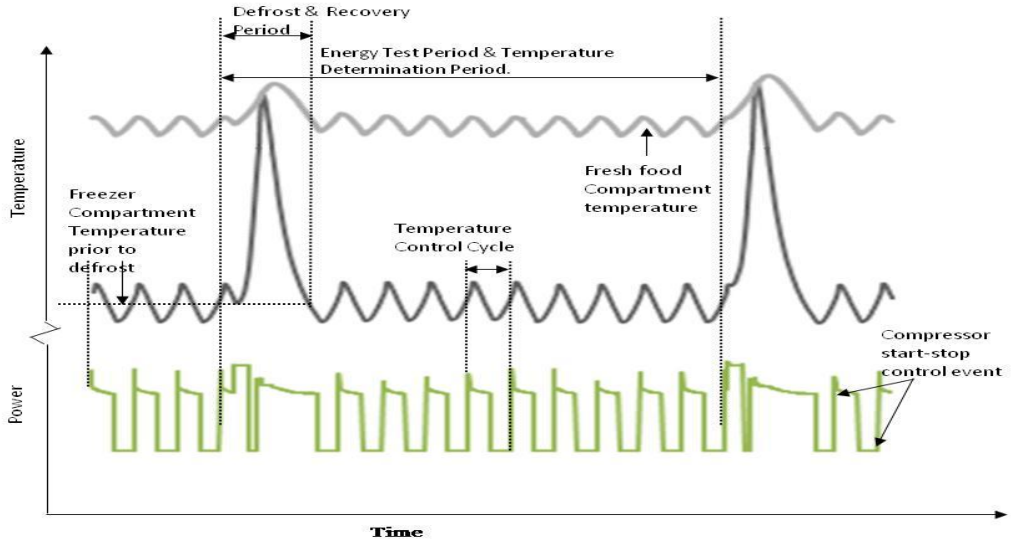


Fig. 4.12 Defrost Cycles

- **Result:**

The following information shall be reported

1) Freezer Average Temperature (Excluding coldest Temperature)
2) Refrigerator Average temperature.
3) Calculate Energy Consumption with the help of the below equation Ex.

Ex: E1 + [(E2-E1) x (Tx – T1)/(T2 – T1)] KWH/Year

Where ,

Ex = Calculated Energy Consumption rate of appliance at the target temperature Tx.

E1 = Measured Energy Consumption rate of appliance at point 1.

E2 = Measured Energy Consumption rate of appliance at point 2.

T1 = Measured compartment temperature for point 1.

T2 = Measured compartment temperature for point 2.

Tx = Targeted Temperature (-15 & + 3 degree C).

Fig. 4.13 Machine under Energy consumption test

4.7.2 Pull down Test: -

This test helps in determining the cooling speed of the refrigerator in no load condition whether it is capable of achieving the desired temperatures in the given specific time period as per the standards.

- **Test Purpose**

  This test is to verify cooling speed of test piece, that is, to check if test piece has enough Cooling capacity.

- **Test Conditions**

  a. Ambient Temperature - 43 ± 1°c

  b. Power - 230V & 50Hz

  c. Sample Quantity - 3

- **Test Equipment & Devices**

Table1.7 Specification of the components used in refrigerator

Name	**Specification**
Chamber	Temperature control range: 0 ~ 43°c, Fluctuation range : less than 2°c
Thermocouple	Measuring Range : -200 ~ 400°c
Copper Ball	Weight : 25g ± 5%, Diameter : 15.2mm

- **Test Method**

1) Any of devices or system (Ex: OLP, Defrost system) that prohibits continuous operation of compressor shall be rendered inoperative.
2) Empty the ice tray. For automatic ice maker, it shall be rendered inoperative.
3) Place thermo-couples at locations listed in table

Table1.8 Locations of thermocouples

No.	**Location**	**Criteria**
1	S-Pipe	43°c -3°c ↑ & +7°c ↓
2	Drier Inlet	43°c +2°c ↑ & +12°c ↓
3	Condenser outlet(Starting point) Wall : Back exit, Wire : wire out	R134a: 2°c ↓ (Condenser – Drier) R600a : 4°c ↓ (Condenser – Drier)
4	Compressor (Top of comp. Dome)	108°c ↓
5	EVA inlet of refrigerator compartment	For reference purpose
6	EVA outlet of refrigerator compartment	
7	1 point per shelf of freezer	Average of shelves: -21°c ↓

4) Place the test sample on wooden board in the chamber and install a screening board.
5) Unplug, leave door open and stabilize until the temperatures of each part of test sample reach at 43℃ and then leave door closed for 30 minutes.

Fig. 4.14 Machine under Pull Down Test

- **Judgment Criteria**

1) Temperatures shall meet design standard or criteria of table 2.
2) Temperature of EVA inlet and outlet shall be within ±3deg. (2EVA : Judged as F EVA)
3) Cooling speed of compartment of fresh food and freezer shall meet 336min (93% of 6 hr) and 342min (95% of 6hr)
4) For compartments listed in below table 3 (except point 3), the cooling speed shall be less than 6 hours.

PULL DOWN TEMPERATURES FOR COMPARTMENTS

Compartment type	Average air temperature, °C
UNFROZEN FOOD TYPES	
Cellar	16
Fresh food	8
Chill	5
Special (unfrozen)	2°C warmer than claimed max.
FROZEN FOOD TYPES	
Ice-making	No test requirement
Short term storage	−8
Freezer	−13
Special (frozen)	2°C warmer than claimed max.

Fig. 4.15 Pull Down Temperatures for Compartments

4.7.3 Volume Measurement Test: -

- **Purpose**

  The purpose is to calculate the gross volume and storage volume of the refrigerator.

- **Determination of Gross Volume**

  The refrigerator's body's overall total volume is known as the gross volume (this would include the various components of the refrigerator as well).

  By splitting the entire volume into manageable, easily measurable units of volume for geometric shapes, the gross volume can be computed. The exact shape of the walls, including any projections or depressions, is taken into consideration by the gross volume.

  Amounts must also be subtracted for that volume that is unavailable because of ducts, fans, evaporators, and other related equipment.

- **Determination of storage volume of fresh food compartment**

  The storage volume of the fresh food compartment is the gross volume of the compartment minus

  - The evaporator space volume.
  - Volume of housings used.
  - The quantity of shelves, dividers, retainers, and other accessories with walls thicker than 13 mm.
  - Volume of the area inside the fresh food storage compartment between the inner door protrusion and the interior.

- **Determination of storage volume of food freezer compartment**

  - Except in the case of appliances fitted with an automatic ice-maker, where the volume occupied by a removable storage bucket should be included in the storage volume unless it is specifically stated in the instructions for use that this volume is suitable for ice storage only, the total volume to be deducted will consist of: Volume of spaces situated outside any load limit (natural or marked by the manufacturer) Volume of spaces provided specifically for making & storing ice.
  - The amount of spaces between the front face of the test package load and the inner vertical surface of the door or any projections from the door if the horizontal distance is greater than 15mm.
  - Volume of all fixed parts that are not exceeding the load limits

4.7.4 Energy Consumption Test (As per new standard):-

- **Objective**

  To determine the value of energy as per new standards.

- **Test Conditions**

  Ambient Temperature: 32 ℃, < 75% throughout the test.

  Soaking at test room temperature is not mentioned for the energy test, as per standard

- **Test Procedure**
- **Setup for Energy Testing**

  for a refrigerating appliance, the set up for energy testing should be in a test room.

- **Steady State Power Consumption**

  for refrigerating appliance, it shall be determined as mentioned in Annex B.

- **Defrost and Recovery Energy and Temperature Change**

  For products with one or more defrost systems (each with its own defrost control cycle), the incremental defrost, the temperature change and recovery energy for a representative number of defrost and recovery periods shall be determined as given in Annex C

- **Defrost Frequency**

  For products with one or more defrost systems (each with its own defrost control cycle), the defrost interval for each and every system should be according to Annex D, depending on the control type.

- **Number of Test Points and Interpolation**

  the energy consumption of a refrigerating appliance is interpolated as given in 6, one of the methods given in Annex E should be used.

Table1.9 Target Temperatures for Energy Consumptions

S.no	Compartment type	Target Average air Temperature °C
1	Pantry	17
2	Wine storage	12
3	Cellar	12
4	Fresh food	4
5	Chill	2
6	Zero-star	0
7	One-star	-6
8	Two-star	-12
9	Three-star and Four star	-18

It lacks a user-adjustable temperature control or has a limited range of active control, a

compartment operating range that does not include any of the target temperatures for the defined compartment types in Table 1 at an ambient temperature of 32 °C will be categorised as the compartment type with the next warmest target temperature. (based on the warmest test result for ambient temperatures) and operated at its warmest setting while still staying at or below the target temperature of the next warmest target temperature (where adjustable) for the energy test at ambient temperatures. The test report shall note that the claimed compartment type and the compartment type assumed for energy testing.

The principal configuration for energy testing is the compartment type with the highest energy consumption when the compartment is a variable temperature compartment type (that encompasses the operational range of many compartment types). In addition to the default setup for energy testing, a variable temperature compartment can be set and tested as other compartment types, as needed. The compartment type and variable temperature compartment type must be noted in the test report.

- **Determination of Energy Consumption:**

  The main components of energy consumption are:

  Steady state power consumption:

  a) This is determined at ambient temperatures of 32 °C

  b) Defrost and recovery energy and temperature change — For products with one or more defrost systems (each with its own defrost control cycle), the defrost and recovery energy for a representative number of defrost and recovery periods for each system shall be determined.

  It is necessary to measure the temperature and energy consumption over a representative time of steady state operation that complies with the pertinent standards in order to evaluate the characteristics of a residential refrigeration device in accordance with this standard (that is, compartment temperatures at or below their target for energy consumption). To achieve the most advantageous (optimal) result for energy consumption, several test points at various temperature control settings can be necessary.

  In the case of products with automatic defrost functions that affect the power consumption of the product (that is, has a defrost control cycle), the incremental energy during defrost and recovery (that is, the additional energy **ΔEdf** over and above the underlying steady state power) shall be determined for a specified number of representative and valid defrost and recovery

  Energy assessments, there are two alternative approaches to the determination of steady state power consumption:

- **Number of Test Runs:**

  The energy consumption must be determined at ambient temperatures of 32 °C either:

  a) immediately from the outcomes of a solitary test run where the appliance's temperature in every compartment is at or below the goal temperatures listed in Table 1; or

  b) by extrapolating the outcomes of two or more test runs that were performed at various settings of one or more user-adjustable temperature controls, as shown below:

  1) Where results have been measured at two temperature control settings, interpolation in accordance with **E-3**;

  2) Where the appliance has at least two independent user-adjustable temperature controls and results have been measured at three temperature control setting combinations, interpolation in accordance with **E-4**; and

  3) Options for interpolating using three or more independent user-adjustable temperature controls are also set out.

- **Steady State Power Consumption:**

  For a refrigerating appliance that does not have a defrost control cycle, the steady state power consumption at each temperature control setting selected and for each ambient temperature should be according to Annex B.

  For a refrigerating appliance with one or more defrost control cycles, the steady state power consumption between defrost and recovery periods at each temperature control setting selected and for each ambient temperature should be specified as given in Annex B.

  The value is given in watt (W).

- **Defrost and Recovery Energy and Temperature Change:**

  For a refrigerating appliance with one or more defrost systems (each with its own defrost control cycle), the additional energy and temperature change associated with defrost and recovery shall be determined for each system for a representative number of defrost and recovery periods according to Annex C, at ambient temperatures of 32 °C.

  The additional energy associated with defrost and recovery is reported in watt-hour (Wh).

  The temperature change associated with defrost and recovery is reported in degree Kelvin-hour (Kh).

- **Defrost Interval:**

  The predicted defrost interval for a refrigeration appliance having one or more defrost systems (each with a separate defrost control cycle) must be calculated in accordance with Annex D at a temperature of 32 °C.

  To the nearest 0.1 hours, the defrost interval must be expressed in hours. The defrost interval may

depend on a variety of factors, depending on the defrost control type.

1. **Calculation of Energy Consumption:**

Daily Energy Consumption

- **For refrigerating appliances with No defrost system:**

All values of energy consumption and power shall be converted to daily energy consumption values in accordance with the following equations for each temperature control setting and ambient temperature.

For refrigerating appliances without a defrost control cycle, the daily energy consumption for each ambient temperature and each temperature control setting is given by:

$$E_{daily} = P \times 24$$

Edaily = energy in Wh over a period of 24 h

24 = h/d and

P = steady state power in watt for the selected temperature control setting as per Annex B

The measured steady state temperature

- **For refrigerating appliances with one defrost system:**

the daily energy consumption for each ambient temperature and each temperature control setting is based on the steady state power consumption as given in Annex B, the incremental defrost and recovery energy determined according to Annex C and the defrost interval determined in accordance with Annex D as follows:

$$E_{daily} = P \times 24 + \frac{\Delta E_{df} \times 24}{\Delta t_{df}}$$

where

Edaily = energy in Wh, over a period of 24 h;

24 = h/d; and

P = steady state power in watt for the selected temperature control setting ;

ΔEdf = representative incremental energy for defrost and recovery, in Wh

Δtdf = estimated defrost interval, in hours

4.7.5 Pull Down Test (As per new standard): -

- **Scope:**

This Test Procedure is applicable for the Pull-Down Test to be conducted on the Refrigerators.

- **Test Conditions:**

1. Ambient Temperature: 43 + 0.5°C throughout the Test.

2. Thermostat to be disconnected from circuit.
3. Ice trays in the appliance should be empty

- **Test Procedure:**

1. Ambient Temperature: 43 + 0.5°C throughout the Test
2. Record the details of Refrigerator in sample receipt register(R/REF/002) and generate test unit identification code. This identification No. is affixed on the Refrigerator.
3. Check the Refrigerator physically and run for 24 hrs. @ Normal Thermostat setting prior to commencement of its first test.
4. Place the refrigerators in the test chamber on a wooden platform with a top that is 300 mm off the ground to allow free airflow underneath the platform and that extends 300 mm to 600 mm horizontally beyond the front and each side of the refrigerator. The vertical surface behind the appliance must be made of plywood that has been painted a dull black colour. This surface must be continuous and extend a minimum of 300 mm above and to each side of the refrigerator. Maintain the maximum distance (Specified by the manufacturer-100 mm) between the rearmost projection of refrigerator and rear wall of plywood pallet.
5. Fix the sensors (comprising a thermocouple in to a drilling in the end of a solid copper cylinder of 15.2 mm diameter & 15.2 mm long or weighting 25g in to short term freezer & Fresh Food compartments.
6. Disconnect the Thermostat from circuit.
7. Ensure that empty Ice trays are kept in place during the test.

- **Precautions:**

Refrigerator doors to be sealed properly (with tape) to avoid heat ingress.

Table1.10 Target Temperatures for Pull Down test

S.No	Compartment Type	Average Temperature °C
1	Pantry	20
2	Cellar	15
3	Fresh food	8
4	Chill	6
5	Zero Star	No requirement
6	1 Star	-1
7	2 Star	-7
8	3 & 4 Star	-12

4.7.6 Volume Measurement Test (As per new standard): -

- **Scope:**

To determine the total volume of refrigerator

- **Description of Item:** Refrigerator 50~300Ltr
- **Test Conditions:**

  1. Measurements to be done at Room Temperature (25±4°C)
  2. Measurements to be done after taking out all internal fittings

- **Procedure for Total Volume measurement (Method-1):**

  1. Record the details of Refrigerator in sample receipt register(R/REF/002) and generate test unit identification code. This identification No. is affixed on the Refrigerator.
  2. Check the Refrigerator physically & inform to user dept. in case of any abnormality.
  3. Remove all internal fixtures, including shelves, movable walls, bins, an evaporator, the thermostat, and light housing, among others.
  4. Divide the total volume contained within the liner into convenient geometric shapes which can easily be measured. Take in to account the exact shape of walls including all projections and depressions.
  5. Measure the dimensions (Height, Width & Depth) of each shape and calculate the volume and measure each dimension three times and take average of them as a final measurement.
  6. Sum-up the volume of each shape.
  7. Any volume which is inaccessible due to Door Profile / protrusions, etc. should be deducted from the Volume sum –up to point No.6t.
  8. Total Volume to be declared in Liters.

- **Procedure for Total Volume measurement (Method-2):**

  1. To stop water leaks, attach the liner to the refrigerator and seal with a metal cabinet.
  2. Place the cabinet horizontally and put the door liner at top of cabinet. Insert a steel strip equal to the Gasket thickness between cabinet & door liner.
  3. Seal the steel strip with cabinet & door with the sealing compound to avoid any water leakage.
  4. Drill a hole at the top most position of door liner to pour water.
  5. Pour the water in measured qty. till water is completely filled with main liner & door liner (start coming out from hole)
  6. After filling the main liner and door liner with water, the total volume capacity should be determined.

- **Precautions:**

  1. Digital Vernier / Measuring Tape to be used to reduce measurement errors.
  2. Geometric shapes to be selected as simpler as possible.

3. Measurements / recording to be done carefully.

4.8 BEE Testing for Washing Machine

4.8.1 Energy and Water consumption test

- **Test Objective:**

  To check and see energy consumption, water consumption as per standard.

- **TestCondition:**

  · Ambient Temperature: 23 ± 2 °C

  · 220v/50Hz

  · Load 8 kg

  · Hot Water Temperature: 60 °C

  · IEC-A-BASE – 104.72 Standard of load

- **Cloth Load:**

  · 03 Bed sheet

  · 08 Towel with Strip

  · 12 Pillow Cover

  · Adjustment towels

- **Test Procedure:**

  Cycle Run:- 15 min –Wash cycle ,01 min –Drain, 03 min –Rinse 1, 01 min –Drain , 03 min – Rinse2, 01 min –Drain, 02 min –Rinse 3, 01 min – Drain, 02 min – Rinse 4, 01 min – Drain, 10 min Spin.

4.8.2 Washing Performance test

- **Test Objective:** To determine the washing performance variation based on the placement of the laundry within the washing machine and its capacity for cleaning, then to calculate the washing machine's mechanical operation.

- **Test Method:**

  1. Make detergent with a 0.2 percent density, or 2 grammes of detergent per litre of water.
  2. Use a photometer to gauge the sample of contaminated cloth's reflectance
  3. Connect the contaminated cloth to the certified test cloth in step iii.
  4. Add detergent, larger cloths folded three times, and smaller cloths
  5. Run the machine at the recommended voltage and frequency for one full wash cycle, or 20 minutes.

- **Result:**

  The machine passed the test because there was a greater difference between the reflectance values before and after the test than was called for by the specifications.

Chapter 5

BIS- Bureau of Indian Standards

5.1 INTRODUCTION

The Bureau of Indian Standards Act of 1986 established the BIS, that charge of creating Indian Standards. BIS runs a Product Certification Scheme to safeguard consumers' interests. According to the plan, BIS issues licenses to firms who are able to produce goods continuously in accordance with the applicable Indian Standards. Making essential testing facilities available is necessary since testing is a crucial complement to evaluating the quality of a product. In order to handle the testing of samples obtained via its Product Certification Scheme, BIS created a network of eight independent laboratories in the nation.

5.2 BIS Testing for Refrigerator

5.2.1 Door Seal Test: -

- **Scope:**

  This Test Procedure is applicable on the Refrigerators.
- **Description of Item:** Direct Cool, Frost Free & Side by Side Refrigerators.
- **Reference Standards:** IS 17550 (Part 1)
- **Test Conditions:**

  1. Ambient Temperature: The ambient temperature shall be between + 16 °C and + 43 °C.
  2. Before conducting the test, the appliance must be turned off and the temperature in the room must be in equilibrium.
- **Purpose:**

  This test checks to see if the gaskets on the appliance's doors or lids are effective in stopping any unusual air infiltration.
- **Test Procedures:**

  1. The door or lid must be closed properly on a strip of paper that is 50 mm wide, 0.08 mm thick, and the appropriate length when inserted at any point of the seal.

  2. You can inspect the area near the seal with the appliance closed and illuminated from the inside to find the worst flaws.

  3. There must be no unusual air entry into the inside while the door or lid is closed.

  4. Both before and after the mechanical durability test, this test must be completed.
- **Judgment Criteria:**

  The paper strip must not slide easily in order to determine whether the seal is intact.

Fig. 5.1 Machine After Door Seal Test

5.2.2 Durability of Hinges & Door Test: -

- **Scope:**

  This Test Procedure is applicable for the Durability of Hinges & Handles to be conducted on the Refrigerators.

- **Description of Item:** Direct Cool, Frost Free & Side by Side Refrigerators.
- **Reference Standards:** IS 17550 (Part 1)
- **Test Conditions:**

  1. Ambient Temperature: The ambient temperature shall be between + 16 °C and + 43 °C.
  2. Loading as per mechanical strength of shelves and similar components test (IS 17550-1).
  3. The appliance shall be switched off.

- **Purpose:**

  The purpose of this test is to check the durability of the hinges and handles of doors and lids.

- **Test Procedure:**

  Opening sequence: The door must move under control from an opening angle of 0° to between 5° and 15° before being allowed to move freely.

  Closing sequence: The door's movement must be restricted from its 45° opening angle to an angle between 40° and 35°, then it must be free to move and close normally as in regular operation.

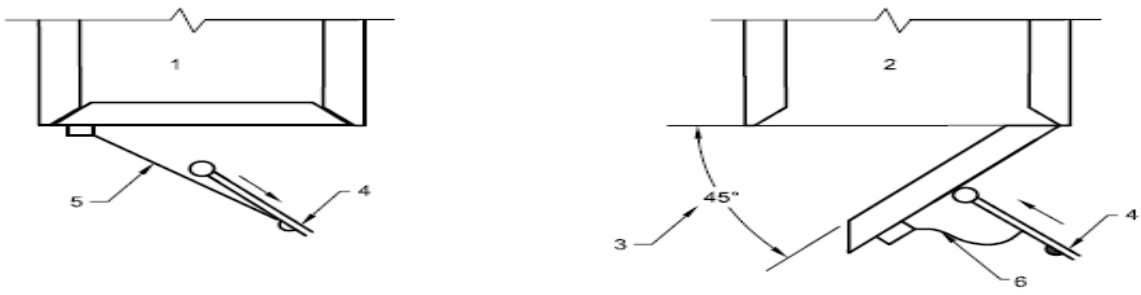


Fig. 5.2 Hinges & Doors

- **Judgment Criteria:**

1. No visible damage to the hinges, doors lids of refrigerator compartment.
2. After the test it is also comply with Door seal test and opening force of doors Test of IS 175501

5.2.3 Force of Opening Door Test: -

- **Scope:**

  This Test Procedure is applicable for the Force of opening of doors test to be conducted on the Refrigerators.

- **Description of Item:** Direct Cool, Frost Free & Side by Side Refrigerators.
- **Reference Standards:** IS 17550 (Part 1).
- **Test Conditions:**

  Ambient Temperature: The ambient temperature must range from 16 to 43 degrees Celsius.

- **Purpose:**

  The purpose of this test is to check that the doors or lids can be opened from the inside.

- **Test Techniques:**

  The 70 N opening force is to be regarded as having been applied to the interior of the door or lid of the appliance at the midpoint of the edge that is farthest from the hinge axis in a direction perpendicular to the plane of the door or lid.

  One of the following methods of measurement shall be used:

  The force needed to open the door or lid from the inside is calculated proportionally based on the distances between the handle and the internal measuring point, and can be applied in one of two ways.

- **Judgment Criteria:**

  The required force should not be greater than 70 N.

5.2.4 Mechanical Strength of Shelves Test:

- **Scope:**
- This Test Procedure is applicable for the Mechanical strength of Shelves Test to be conducted on the Refrigerators.
- **Description of Item:** Direct Cool, Frost Free & Side by Side Refrigerators
- **Reference Standards:** IS 17550 (Part 1)
- **Test Conditions:**

  Ambient Temperature: The ambient temperature shall be between + 16 °C and + 43 °C.

- **Purpose:**

  The components used to store food should be examined for mechanical strength (shelves, suspended containers).

- **Test Procedures:**

  1. For Frozen Food Storage Cabinet and Low Temperature Compartments:

  The midway position, A/2, of all sliding or rotating shelves and containers must be reached without modifying their load , with the exception that if stops are present that prevent movement beyond the halfway point, the components must be relocated to the stop. They must remain in this posture for one hour before being moved back to their starting position.

  When a product's manufacturer specifies in the usage instructions that a shelf or container must slide out for repair or shipping but must remain in a fixed position when in normal use, the item is deemed fixed, and the checking is done in the same manner as for the storage test.

  2. For Fresh Food Storage, Chill and Cellar Compartments:

  The appliance must be turned off, and the door(s) must be open.

  The components that will be put through testing must each be weighted with weights that have an 80 mm diameter and weigh 1000g, but only 500g in the event of components whose clear height in normal use cannot be higher than 150 mm. It is forbidden to load components that are made specifically to hold eggs.

  In order to fit the greatest number of weights without stacking them on top of one another or covering the edge of the component being tested, the weights must be positioned with their axes vertical.

5.2.5 Temperature Rise Test: -

- **Scope:**

  This Test Procedure is applicable for the Temperature Rise Test to be conducted on the Refrigerators.

- **Description of Item:** Direct Cool, Frost Free & Side by Side Refrigerators
- **Reference Standards:** IS 17550 (Part 2)
- **Test Conditions:**

  Ambient Temperature: The ambient temperature shall be between + 16 °C and + 43 °C.

- **Purpose:** This test's goal is to determine how long it takes for packages inside a refrigerator with one or more three- or four-star compartments to reach the desired temperature.
- **Test Techniques:**

  1. Annex B of IS 17550 must be followed while installing the refrigeration device (Part 1).

  2. [As for the storage test (see 6)], it shall be prepared, stabilised, and filled with test packages and M-packages.

  3. All frozen compartments must reach or be colder than the temperatures listed in Table 2 before the controls are set and the refrigerator is turned on.

Sl No.	°C								
	Compartment type								
	Fresh Food		Three-star and Four-star	Two-star	One-star	Zero-star	Chill	Cellar	Pantry
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	T_{1m}, T_{2m}, T_{3m}	T_{ma}	T^{***a}	T^{**a}	T^{*a}	T_{zma}	T_{oci}	T_{cma}	T_{pma}
ii)	$0 \leq T_{1m}, T_{2m}, T_{3m} \leq +8$	$\leq +4$	≤ -18 [b]	≤ -12 [b]	≤ -6	≤ 0	$-3 \leq T_{oci} \leq +3$	$+2 \leq T_{cma} \leq +14$	$+14 \leq T_{pma} \leq +20$
	average	average	maximum	maximum	maximum	average	instantaneous	average	average

[a] The superscripts attached to the symbol *T* correspond to the three-star and four-star, two-star or one-star compartment temperature.

[b] During a defrost and recovery period, these storage temperatures of frost-free refrigerating appliances are permitted to rise by no more than 3 K.

NOTE — For definitions of symbols, *see* 3.7 in IS 17550 (Part 1).

Fig. 5.3 Compartment Temperatures

- **Test Period & Measurements:**

  1. As soon as steady working conditions are attained, the power supply to the refrigeration equipment must be shut off. This must occur during the stable portion of the defrost control cycle for automatic defrosting refrigerators.

  2. The times when the first M-package in any three-star or four-star compartment initially reaches - 18 °C and the first time that it hits - 9 °C must be recorded.

  3. It's possible that the first M-package to reach - 18 °C wasn't the first to - 9 °C.

- **Data to be recorded:**

  For each test, the following information must be documented (where appropriate):

  a) The surrounding temperature.

  b) The amount of time needed for the temperature to drop from - 18 °C to - 9 °C.

- **Judgment Criteria:**

  The time for temperature rises at the conclusion of the test must equal at least 10% of the manufacturer's reported value.

5.2.6 Test for absence of odour and taste: -

- **Scope:**

  This Test Procedure is applicable for absence of odour and taste to be conducted on the Refrigerators.

- **Description of Item:** Direct Cool, Frost Free & Side by Side Refrigerators
- **Reference Standards:** IS 17550 (Part 1)
- **Test Conditions:**

  1. Ambient Temperature: The ambient temperature must range from 16 to 43 degrees Celsius.

  2. The device must be cleaned prior to the test as directed by the manufacturer and then with pure water.

- **Goal:** The materials used within the appliances must not impart flavors or odors to meals.
- **Test Techniques:**

  1. The appliance must first be used for 48 hours while the thermostat and other control devices are set to the target temperatures.
  2. For each compartment, 100 ml of potable water and a fresh, unsalted butter slice with measurements of 75 mm by 35 mm by 5 mm will serve as the analysis samples and check samples, respectively.
  3. The check samples should be put in hermetically sealed glass containers, while the analysis samples should be put on petri plates. Before the test, all petri dishes and containers must be cleansed with strong nitric acid and then thoroughly washed with distilled water until the smell is completely gone.

- **Examination of Samples:**

  At least three expert assessors who are familiar with the test procedure must conduct the examination, which must take place roughly two hours after the samples have been removed from the appliance. The following samples must be given to each expert assessor: two samples of water for analysis, two samples of water for verification, two samples of butter for analysis, and two samples of butter for verification.

  The expert assessors must not be informed of the samples' identities. Prior to doing a taste test, an odour test must be conducted.

- **Judgment Criteria:**

  The odour and taste shall not be greater than mark1.

5.2.7 Water Vapour Condensation Test: -

- **Scope:**

  This Test Procedure is applicable for the Water Vapour condensation test to be conducted on the Refrigerators.

- **Description of Item:** Direct Cool, Frost Free & Side by Side Refrigerators.
- **Reference Standards:** IS 17550 (Part 1) & IS 17550 (Part 2)
- **Test Conditions:**

  1. Ambient Temperature: The ambient temperature must range from 16 to 43 degrees Celsius.

  2. For class ST and T refrigerating equipment, the humidity must be such that the time-averaged dew point is + 27 °C 0.5 K.

- **Purpose:**

  This test's objective is to ascertain how much water condenses on the exterior of the refrigerator

under particular environmental conditions.

- **Test Procedures:**
  1. The refrigerating appliance shall be installed in accordance with Annex B of IS 17550 .
  2. Compartment average air temperatures shall be determined as specified in Annex D of IS 17550-1 and throughout the test average compartment.
  3. Air temperatures shall be at or below the target temperatures for an energy test in specified in Table 1 of IS 17550 (Part 3)

Sl No.	Compartment Type	Target Average Air Temperature °C
(1)	(2)	(3)
i)	Pantry	17
ii)	Wine storage	12
iii)	Cellar	12
iv)	Fresh food	4
v)	Chill	2
vi)	Zero-star	0
vii)	One-star	−6
viii)	Two-star	−12
ix)	Three-star and four-star	−18

Fig. 5.4 Target Temperature for Energy determination by compartment type

- **Test Period:**

  All external surfaces of the refrigeration appliance must be gently dried with a clean towel once stable working conditions have been reached before the test is resumed for another 24 hours. The most likely time for condensation to occur should be chosen as the observation period.

- **Judgment Criteria:**

  At the end of the test, no running water shall appear externally.

Chapter 6

Results And Discussions

Throughout the entire process of manufacturing home appliances, quality control is crucial. The maker of the appliances runs a number of tests on the home appliances. The majority of the tests are done by the testing systems at many testing laboratories spread out over a large area. The test systems are composed of three components: sensor-equipped equipment, computing devices, and sensor-based test software. The test application component, which is thought of as the foundation of the test systems, is in charge of automatically gathering, managing, analyzing, and displaying the data for the users.

6.1 BEE Testing Results

6.1.1 Comparison Test between Old standard and New Standard For refrigerator

Table1.11 Comparison between Standards results

S No.	FF Model	Total Net Volume	Tot.Adj Volume	BEE Current Limit Kwh/Yr	BEE New Limit Kwh/Yr	LG Current Declared Kwh/Yr	BEE New Std Measured Value Kwh/Yr				
							CH#14	CH#13	CH#04	CH#02	CH#03
1	GL-T382VPZX	335	384	229.3	256.6	217	254.4	262.2	257.1	256.6	260.6
2	GL-B199O**C	180	184.3	215.9	271.3	197	182.5	184.3	179	169.9	176.7

Chamber Variation									
CH#14 to CH#13	CH#14 to CH#04	CH#14 to CH#02	CH#13 to CH#04	CH#13 to CH#02	CH#04 to CH#02	CH#14 to CH#03	CH#13 to CH#03	CH#04 to CH#03	CH#02 to CH#03
3.10%	1.10%	0.90%	1.90%	2.10%	0.20%	2.44%	0.61%	1.36%	1.56%
1.00%	1.90%	6.90%	2.90%	7.80%	5.10%	3.17%	4.12%	1.28%	4.01%

6.1.2 Washing Machine Test Results

Table1.12 Result for Energy test for Washing machine

Parameters	Specification	Test Result	Units
Energy Consumption	Observation	0.0106	KWh/Kg/cycle
Water Consumption	< 23L/Kg/cycle	15.32	L/Kg/cycle
Washing Performance	>80%	91.3	%
Water Extraction	<75%	57.71	%
Rinsing Performance	<2.25	1.15	Ratio

6.1.3 Room Air Conditioner Test Results

Table1.13 Result for Energy test for Room Air Conditioner

To be Filled by the Laboratory/Manufacturer				
S No.	**Parameters**		**35°C**	**29°C**
a	Cooling Load			
b	Cooling Capacity	Full Capacity	**5106**	5499
		Half Capacity	**2523**	2717
		Minimum Capacity		
c	Power Consumption	Full Capacity	**1458**	1332
		Half Capacity	**483**	442
		Minimum Capacity		
1	Cooling Seasonal Total Load (CSTL) in kWh		**3952.51**	
2	Cooling Seasonal Energy Consumption (CSEC) in KWh or Electricity Consumption in units per annum		**847.97**	
3	Indian Seasonal Energy Efficiency Ratio - Cooling (ISEER-Cooling)		**4.66**	

6.1.4 Microwave Oven Test Results

Table1.14 Result for Standby Power and Energy Efficiency test

Test Item	MS4295 TA 1# (011)	MS4295 TA 1# (007)	MS4295 TA 3# (009)
Standby Power (Limit: 0.6 watt ↓)	0.55 watt	0.58 watt	0.57 watt
Energy Efficiency (Limit: 54% ↑)	62.5%	62.2%	62.2%

6.2 BIS Testing Results

Table1.15 Result for Door Seal Test

Door Seal Test Report					
Model Name	GL-T382VPZX	Market	India	Prepared By	
Platform	-	Climate Class	T	Approved By	
Development grade	-	Test Condition	Room ambient	Result	Pass
Event	-	Input Supply (Vac/Hz)	-	BIS test Report	
Test Period		Chamber No	-		
Test Standard	IS 17550-1	Test Report Date			

Test	Door Seal test
Purpose	To ensure that the gasket of the door of the refrigerator adequately prevents any ingress of the surrounding air.
Test Equipment	Paper Strip: Width: 50mm, Thick: 0.08mm, suitable length
Test Method	Strip inserted at any point of the seal and the door closed normally on it. The strip of paper shall not slide freely.
Ambient	Between +16°C and +43°C
Judgement Criteria	Strip shall not slide freely
Comment	
Before durability test	Strip is not slide freely
After durability test	

Table1.16 Result for Durability Test

Durability test (Door opening & closing) Test Report					
Model Name	GL-T382VPZX	Market	India	Prepared By	
Platform	-	Climate Class	T	Approved By	
Development grade	-	Test Condition	Room ambient	Result	Pass
Event	-	Input Supply (Vac/Hz)	-		
Test Period		Chamber No	-	BIS Test report	
Test Standard	IS 17550-1	Test Report Date			

Test	Doors & lids opening - Closing durability test
Purpose	The purpose of this testis to check the durability of the hinges and handles of door(s) and lid(s),
Test Equipment	Opening closing test setup
Test Method	The door shall be opened at least 45° from the cabinet reference wall before it starts closing. The number of cycles per minute shall be 10 to **20**. Opening sequence: From 0° to between 5° and 15° Closing sequence: From 45° to between 40° and 35°, The number of cycles per minute shall be **20** to 25 a) For compartments with an internal temperature T> -6°C, external doors and lids shall withstand 100000 opening and closing operations without deterioration whichcould be prejudicial to the air tightness of the door or lid. b) For compartments with an internal temperature Ts -6°C, external doors and lids shall withstand 30000 opening and closing operations without deterioration which could be prejudicial to the air tightness of the door or lid.
Ambient	Between +16°C and +43°C
Judgement Criteria Door-Fresh food	Shall withstand 100000 openings and closings without deterioration
Judgement Criteria Door-Freezer	Shall withstand 30000 openings and closings without deterioration
Tester Comment	

Table1.17 Result for Door Opening Force Test

Door Opening Force Test Report					
Model Name	GL-T382VPZX	Market	India	Prepared By	
Platform		Climate Class	T	Approved By	
Grade	-	Test Condition	Room ambient	Result	Pass
Event	-	Input Supply (Vac/Hz)	-		
Test Period	9/5/2022	Chamber No	-		
Test Standard	IS 17550-1	Test Report Date			
	Door	Sample #1			
		Reading (Newton)			
		Door Center		Door corner	
	R Door	55		30	
	F Door	33		21	
Judgment	Door Opening Force for both R&F Door is <70N				
Comment	The force required for opening the door is not exceding 70 N				
Before durability test					
After durability test					

Table1.18 Result for Mechanical Strength test

Mechanical strength of shelf & similar components						
Model Name	GL-T382VPZX	Market	India	Prepared By		
Platform	-	Climate Class	T	Approved By		
Development grade	-	Test Condition	Room ambient	Result	Pass	
Event	-	Input Supply (Vac/Hz)	-			
Test Period		Chamber No	-	BIS Test report		
Test Standard	IS 17550-1	Test Report Date	-			
Test	Mechanical strength of shelf & similar					
Purpose	To check the mechanical strength of the components used for storing food					
Test Equipment	Cylindrical weight (80mm) Dia: 80mm (may varry as per area)					
Test Method	Put load for 1 hour, max possible load					
Ambient	Between +16°C and +43°C					
Judgement Criteria	1. After storage test show no visible distortion after removal of the weights					
	2. Should show no visible distortion					
Tester Comment	**No visible distortion**					

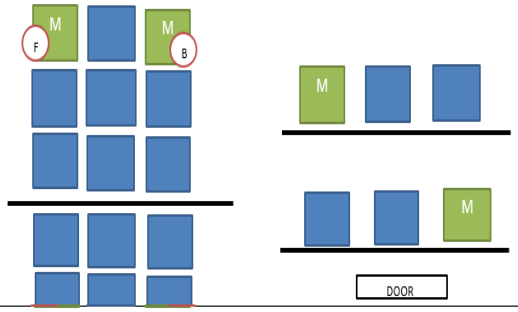
Table1.19 Result for Temperature Rise Test

TEMPERATURE RISE TEST REPORT

Model Name	GL-T382VPZX	Market	India	Test Report Date	
Platform	-	Climate Class	T	Prepared By	
Development grade	-	Test Condition	25°C	Approved By	
Event	-	Input Supply (Vac/Hz)	230V/50Hz	Result	PASS
Test Period	12-05-22 to 15-05-22	Star Rating	4 STAR	Chamber no	13
Test Standard	IS 17550-2.1	Total Load	21Kg	BIS Testing Report	

LOCATION OF M-PACKAGE

TEMPERATURE RISE TEST



	Time	Ambient(°C)
Temperature rise time from -18°C to -9°C	15.95 hours	25.2

Table 1.20 Result for absence of odour and taste test

Test for absence of odour and taste Test Report

Model Name	GL-T382VPZX	Market	India	Prepared By	
Platform	*	Climate Class	T	Approved By	
Development grade	*	Test Condition	At room ambient	Result	PASS
Event	*	Input Supply (Vac/Hz)	230V/50z	BIS test Report	
Test Period		Chamber No			
Test Standard	IS 17550-1	Test Report Date			

Test	Test for absence of odour and taste
Purpose	The purpose of this test is to check that materials used for the internal components of the fresh food storage compartments and cellar and chill compartments, if any, will not impart either taste or odour to food.
Test Equipment	Petri dishes Glass container
Test Method	First operate for 48 hour For Fresh food tam= + 4 °C ± 2K; For Cellar 8 °C ≤ tcm.a ≤ +14 °C; and
Ambient	16°C to 32°C
Sample	a) 100ml potable water (six sample) b) Slice of fresh unslated butter (75×32×5)mm (six sample)
Judgement Criteria Door	By three exper assesors Mark 0/1/2/3

Evaluator Observation

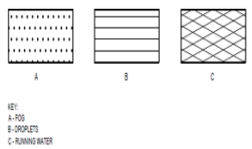
Name	Observation	Mark
EUINSIK	**No Odour**	**0**
ABHISHEK	**No Odour**	**0**
AVANTIKA	**No Odour**	**0**

Table 1.21 Result for Water Condensation Test

Water condensation Test Report

Model Name	GL-T382VPZX	Market		India		Prepared By	
Platform	-	Climate Class		T		Approved By	
Development	-	Test Condition		RT 32 ± 0.5°C RH 74%		Result	Pass
Event	-	Input Supply (Vac/Hz)		230V/50Hz			
Test Period		Test Report Date				BIS Test report	
Test Standard	IS 17550-2	Chamber No		6			
	Front Side	Left Side	Right Side	Back Side	Top Side & Door	F C & LC	PCB

A	Fog
B	Droplets
C	Running waters



Compartment		Sample #1	
		Observation Level	Status
Door Out Side (F/R)	F/R Gasket out side	No fog & No dew	ok
	Gasket inside	No fog & No dew	ok
	F/R Door Front	No fog & No dew	ok
	Not Visible area Cap Deco	No fog & No dew	ok
	Inner Dike	No fog & No dew	ok
	F/R door Side	No fog & No dew	ok
	F/R Handle	No fog & No dew	ok
Case	Case Top/left /right	No fog & No dew	ok
	Case Left/Right/ Top near gasket area	No fog & No dew	ok
	Case Back	No fog & No dew	ok
	Front C	No fog & No dew	ok
	Front L	No fog & No dew	ok
Other Area	Door Switch	No fog & No dew	ok
	Main PCB	No fog & No dew	ok
	Out let Lead wire	No fog & No dew	ok
	Display	N/A	ok
	S- Pipe	No fog & No dew	ok
	Hinge Cover	No fog & No dew	ok
	Hinge Cover inside	No fog & No dew	ok
	PCB cover inside	No fog & No dew	ok

Conclusion & Future Scope

Considering the fact that Standardization, Standard Testing and Product Certification is one of the major aspects in any organization, it is anticipated that the so far discussed projects would go a long way in the premises of **LG Electronics India Limited, Greater Noida.**

Overall, my stay at LG Electronics India Limited, Greater Noida as a member of STANDARD and DEVELOPMENT PLANNING team has been quite beneficial for me. It was extravagant learning process for me where I face the technical as well as the practical aspects of how a department functions and how it remains flexible & maintains its efficiency even at some unfavorable times.

With the help of the testing results we are trying to develop a new export model as per the export standards and also, we are trying to reduce the value of energy by 20% especially for washing machine product.

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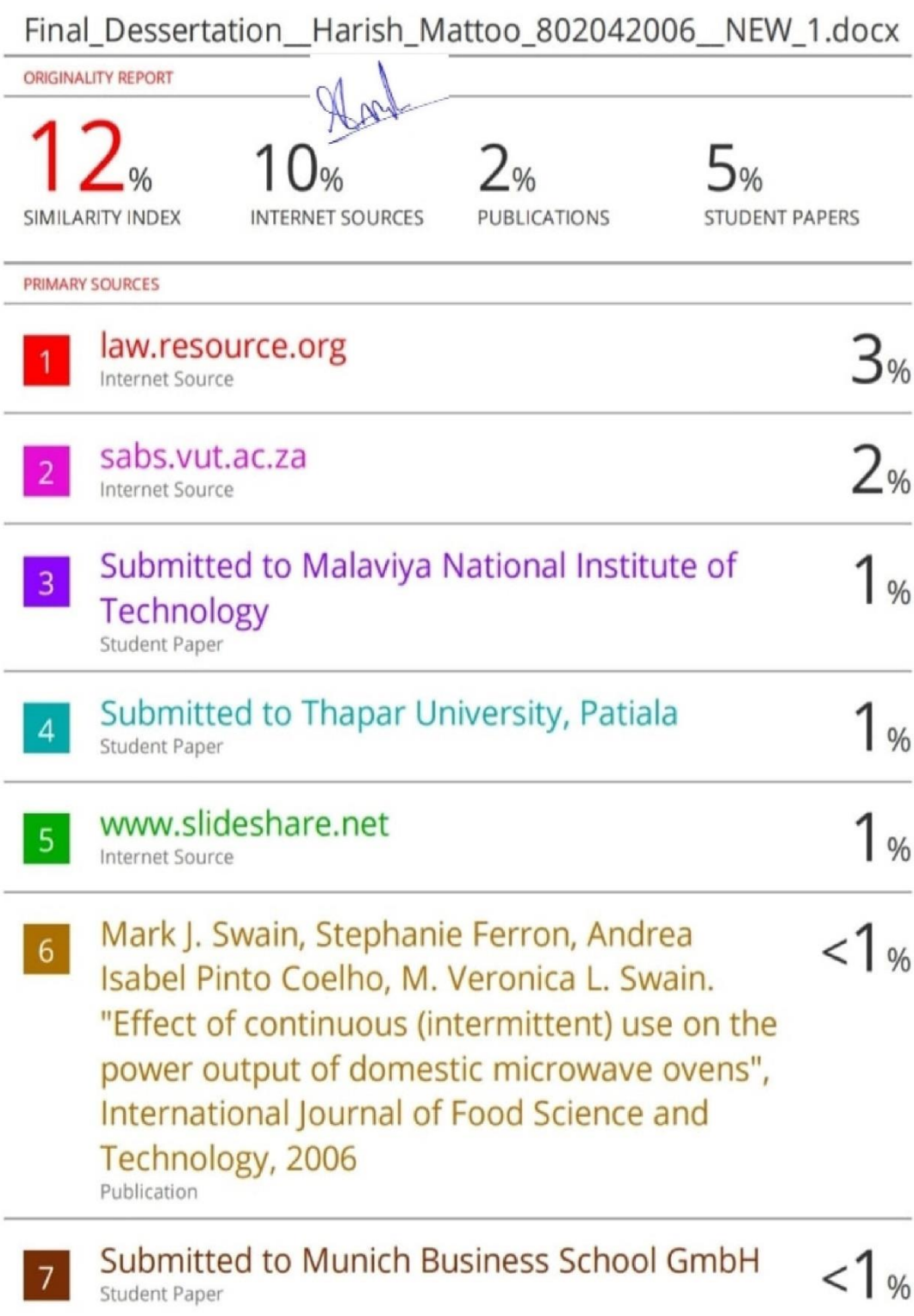

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