ETHIOPIAN STANDARD

ES 6053:2018

First edition

Electric Power Supply System and Machines - Technical and Performance Requirements For Household Open Resistor Based Electric Stove

ICS:97.040.20

Published by Ethiopian Standards Agency

FOREWARD

This Ethiopian Standard has been prepared under the direction of the Technical Committee for Electric Power Supply System and Machines (TC 62) and published by the Ethiopian Standards Agency (ESA). The standard has been developed to address observed needs and to support the local industry in order to make progress through upraising competitiveness and maintain comparative market advantage both domestically and internationally. Information has been gathered from various relevant sources in developing the technical specification.

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Abbreviations

ES - Ethiopian Standard

IEC - International Electro technical commission

OIML- International Organization of legal metrology

ISO - International organization for standardization

SEC - Specific energy consumption

kWh - Kilo watt hour

kg- Kilo gram

cm- centimeter

mm- Millimeter

CCT- controlled cooking test

PC- Power consumption

C-KPT- controlled Kitchen Performance Test

PC – power consumed

PHU (percentage heat utilized) or Efficiency

Electric Power Supply System and Machines - Technical and Performance Requirements For Household Open Resistor Based Electric Stove

1 Scope

This E thiopian standard covers cons tructional, electrical and physical (design a nd di mensional) requirements for household and similar use open Resistor Electric heated Cook Stove, rated voltage being not more than 250 Vfor single phase appliances connected between phase and neutral.

2 Normative reference

The following reference documents are used for the application of this Ethiopian standard. For dated references, only the latest edition of the documents (including any amendments) shall be applicable. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60335-1:2013, Household and similar electrical appliances-safety Part 1: General requirements.

ES IEC60335-2-6:2014, Household and similar electrical appliances-safety Part-2-6: Particular requirements for stationary cooking ranges, hobs, ovens and similar appliances.

ES IEC60335-2-9:2012, Household and similar electrical appliances-safety Part-2-9: Particular requirements for grills, toasters and similar portable cooking appliances.

IEC 60335-2-36:2008, Household and similar electrical appliances-safety Part-2-36: Particular requirements for commercial electric cooking range, ovens and hobs and similar elements.

ES 3406:2007, Electric cooking ranges, hobs, ovens and grills for household use — Methods for measuring performance.

ES IEC 60906-1, Plugs and socket outlets for household and similar purposes.
ES IEC 60245-1, Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 1: General requirements

IEC 60245-4 , Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 4: Cords and flexible cables

ES IEC 60990, Methods of Measurement of touch current and protective conductor current

ES OIML R79:2013, Labeling requirements for prepackaged products

ES 3978:2016, Electric heating element/resistor

3 Terms, definitions and abbreviations

3.1 Terms and definitions

Also terms and definitions described in ES IEC 60335-2-6 and ES IEC 60335-2-9, ES 3788, ES OIML R79 shall be used. For the purpose of this standard, the following definitions shall apply:

3.1.1 Electric Insulator
A substance which does not readily allow the passage of electricity

3.1.2 Heat Insulator
A substance which does not readily allow the passage of heat

3.1.3 Electric Conductor
Material or device that allows electricity.

3.1.4 Heat Conductor
Material or device that allows heat.

3.1.5 Clay Liner
A ceramic material used to produce stove plate

3.1.6 Plate
Moldedand fired clay, ceramic ormolded gypsum liners that are used for holdingstove resistor (heating element)

3.1.7 Resistor
Heating element that is used to heat the electric cook stoveplate.

3.1.8 Switch
A device for making and breaking the connection in an electric circuit.

3.1.9 Pitch
The space between successive corresponding grooves where heating element is inserted.

3.1.10 Depth
The measure that indicates how deep the plate is grooved to place the resistor (heating element).

3.1.11 Diameter
The distance between ends to end across the center of the plate

3.1.12 Cladding
Covering of the side and bottom of the clay plate

3.1.13 Electrical energy input
The energy required to raise the temperature ($T^{o}c$) of water from initial to test $T^{o}c$ during water boiling test.

3.1.14 Thermal efficiency
The Ratio of heat absorbed by water to the equivalent electrical energy supplied.

3.1.15 Rated voltage
The supply voltage assignedfor the appliance by the manufacturer

3.1.16 Rated power
Maximum power declared by the manufacturer

3.1.17 Rated current
Maximum current declaredby the manufacturer

3.1.18 Normal operation
Conditions under which the electric stoves operated in normal use when it is connected to the main supply

3.1.19 Connecting wire (Amharic: *'woraj'*)
A heat resistant electric wire that connects the heating element and the terminal connector.

3.1.20 The power output rating (Po)
Useful energy received per unit of time.

3.1.21 Specific Energy consumption

3.2 General requirements

3.2.1 The electric stoveplate shall be made from clay, gypsum and ceramic material or other materials having similar properties
3.2.2 The thickness of plate for flat type shall be uniform.
3.2.3 The slot depth and slot pitch shall be uniform throughout the plate.
3.2.4 Terminal connector shall be made of heat resistant material.
3.2.5 The accessible metal parts of electric stoveshall be connected to earthling terminal/contact for protection against electric shock..
3.2.6 Connecting wire (Amharic: woraj) between the heating elementandthe terminalconnector shall be enclosed in high heat resistive insulator.
3.2.7 The wire between the terminal connector and the double pole switch shall be heat resistant or enclosedwith heat resistant material.
3.2.8 Each cooking plate shall be equipped with variable energy regulator, thermostatic or other automatic control, or a double pole switch having at least on and off position.
3.2.9 All legs of electric stove shall have uniform height
3.2.10 Electric stove shall have safehandling
3.2.11 Slot pitch shall be uniform across the stove plate

4 Specific requirements

4.1 Switch

4.1.1 The switch shall bethermostat switch with user selectable range.
4.1.2 Switch shall be protected against heat and /or liquid.

4.2 Power cable

4.2.1 The electric stove power cable quality shall comply with ES IEC 60227, rubber insulated cables rated voltage up to and including 450/750V.

4.2.2

4.2.3 the power cable size shall with stand the current carrying capacity and comply with ES IEC xxxx.

4.2.4 The minimum power cable length shall be not less than 1.5 meter from the switch

4.3 Plug

4.3.1 The plug of electric stove shall comply with ES IEC 60906-1, plugs and socket outlets for household and similar purposes

4.4 Cable entrances (grommet)

4.4.1 Cable entrance shall be made of rubber, free from sharp edge and tightly fixed to the body

4.5 Protection against electric shock

4.5.1 All accessible metal parts shall be connected to an earthling terminal or contact reliably.

4.6 Clamp

4.6.1 The stove power cable shall be fixed to the stove body with appropriate clamp.

4.7 External Finish (Body)

4.7.1 The external finish used on metal components shall be of heat and moisture resisting nature and shall not be adversely affected by variation in temperature occurring under normal operating conditions.

4.8 Plate

4.8.1 The width and depth of the slot shall

4.9 Resistor Wire

4.9.1 Tightly hold the resistance wire in the slot with enough clearance from the top surface of the plate.

4.9.2 Hold the resistor wire in place during normal operation and under idle condition in up-right position.

4.9.3 A bowel type electric stove shall not have a hole at the center.

4.10 Resistor Wire Standard

4.10.1 Electric stove resistor shall comply with ES 7938

5 Safety

The safety requirement for electric Cook stoveshall comply with ES IEC 60335-2-6wheneverapplicable

5.1 Body temperature of the stove

5.1.1 5.1.1 Bottom temperature of the stove shall not exceed 80oC

5.1.2 5.1.2 Side temperature of the stove shall not exceed 60oC

5.2 Constructional requirements

The frame and enclosure of an appliance shall be of substantial angle iron and sheet metal or ofreinforced sheet metal or of cast iron or other acceptable construction and shall be sufficiently rigid and robust to withstand, without deformation, the stresses applied during installation, transportation, and general usage of the appliance.

6 Performance Requirement

The minimum Thermal Efficiency

The minimum thermal efficiency of locally produced single resistor electric stove shall be 40%. It shall be determined based on Water Boiling Test Procedure shown below:

Table below lists the analysis needed to determine the performance of the stove. See details in Annex Section 7.1.8

Parameters	Unit	Formula
Time to Boil	(min)	t2 – t1
Temperature corrected Time to Boil	(min)	(t1 – t1)*75/(T2 - T1)
Energy Input	(kWh)	E2 – E1
Energy Output	(kWh)	[Ww/1000 * 4.186*(T2 – T1) + 2.26 * (W1 – W2)]/3600
Power Input	(kW)	Energy Input / (Time to Boil * 60)
Power Output	(kW)	Energy Output / (Time to Boil * 60)
Efficiency	(%)	(Energy Output / Energy Input)*100%
Temperature corrected Time to Boil	(min/kg)	**Time to Boil / (Ww * 1000)**
Specific Energy Consumption	(kWh/kg)	**Energy Input / (Ww * 1000)**

Where:

t1	Starting time
t2	Time water boils
E1	Initial kWh reading
E2	kWh reading at boiling
Ww	Initital weight of water
WP	Weight of dry empty pot or saucepan
W1	Initial weight of water and pot
W2	Final weight of water and pot
Tai	Ambient Temperature at the beginning of test
Taf	Ambient Temperarature at the end of test
T1	Initial temperature of water
T2	Boiling temperature of water
HP	High Power Phase

7 Labeling and packing

Labeling

In addition to the requirements in ES OIML R79:2013, each package shall be legibly and indelibly marked with the following:

a) Name of Producer
b) Description of the Product
c) RatedVoltage
d) Rated frequency
e) Rated Power
f) Trade name;
g) Address

8 Testing Method

See Annex A for detail testing method.

Annex A

Testing Method for Locally Manufactured Electric Stoves

1 Dimensions of stoves (with hotplates and cooking zones)

The main dimensions of hotplates and cooking zones are determined as follows

Size of the stove

- for solid hotplates, the diameter of the surface intended to come into direct contact with the bottom of saucepans is measured;
- for open resistor based electric stoves, the cooking zone is the area bound by the diameter of the outer resistor.
- The dimensions are indicated in millimetres rounded to the nearest 1 mm.

Mass of the stove

- The mass of the stove is determined and expressed in grams, rounded to the nearest gram.

2 List of measurements

The performance of the stove is determined by the tests listed below:

The following tests are carried out. A minimum of three sets of tests need to be conducted. The first set of tests should be conducted but each time sufficient time need to be allowed for any part of the stove body to come to the room temperature.

First Set of Tests:-

- Water heating to the boiling temperature
- calculation for the result of the stove

3 Standard Test Conditions

Unless otherwise specified, the measurements are made under the following conditions.

3.1 Test room

The tests are carried out in a substantially draught-free room in which the ambient temperature is preferably maintained at 20 °C ± 5 °C.

3.2 Voltage

The stove is supplied at rated voltage, 220 V ± 5 Volt.

3.3 Instrumentation

The temperature measuring instrument including thermocouples shall have an accuracy of 0.5 °C.

The energy measuring meter shall have an accuracy of 1 %.

3.4 Positioning the stove

Table-top stoves are positioned away from side walls.

3.5 Setting of controls

The control is set to give the temperature specified for the test. However, if the temperature cannot be attained due to the construction of the control, the nearest setting related to the specified temperature is chosen. This applies only to stoves that have power control nobs.

4 Specifications

Specifications of the saucepan (or cooking pan)

The saucepan is made of aluminium and same type should be used for all tests. It should be cylindrical with flat area at the base. It should be without metallic handles or protrusions.

The size of saucepan shall match the size of the cooking zone as much as possible. However, it may vary by a maximum of +20 mm and −10 mm. For determining the size of the saucepan, the outer diameter of the flat bottom of the saucepan is measured. Saucepan sizes are shown in table below.

Saucepan for test is fitted with holder for thermometer without lid. The temperature sensor is positioned at the center of saucepan in the middle level between the saucepan bottom and the top level of the water.

NOTE - The base of the saucepan shall not to be convex for flat cooking area.

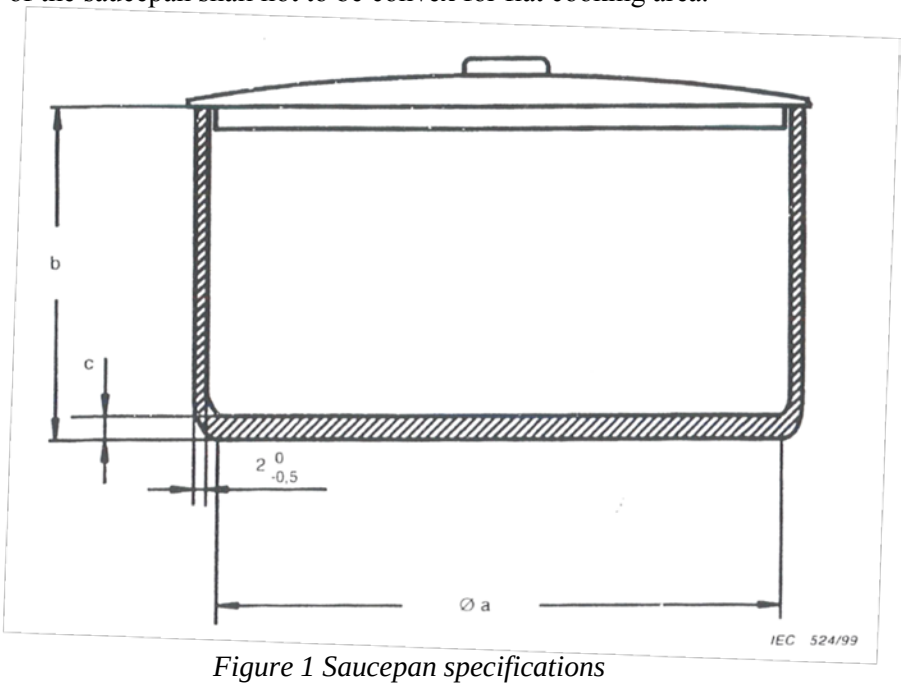

Figure 1 Saucepan specifications

Table 1 Saucepan dimensions

Diameter of cooking zone mm	**Diameter of the saucepan bottom ('a' outside)** mm	**Height of the saucepan ('b' outside)** mm
≥100<130	120	125
≥130<160	150	125
≥160<190	180	125
≥190<220	210	125
≥220<250	240	**125**
≥250<280	270	125
≥280<310	300	125
≥310<330	330	125

5 Testing process for locally manufactured stoves (measurements)

Measuring the energy consumption
The test is performed three times (the stove is tested only with one saucepan)

5.1 Water Boiling Test (i.e. Water heating to the boiling temperature)

5.1.1 High Power Test -

This test is separately conducted for the same stove with a cold start.
An aluminium saucepan is used for the test, as per the specification given in Section 4 above, figure 1.
The saucepan is filled with the quantity of potable water as specified in Table 2 below.
Initial water temperature should be about the same as the room temperature.

The saucepan with the fixture of thermometer is positioned centrally on the cooking zone. The fixture for the thermometer is used and sensor is placed on the centre of the pot in the middle between the saucepan bottom and the top level of the water.

See footnote for notes[1]

Table 2 - Quantity of water in the saucepan

Diameter of cooking zone Mm	**Quantity of water** *gram*
≥100<130	650
≥130<160	1030

[1]NOTE 1 - This test is applicable tor comparative testing only.
NOTE 2 - Commercially available saucepans which have equivalent thermal and mechanical properties may be used.
NOTE 3 - For non-circular cooking zones, an appropriately shaped saucepan may be used.

≥160<190	1500
≥190<220	2050
≥220<250	**2700**
≥250<280	3420
≥280<310	4240
≥310<330	5140

- For stoves with a power control nob, the cooking zone is heated with the control set at maximum.
- The time taken for the water temperature to rise to the local pre-determined boiling temperature and the corresponding energy consumption ismeasured.
- The time is stated in minutes and seconds.
- The energy consumption is expressed in watt-hours.

5.2 Calculation of the result for a stove

The energy consumption for cooking stoves shall be normalized to 1000 g. This is done by dividing the energy consumption by the quantity of water used for the saucepan under test.

6 Test results

Test report shall include the following per tested stove:

- Date/time of test
- Manufacturer / Brand
- Model/Name/Serial number
- Power rating / Rated power proclaimed by manufacturer
- Material, weight and dimensions of appliance
- Test conditions, if differ from baseline
- Type of switch/regulator
- Photo for the stove
- Test data

The test results can be reported on the test data sheet of test results for energy consumption of cooking process. The data sheet is shown in 7.1.8 below.

7 Instruction for Water Boiling Lab Test

7.1 Preparation for test

7.1.1 General

Before conducting the test determine the size of the saucepan and the weight of water for the test as per the specification in Section 5. For instance, for a stove with a cooking zone of 220 mm, use a saucepan of diameter 240 mm and height of 125 mm. Fill the empty saucepan with 2,700 gram of water. Both the stove and the saucepan shall be at ambient temperature.

7.1.2 Preparation before start of testing

Prepare the test set up including fixtures to hold a thermometer.
Measure and record ambient air temperature.
Determine the local boiling temperature of water. The boiling temperature is the temperature where water is boiling at the stabilized temperature with small difference.

7.1.3 Preparation for testing

- Measure and record the **ambient air temperature**.
- **Record dry weight of the pot Wp (g)**.
- Weigh the determined amount of **water Ww**and pour water to the pot.
- Place the saucepan without lid at the centre of the cooking zone.
- Using the fixture for the thermometer, place thermometer in the centre of the pot in the middle between the bottom of the pot and the water level.
- The **initial water temperature (T1)** shall be the same as the room temperature.
- Measure and record the **initial water temperature in the pot**.

7.1.4 High Power Phase (HP)

- Make sure the stove and the saucepan are at room temperature before starting the test.
- Start heating the stove after the saucepan is properly placed on the stove. If the stove has power regulator nob, make sure that it is set to maximum power and start the measurement immediately.
- Start the timer and record **the starting time (t1)**.
- Start the energy meter and record **energy consumption (Watt hours**).
- When the water reaches the pre-determined local boiling temperature record the **time (t2)** and this **temperature (T2)**.
- At the end of the test, weigh and record theamount of water in the pot. Weigh the water together with the pot. A loss of water is assessed to be vaporized during the test.
- Record the **energy consumption E2**.

Repeat the test for High Power Phase (HP) at least three times. If consistent data is not obtained repeat few more times and discard outlier which are caused by uncontrolled outside interferences (i.e. wind, too low or high a voltage from the main, errors in recording test data, etc.)

7.1.5 Analysis of test data

- Note the **energy consumption is** normalized to 1,000 g.
- Divide the energy consumption by the quantity of water used for the saucepan under test.

7.1.6 List of Testing Equipment

Below is basic testing equipment needed to conduct a water boiling test on an electric stove in a simple lab:

- Digital energy meter for measuring: electricity consumption (Wh), voltage (V), current (A), time (s), power (W)

- Digital temperature meters: thermocouples or thermometer
- Non-metallic holder fixture for thermocouple (this shall be constructed for measurements)
- Digital weighing scale
- Air pressure meter (barometer) to determine local boiling temperature from local atmospheric pressure. If barometers are not available, boil water until it comes to boil while monitoring the temperature. Mark the temperature the water boils. Repeat this test several times until a repeated value is obtaine to be certain.
- Saucepan (cooking pot) with diameter determined as in the specification in Section 5
- Non-metallic mixer (this shall be organized for measurements)

7.1.7 Data collection format

Description of stove, saucepan and amount of water used for test

No.	Manufacturer / Brand	Model/ Type	Material	Diameter of cooking zone (mm)	Weight of stove (g)	Rated Power (W)	Switch, regulator	Pot size (mm)	Pot height (mm)	Amount of water (g)

7.1.8 Test Data Collection Format

The Table below is a test data collection format recommended. However, one can use other formats as well

Initial Readings	Date	Date					
	Test No.	No.					
	Name of Stove	Name					
	Initial Ambient Air Temperature (Tami)	(^{o}C)					
	Dry Weight of Pot without lid	(g)					
	Initial Weight of Water	(g)					
	Initial Weight of Pot + water	(g)					
	Initial Water Temperature (T1)	(^{o}C)					
	Initial kWh Reading (E1)	(kWh)					
	Starting Time (t1)	(H:M:S)					
	Current (I)	(A)					
	Voltage (V)	(V)					
	Rated Power	(kW)					
	Body bottom Temperature	(^{o}C)					
	Body side Temperature	(^{o}C)					
Final Readings	Time Water Boils (t2)	(H:M:S)					
	Boiling Temperature (Tb)	(^{o}C)					
	Final Weight of pot + water	(g)					
	Boiling kWh Reading (E2)	(kWh)					
	Final Ambient Air Temperature (Tamf)	(^{o}C)					
End of Test	Name of Expert conducting the test	Name					

7.1.9 Data Analysis Format

Table below lists the analysis needed to determine the performance of the stove.

Analysis of Test Results	Time for Boiling	(min)					
	*Time for Boiling (Temperature Corrected)	(min)					
	Energy Input	(kWh)					
	Energy Output	(kWh)					
	Efficiency	(%)					
	Temp. Corrected Time to Boil 1 kg of water	(min/kg)					
	HP-Specific Energy Consumption	(kWh/kg)					
Statistical Analysis	Mean of Thermal Efficiency						
	Standard Deviation of Thermal Efficiency						

Formula for Test Result Anaysis

	Parameters	Unit	Formula
Analysis of Test Results	**Time toBoil**	(min)	t2 – t1
	Temperature corrected Time to Boil	(min)	(t1 – t1)*75/(T2 - T1)
	Energy Input	(kWh)	E2 – E1
	Energy Output	(kWh)	[Ww/1000 * 4.186*(T2 – T1) + 2.26 * (W1 – W2)]/3600
	Power Input	(kW)	Energy Input / (Time to Boil * 60)
	Power Output	(kW)	Energy Output / (Time to Boil * 60)
	Efficiency	(%)	(Energy Output / Energy Input)*100%
	Temperature corrected Time to Boil	(min/kg)	**Time toBoil / (Ww * 1000)**
	Specific Energy Consumption	(kWh/kg)	**Energy Input / (Ww * 1000)**

(1 kWh = 3,600 kJ)

Specific heat capacity of water = 4.186 kJ/kg

Latent heat of vaporization = 2.26 kJ/g

Where:

t1	Starting time
t2	Time water boils
E1	Initial kWh reading
E2	kWh reading at boiling
Ww	Initital weight of water
WP	Weight of dry empty pot or saucepan
W1	Initial weight of water and pot
W2	Final wewight of water and pot
Tai	Ambient Temperature at the beginning of test
Taf	Ambient Temperarature at the end of test
T1	Initial temperature of water
T2	Boiling temperature of water
HP	High Power Phase

4.186 kJ/kg = specific heat of water
2.26 kJ/gm = Latent heat of vaporization

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Ethiopian Standards Agency

Organization and Objectives

The Ethiopian Standards Agency (ESA) is the national standards body of Ethiopia established in 2010 based on regulation No. 193/2010.ESA is established due to the restructuring of Quality and Standards Authority of Ethiopia (QSAE) which was established in 1970.

ESA's objectives are:-

- ❖ Develop Ethiopian standards and establish a system that enable to check whether goods and services are incompliance with the required standards,
- ❖ Facilitate the country's technology transfer through the use of standards,
- ❖ Develop national standards for local products and services so as to make them competitive in the international market.

Ethiopian Standards

The Ethiopian Standards are developed by national technical committees which are composed of different stakeholders consisting of educational Institutions, research institutes, government or ganizations, certification, inspection, and testing organizations, regulatory bodies, consumer association etc. The requirements and/ or recommendations contained in Ethiopian Standards are consensus based that reflects the interest of the TC representatives and also of comments received from the public and other sources. Ethiopian Standards are approved by the National Standardization Council and are kept under continuous review after publication and updated regularly to take account of latest scientific and technological changes.
Orders For all Ethiopian Standards, International Standard and ASTM standards, including electronic versions, should be addressed to the Documentation and Publication Team at the Head office and Branch (Liaisons) offices. A catalogue of Ethiopian Standards is also a vailable freely and can be accessed in from our website.

International Involvement

ESA, representing Ethiopia, is a member of the International Organization for Standardization (ISO), and Codex Alimentarius Commission (CODEX). It also maintains close working relations with the in ternational Electro-technical Commission (IEC) and American Society for Testing and Materials (ASTM).It is a founding member of the African Regional Organization for standardization (ARSO).

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