

**ETHIOPIAN  
STANDARD**

**ES6086:2017**

First edition  
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**Biomass Baking Stoves – Performance  
Requirements and Test Methods for Household  
Biomass Baking Stove**



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Commissioned by:





**Foreword**

This Ethiopian Standard has been prepared under the direction of the Technical Committee for Biomass Cook Stove (101) 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 specifications.



# Biomass baking stoves – Performance requirements and test methods for Household Biomass baking stove.

## 1. Scope

This Ethiopian Standard applicable for household biomass Injera/Bread baking stoves.

This Standard specifies the performance requirements (thermal, emission and safety), test methods and inspection requirement for household biomass Injera/Bread baking stoves. These standards focuses mainly on stove performance (fuel use and emissions), for household biomass cooking and baking stoves to serve as a minimum requirements to classify a stove as “improved”.

**Application:** This standard is applicable to household Injera/Bread baking stoves using solid biomass in its natural or densified form

## 2. Normative reference

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

ES 3788: Teff Injera Specifications

ES 04090: Ethiopian Electric Injera Mitad

ES 6085: Ethiopian Biomass cooking stove

## 3. Terms definitions

For the purpose of this standard, the following definitions shall apply: Also terms and definitions described in ES 3788 shall be used.

### 3.1.

#### **household biomass baking stove**

device where biomass fuel is burnt to produce heat for baking purpose

### 3.2.

#### **baking**

baking is a process of making food such as bread, Injera from dough, batter etc.,

### 3.3.

#### **biomass**

plant materials and animal waste used especially as a source of fuel.

**3.4.**

**mitad**

a circular griddle made of locally available clay soil and fired.

**3.5.**

**clay**

an earthy material that is plastic when moist and hard when fired, that is used for pottery, tile and brick.

**3.6.**

diameter of mitad

Is the distance from one end to the other end through the center of the Mitad.

**3.7.**

**thermal conductivity**

heat flow per unit area developed under unit temperature gradient.

**3.8.**

**insulator**

a material used to reduce heat dissipation from the stove combustion chamber to the surrounding.

**3.9.**

**normal operation**

is a condition under which the stove is operated for household application.

**3.10.**

**liner**

molded and fired clay or made from mortar (cement plus scoria/sand/pumice that reduces heat loss to the surrounding

**3.11.**

**baseline / traditional stove**

for this specific standard the base line stove is three stone open fire/traditional stove with thermal efficiency less or equal to 10% (IPCC default value is taken for this specific standard).

**3.12.**

**thermal efficiency**

thermal efficiency is a measure of the fraction of heat produced by the fuel that made it directly to the water in the pot.

**3.13.**

**specific fuel consumption**

this is a measure of the amount of fuel required to boil (or simmer) 1 liter of water.

3.14.

**temp-corrected specific fuel consumption**

this is the previous measure, also corrected as if the temperature rise from start to boil was 75 OC, in order to easily compare different tests that may have had different starting or boiling temperatures.

3.15.

**temp-corrected specific energy consumption**

this is the same measure as the previous , but reported as energy (kilojoules) rather than fuel (grams).

3.16.

**useful energy delivered**

energy transferred to the content of baking Mitad, including sensible heat that raises the temperature of the content of baking Mitad and latent heat that evaporates water from the baked food.

3.17.

**rated heating capacity**

the heat received from baking stove during steady-state operation per unit time.

3.18.

**efuel (fuel energy used)**

product of the heating value of the fuel and the mass of the fuel consumed.

3.19.

**fire power**

rate of energy released from the combustion of the fuel over the period of baking task, in kw.

3.20.

**emission Factor**

ratio of the mass of pollutants emitted by a cook stove to a defined measure (useful energy delivered, mass of fuel wood consumed, the energy of the fuel consumed ...) that quantifies the activity emitting the pollutant.

3.21.

**emission rate**

mass of an air pollutant emitted per unit time

3.22.

**densified biomass**

Solid biomass made by mechanically compressing biomass or thermally treated biomass into a specific size and shape such as cubes, pressed logs, pellets or briquettes

**3.23.**

**gravimetric measurement**

Is quantification of sample of particulate matter through the direct measurement of mass.

**4. Technical requirements**

**4.1. General**

4.1.1. The baking Stove should have attractive appearance with smooth surface, without burr or rust outside.

4.1.2. Stove structure shall be designed to ensure safety and convenience for use

4.1.3. The biomass baking stove shall be supplied with an instruction leaflet

**4.2. Specific requirement**

**4.2.1. Material requirements**

4.2.2. Cladding - The cladding used in the manufacture of household biomass cooking stoves shall be a galvanized sheet with minimum thickness of 0.40mm (Gauge 28), for mild steel sheet metal, 0.6 mm (gauge 24) and for stainless steel sheet, 0.2 mm.

4.2.3. Insulation - The insulation between the steel sheets/cladding and ceramic liner should be made of various mixtures of insulating material (like pumice, Scoria, Red ash, etc.).

4.2.4. The ceramic liners/stoves - The ceramic liners/stoves used in the manufacture of household biomass Baking stoves shall be made from a clay mix which is thermal shock resistance. As the stove is used over a period of time, the ceramic liner/stove should withstand many cycles of heating and cooling without cracking.

**4.3. Performance requirement**

4.3.1. The stove shall have a minimum of 15 % thermal efficiency, And shall be computed in accordance with Annex B – B6 (A&B)

4.3.2. The stove shall have a maximum PM of 979mg/MJ,

4.3.3. The stove shall have a maximum CO emission level of 16 g/MJ,

4.3.4. The stove shall have a minimum Specific Fuel Consumption Sfc of 0.050MJ/min/l

**4.4. Manufacturing requirements**

4.4.1. The stove or any of its parts may be manufactured using different materials and/or



methods.

4.4.2. Castings shall have a good finish and without cracks, stomata (holes) and sand holes.

4.4.3. Weldments shall be flat and uniform without perforations and slag stomata.

4.4.4. Stamped parts have a good finish without cracks, wrinkles, flashes and burrs.

4.4.5. Sheet metal surfaces and edges shall have a good finish without cracks, wrinkles, bumps and any type of imperfection.

4.4.6. Riveted pieces shall be firmly attached and the rivets shall not be loose and/or skewed. Rivet heads shall be smooth and shall not protrude.

4.4.7. Ceramic parts shall have a good finish without cracks and voids.

4.4.8. For stoves made of different parts such as ceramic core and a metal cladding, the parts shall be firmly assembled.

#### 4.5. **Assembling/Installing**

4.5.1. The biomass baking stove should be assembled/ installed as per the assembling /installing guild line which is provided by manufacturer.

#### 4.6. **Safety use requirement**

When the stove is in use the stove shall have a minimum safety of 76, when tested in accordance to Annex D. The design and production of cooking stoves shall ensure the following safety requirements:

4.6.1. Sharp Edges and Points: Sharp edges and points present on a cook stove can cut flesh or entangle clothes and overturn the stove.

4.6.2. Baking stove Tipping: It is important that a cook stove be stable enough to maintain an upright orientation when in operation.

4.6.3. Containment of Fuel: Burning fuel may be expelled from a combustion chamber or spilled when a stove becomes overturned.

4.6.4. Obstructions near Cooking Surface: Areas surrounding the cooking surface should be flat so that pots being moved from the stove do not collide with protruding components and overturn boiling contents onto hands or nearby children.

4.6.5. Surface Temperature: This test is employed with the intention that burns should not occur if the cook stove surface is touched for a short duration.

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- 4.6.6. Heat Transmission to Surroundings: Large amounts of heat transmission to surroundings may ignite combustibles or construction in the area of the cook stove.
- 4.6.7. Temperature of Operational Construction: Parts of the cook stove that need to be touched during regular operation should not reach a level where use can cause harm either directly or indirectly.
- 4.6.8. Chimney Shielding: Chimneys can become extremely hot during use and easily cause burns.
- 4.6.9. Flames Surrounding the Cookpot: Flames touching the cookpot should be concealed and not able to come into contact with hands or clothing.
- 4.6.10. Flames/Fuel Exiting Fuel Chamber, Canister, or Pipes: Flames or fuel should not protrude from any fuel loading area, storage container, or flow-pipes during use.

## **5. Testing methods**

- 5.1. Requirements for 5.1., 5.2 (except), 5.4., 5.5. can be checked by the necked eye.
- 5.2. Requirements for 5.2.1.3. shall be tested as per the Annex E.
- 5.3. The performance requirement 5.3.1 of Biomass baking stove shall be tested as per the Annex B and shall comply with ES 6085:2017 clause 7.2 table 1.
- 5.4. Requirements 5.3.2, 5.3.3. and 5.3.4. Shall be tested using following clean cook stove IWA interim agreement and WBT guidelines simultaneously along with thermal performance test Annex B.
- 5.5. The safety of the baking stove test shall be as per the safety test protocol of Annex D.

## **6. Emission testing**

The stoves shall be tested for its emission (PM, CO, CO<sub>2</sub>) simultaneously along with the testing of thermal efficiency.

- a) The emission sampling shall be started immediately before lighting the fire.
- b) The emission sampling shall continue until the end of the test phase.

## **7. Test equipment requirements**

For testing method the equipment required shall be as listed on annex B –B1

## **8. Testing conditions and preparation**

Testing conditions and preparation shall be conducted according to the criteria of Annex B – B2 &B3

## 9. Testing Procedures

The testing procedure shall be conducted according to the criteria of Annex B – B5

### 10. Method of computing test result.

After completing the test, the computation for evaluation of baking power & Thermal Efficiency test results shall be conducted according to Annex B – B6 (A & B)

### 11. Data sheet

Data recording/collection shall be conducted according to Annex C

### 12. Performance test reporting format

Performance Test Reporting shall be conducted according to Annex A- A1

### 13. Safety reporting format

Safety Test Reporting shall be conducted according to Annex A- A2

### 14. Inspection rules

14.1. Inspection Method

14.2. Production tests should include delivery inspection and the type approval test.

14.3. Delivery inspection

14.4. Each biomass stove should be tested before leaving the factory.

### 15. Approval test

An approval test should be conducted in the following situations and at least 2 biomass Injera/bread stoves should be tested in every test term.

- a) Quantity production should be tested every 2 years.
- b) After any changes in the structure, material or manufacturing technique.
- c) At the beginning of production of a new model.
- d) After a long shutdown, when the product is put back into production.
- e) In the case of a significant difference between the result of routine test and that of model test.
- f) When a model test is required by the State Administration of Quality Supervision requires.

## **16. Labeling**

The marking should be placed at a clear position on the stove. The basic components of the mark include:

- a. Name of the manufacturer
- b. Name of product
- c. Trademark if any
- d. model and Serial number if any
- e. Thermal efficiency or Reduction over baseline
- f. Production Date

## Bibliography

ES ISO IWA (International workshop Agreement) -Biomass stove safety protocol

ES ISO 18125, solid Biofuel-determination of calorific value

ES ISO 4224, Ambient air –determination of carbon-monoxide-non-dispersive infrared spectrometric method

ES ISO 25597, Stationary sources emission-test method for determining PM<sub>2.5</sub> and PM<sub>10</sub> mass in stack gasses

ES ISO 9096, stationary source emission-manual determination of mass concentration of particulate matter

ES ISO 12039, Stationary source emission-determination of carbon-monoxide, carbon-dioxide and oxygen-performance characteristics and calibration of automated measuring systems

## ANNEX A1

Table 1 Performance Test Report Format

Stove Manufacturer: _____		
Stove Model: _____		
Test Protocol: _____		
Fuel Used: _____		
Test Dates: _____		
<b>Test results</b>		
<b>1. Description</b>	<b>Unit</b>	<b>Average value</b>
Thermal efficiency	%	_____
Firepower	watts	_____
<b>Emission (Optional)</b>		
High power CO	g/MJd	_____
Low power CO	g/min/l	_____
High power PM 2.5	g/MJd	_____
Low power PM 2.5	mg/min/l	_____
Test conducted by: _____		
Date: _____	Signature: _____	
Approved by: _____		
Date: _____	Signature: _____	

## Annex A2

Table 2 Safety test report format

Assessment Criteria	Score 1-4	Multiplier	Subtotal
Sharp Edges and Points		1.5	
Cookstove Tipping		3.0	
Containment of Fuel		2.5	
Obstructions Near Cooking Surface		2.0	
Surface Temperature		2.0	
Heat Transmission to Surroundings		2.5	
Temperature of Operational Construction		2.0	
Chimney Shielding		2.5	
Flames Surrounding the Cookpot		3.0	
Flames/Fuel Exiting Fuel Chamber, Canister, or Pipes		4.0	
Total			

Stove Rating	_____
	—

**ANNEX B**

**(Normative)**

**Biomass baking stove thermal performance test**

**B1. Test instruments & equipment**

- a) Digital scale and heat resistant pad to protect the scale
- b) Digital thermocouple with thermocouple probe suitable for immersion in liquids and wood fixture to hold the probe (see the drawing on the annex)
- c) Timer
- d) Moisture meter/oven dried wood
- e) Tape measure for measuring wood stove
- f) Standard pots that are most frequently used For each size, you should choose a standard shape (height and circumference) that is used in your area (But for baking test as per the description on the standard document)
- g) Charcoal container, tong and spatula for charcoal handling
- h) Safety equipment

**B2. Pot size and quantity of water**

The size of pot to measure the performance of the stove shall be diameter 600mm and 300mm height and quantity of water shall be 2/3 of the volume of the pot.

**B3. Test conditions & preparations**

- a) Each baking stove should be tested at least 3 times.
- b) The physical test parameters should be constant for all tests.
- c) The test cook stove shall be located far away from any other heat source. If multiple cook stoves are being tested in the same space, the distance between cook stoves shall be greater than 3 m.
- d) Environmental temperature, 10 °C ~ 35 °C
- e) Wind speed, <1.0 m/s
- f) The local boiling point shall be determined as per the test procedure annexed

**B4. Required measurements**

**Standard test measurements shall include for each test phase:**

- a) mass of fuel consumed;
- b) mass of any char remaining at the end of the test phase;
- c) moisture content of fuel;
- d) energy content of fuel (lower heating value);
- e) energy content of char remaining at the end of the test phase (lower heating value);



- f) mass of water in cooking vessel(s) at the beginning and end of the test phase;
- g) temperature of water in cooking vessel(s), recorded at least every 10 s;
- h) time during the test phase, recorded at least every 10 s;
- i) mass of emissions of PM<sub>2.5</sub> by the gravimetric;
- j) mass of emissions of CO;
- k) mass of emissions of CO<sub>2</sub>.

## B5. Testing procedure

- a) The tester shall be familiar with the operation of the stove and have sufficient experience in testing stoves.
- b) The instruments shall be calibrated.
- c) Use appropriate fuel types according to the stove instructions.
- d) Weigh and record the mass, B of enough biomass fuels, based on a burning duration of 1h.
- e) Measure the low calorific value of biomass fuel according to ISO 18125.
- f) Weigh the water and then pour it into the pot. Record the initial mass of water, G<sub>1</sub> and initial water temperature T<sub>1</sub>.
- g) Place the thermometer in the pot using a holder; the sensor of the thermometer should be 5 cm above the bottom of the pot. Do not use a pot lid.

## B6. Test steps

Light the fire and record the time as t<sub>1</sub>

When the water temperature has increased to the boiling point, record the temperature of the water T<sub>2</sub> and the time as t<sub>2</sub>, and continue with the testing during the water evaporation phase.

During the simmering phase, record water temperature every 5 minutes.

Check the water temperature not to drop 6°C below the boiling point, end the test on 45 minute, record the time t<sub>3</sub>, and weigh and record the water mass in the pot as G<sub>2</sub>.

Calculation

### A. Useful energy

$$Q_1 = 4.18 \cdot G_1 \cdot (T_2 - T_1) + (G_1 - G_2) \cdot \dots$$

Where;

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Q1 the useful energy, kJ;

G1 the initial mass of water in the pot, kg;

G2 the final mass of water in the pot, kg;

T1 the initial temperature of water, °C;

T2 the boiling point of the water, °C;

$\gamma$  the latent heat of water vaporization at boiling point, kJ/kg; and

4.18 the specific heat capacity of water, kJ/ (kg·°C).

### B. Cooking power

$$P_c = \frac{Q_1}{t_3 - t_1}$$

Where;

$P_c$  cooking power, kW;

$Q_1$  is useful energy, KJ;

$(t_3 - t_1)$  test duration, s.

Cooking thermal efficiency

$$\eta_c = \frac{Q_1}{BQ_{net.ar}} \times 100$$

Where;

$\eta_c$  cooking thermal efficiency;

B mass of biomass fuel, kg;

$Q_{net.ar}$  lower heating value (as received) of the biomass fuel, kJ/kg.

### Annex C (Normative)

#### Water Boiling Test – Test Entry Form

Air Temperature

Name of Testers

Fuel Dimensions

Date

Stove Type/Model and Test Number

Gross Calorific Value

Location

Moisture Content

Fuel Type

Notes

Dry Weight Pot 1

Dry Weight Pot 2

Dry Weight Pot 3

Dry Weight Pot 4

Weight Container for Char

Local Boiling Point

**Cold Start****Hot Start****Simmer**

Start

End

Start

End

Start

End

Time

Weight of Wood

Water Temperature, Pot 1

Water Temperature, Pot 2

Water Temperature, Pot 3

Water Temperature, Pot 4

Weight of Pot 1 with water

Weight of Pot 2 with water

Weight of Pot 3 with water

Weight of Pot 4 with water

Fire Starting Materials

Weight of Charcoal + Container

## ANNEX D:

## Biomass stove safety protocol guidelines

**1. Sharp edges and points**

Overview: Sharp edges and points present on a cookstove can cut flesh or entangle clothes and overturn the stove. Consequently exterior surfaces of a cookstove should not catch or tear any article of clothing or cut hands during normal use. The stove does not need to be lit for this evaluation.

Equipment: Cloth, rag, or loose clothing

Procedure:

Note: stone or clay stoves may provide resistance to the material being run over the surface, but this should not be deemed unsatisfactory unless the stove moves or the rag becomes completely snagged.

- b) Rub cloth gently over the entire exterior surface of the cookstove to find areas that catch or tear the cloth.
- c) Note number of times cloth catches / tears and write this value in the Entry Form under “Number of catches/tears” for Procedure 1. Take care to only count each snagging spot once.

Table 3: Rating of sharp age and points

Number of catches	Rating
None (0)	Best
1 or 2	Good
3	Fair
4 and more	Poor

**2. Cookstove tipping**

Overview: It is important that a cookstove be stable enough to maintain an upright orientation when in operation. Otherwise, burning or boiling contents could spill onto surrounding persons or materials. Therefore cookstoves should come back to rest upright after being slightly tipped from their regular resting position.

Testing for this hazard is performed only if the cookstove is not considerably heavy nor secured to the ground or wall. The number of runs conducted is equal to the number of legs or corners on the base of the cookstove because it is not always clear where the center of gravity is located. If tipping toward the direction of a fuel entry point is not possible, avoid that direction and use

multiple other tipping directions for the procedure. Measurements should be taken with care because the change in height may be small.

Equipment: Fuel, ruler/tape measure

Procedure:

Note: Write in “Best” rating for immobile stoves on the Entry Form for RESULT 2

- Set stove on flat surface and load with fuel but do not ignite.
- All cookstove covers and/or utensils are left in their normal positions during the Procedure.
- With the stove stable and upright, measure the height of the tallest point (in cm) on the side you will tip towards, place this value into “Starting Height” in the Entry Form for Procedure 2.
- Slowly tip cookstove to the chosen side until the stove is able to tip over on its own (when the center of gravity is directly above the point of contact with the ground).
- Hold stove tilted where it can overturn and measure the new height of the same point chosen in part ‘c’, place value into the Entry Form for “Tipped Height” for Procedure 2.
- Repeat process for as many runs as there are legs on the stove (or four times for a circular base) and record values in the Entry Form.

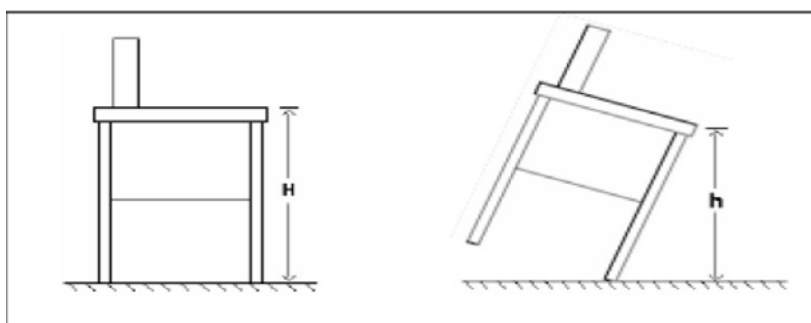


Figure 1: Diagram of height measurements for Cookstove Tipping Procedure 2.

Note: Starting Height (H) is measured prior to tilt; Tipped Height (h) is measured after tilt.

Maximum ratio (R)	Rating	Score
$\leq 0.940$	Best	4
$0.940 < R \leq 0.961$	Good	3
$0.961 \leq R < 0.978$	fair	2
$R \geq 0.978$	poor	1

Table 4: Scoring system for cookstove tipping

### 3. Containment of fuel

Overview: Burning fuel may be expelled from a combustion chamber or spilled when a stove becomes overturned. This can cause burns to the eyes and may also set fire to surrounding materials or construction. Therefore flaming fuel should rarely fall from the cookstove when it is overturned and embers/burning fuel should have little chance of being expelled from the combustion chamber.

Equipment: Fuel, cookpot, ruler / tape measure, calculator (optional)

Procedure:

- The cookstove should still be stocked with fuel from the previous procedure but not ignited.
- Place a cookpot (one that is normally used with this stove) onto the burner surface.
- Visually inspect to find exposed areas that fuel can be seen through (often around the sides of the pot or through the fuel loading chamber)
- Measure the area of the Exposed Areas. If gaps are roughly square, you may enter one side length in the “cm” column of the Entry Form for Procedure 3 and the Area will be calculated automatically. If the gaps are not square, calculate the Area by using the formulas below. Choose the appropriate formula based on the shape of the gap. If you calculate the areas using the formulas below, enter them directly into “Area (cm)” column of the Entry Form for Procedure 3.

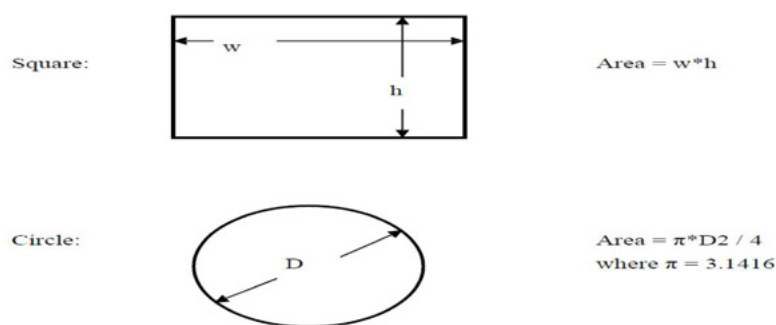


Fig 2: Area calculation method

Area exposed (A) (cm <sup>2</sup> )	Rating	Score
$A \leq 50$	Best	4
$50 < A \leq 150$	Good	3
$150 < A \leq 250$	Fair	2
$A > 250$	Poor	1

Table 5: Scoring system for containment of fuel

#### 4. Obstructions near cooking surface

Overview: Areas surrounding the cooking surface should be flat so that pots being moved from the stove do not collide with protruding components and overturn boiling contents onto hands or nearby children. Typically, these obstructions include handles perpendicular to the griddle that are used for removing the cooking surface during cookstove maintenance. A ruler or tape measure is used to find the difference in height of the cooking surface to the height of any protrusions closely surrounding it.

Equipment: Ruler/ tape measure

Procedure:

Note: Write in “Good” for stoves with a skirt for RESULT 4.

- d) Inspect cookstove for skirt – pot sits partially into a near cylindrical extension to the combustion chamber. Do not perform if skirt is present. (write in “Good” for Result 4)
- e) Measure the “Height of Cooking Surface” and record Entry Form for Procedure 4.
- f) For each obstruction or protrusion closely surrounding the cooking surface, measure the “Height of Obstruction” in cm and record on the Entry Form for Procedure 4. (This can include small but solid obstructions such as handles perpendicular to the griddle)

Maximum height difference (D) cm	Rating	Score
$D \leq 1$	Best	4
$1 < D \leq 2.5$ or cookstove with skirt	Good	3
$2.5 < D \leq 4$	Fair	2
$D > 4$	Poor	1

Table 6: Scoring system for obstruction near cooking surface

#### 5. Surface temperature

Difference between maximum temperature and air temperature (T)	Rating	Score
$T \leq 30$	Best	4
$30 < T \leq 35$	Good	3
$35 < T \leq 40$	Fair	2
$T > 40$	Poor	1

Table 7: Scoring system for surface temperature

#### 6. Heat transfer to the environment;

Surface	Difference between maximum temperature and air temperature (T)	Rating	Score
Floor	$T \leq 30$	Best	4
	$30 < T \leq 40$	Good	3
	$40 < T \leq 50$	Fair	2
	$T > 50$	Poor	1
Wall	$T < 20$	Best	4
	$20 \leq T \leq 30$	Good	3
	$30 < T \leq 40$	Fair	2
	$T > 40$	Poor	1

Table 8: Scoring system for heat transfer to the environment

## 7. Handle temperature

Overview: For procedures 5, 6, and 7 the ambient air temperature (C°) is used as a reference point to allow comparison to the stove and surrounding area temperatures.

Procedure 5 is employed with the intention that burns should not occur if the cookstove surface is touched for a short duration. The importance of this test is apparent since children have a tendency to touch cookstoves and women are likely to come into contact with stove surfaces during normal use. Since children are more sensitive to heat than adults, lower surfaces temperatures are suggested for heights within accidental touch of a child (0.9m or less). Conversely, adults are assumed to be susceptible to accidental contact at heights below that of 1.5m. Therefore heights above this are considered out of reach from accidental contact and are not tested. The most deficient rating based on material, temperature, and location is used to determine the likelihood for a person to avoid burns when touching a cookstove.

Procedure 6 is employed with the knowledge that large amounts of heat transmission to surroundings may ignite combustibles or construction in the area of the cookstoves. Therefore cookstoves should not cause elevated temperatures on surrounding surfaces in the environment. The following procedures are used if the cookstove is placed within 10 cm of a combustible or has a combustion chamber less than 5 cm in height from the ground. If the stove is located outside these bounds it receives a rating of "Best". Alternate procedures are provided for stoves that are designed to be attached to the floor or wall.

Procedure 7 is meant to measure parts of the cookstove that need to be touched during regular operation. Temperatures should not reach a level where use can cause harm either directly or indirectly. Components where excessive temperatures may occur, yet need to be handled during regular use, include doors for combustion chambers and handles to regulate the flow of gas/liquid.

Equipment: Fuel, igniter, chalk, ruler/tape measure, hand-held thermocouple

Procedure:



Note: For Procedure 7: Stoves that do not have any components which need to be touched during stove use receive a rating of “Best” in this category. Write in “Best” for RESULT 7.

- a) Make sure the stove is shaded during the evaluation.
- b) Take air temperature and record on the Entry Form just under the “5. SURFACE TEMPERATURE” box.
- c) Chalk extra thick lines at 0.9m and 1.5m onto cookstove, if the stove reaches that height measured from the ground.
- d) Chalk 8 x 8 cm grid onto cookstove surface below the 0.9m line, and between the 0.9m and 1.5m lines if applicable.
- e) Chalk a grid within an outline of the cookstove on the floor if within 5 cm of undercarriage, and within an outline of cookstove onto the wall if it sits within 10 cm from the wall, while continuing the grid 16 cm higher up the wall above the top of the cookstove.
- f) Ignite fuel and wait until cookstove has reached max temp (~20 min) before proceeding, adding fuel when necessary.
- g) Take data temperatures using the thermocouple at each grid intersections:
- h) Start with the Wall and Floor measurements by moving the cookstove away to take measurements for up to one minute, then return the cookstove for at least five minutes, taking surface temperature and Handle temperature while waiting. Repeat step “h” until all data points have been checked.
  - a. No more than one minute should transpire when taking data with the stove moved away from its original position. After the data taking period, the cookstove is placed back in its original position for a period of no less than three minutes to give time for surfaces to warm back up.
- i) If stove is mounted to floor or wall, take supplementary wall and floor temperatures by using cookstove surface temperature near where it attaches to floor and/or wall.
- j) Record each temperature in the Entry Form for their corresponding Surface (Below/ Above Child Line and Metallic or Non-Metallic), Floor and Wall, and Handle Temperature (Metallic or Non-Metallic) for Procedure 5, 6 and 7.
- k) Repeat
  - l) Through
  - m) up to five times.

Difference between maximum temperature and air temperature (T)	Rating	Score
$T \leq 32$	Best	4
$32 < T \leq 38$	Good	3
$38 < T \leq 40$	Fair	2
$T > 40$	Poor	1

Table 9: Scoring system for obstruction to the environment handle temperature

## 8. Chimney shielding

Overview: Chimneys can become extremely hot during use and easily cause burns. The high temperatures present on a chimney are from hot flue gases leaving the stove, often creating higher temperatures on the chimney than anywhere else on the stove. To prevent these injuries, insulation can be placed around the chimney, or a cage may be utilized to “shield” people from accidental contact. Testing for this hazard occurs in two steps. First, the ambient air and chimney surface temperature are taken and applied in Procedure 5 “Surface Temperature” to determine that safety rating. If that rating is unacceptable for the designer or user, a shield can be employed to increase safety from dangerous chimney contact. Procedure 8 then evaluates the chimney shield for the risk of contact. Since chimneys are nearly always made from a uniform pattern for reduced cost, only one (largest if there are multiple) “gap” in the shielding needs be measured.

Equipment: ruler/ tape measure

Procedure:

(Note: Write in “Best” rating for stoves without chimneys for RESULT 8)

- If the chimney has no protective shielding, write the worst rating from RESULT 5 (Surface Temperature) in the RESULT 8 box.
- If the chimney has protective covering, inspect it for any open holes.
- Measure the area of any open holes or gaps in the chimney and record in the Entry Form. If the holes are in a square shape you can measure the length of the hole across and input that in “Hole Size (cm across)” box in the Entry Form. If the holes are other shapes, calculate the area using the formulas in Procedure 3 above and input in the “Hole Area (cm<sup>2</sup>)” box.

Hole area (A) (cm <sup>2</sup> )	Rating*	Score
$A \leq 10$	Best	4
$10 < A \leq 50$	Good	3
$50 < A \leq 150$	Fair	2
$A > 150$	Poor	1
*Stoves without a chimney are scored best		

Table 10: Scoring system for obstruction to the environment handle temperature

## 9. Flames surrounding cookpit

Overview: Flames touching the cookpot should be concealed and not able to come into contact with hands or clothing. Large amounts of flames around the cookpot can easily ignite clothes or produce severe burns to the hands and other parts of the body. Equipment: cookpot

Procedure:

- Keep cookstove fully ablaze from previous Procedures.
- Place cookpot into cooking position.
- Observe the amount of uncovered flames surrounding the cookpot and record a description in the observations box on the Entry Form. These should be based on the four possible descriptions for each rating given on the Entry Form.
- Cookstoves that fully enclose all flames (such as stoves that use a griddle) receive a rating of “Best” because there is no danger from a stray flame.
- Select the rating that most closely describes your observation in the drop down menu in the RESULT 9 box or write in.

Amount of uncovered flames touching cooking vessel	Rating	Score
None	Best	4
Less than 4 cm up the sides of cooking vessel, not handles	Good	3
Most of cooking vessel, not handles	Fair	2
Entire cooking vessel and/or handles	Poor	1

Table 11: Scoring system for flames surrounding cookpot

## 10. Flames exiting fuel chamber, Canister, or pipes

Overview: Flames or fuel should not protrude from any fuel loading area, storage container, or flow-pipes during use. Uncontrolled flames that exit these areas very easily ignite clothes and burn nearby children and adults. Furthermore, flames or fuel exiting fuel canisters or pipes, as with liquid/gas stoves, show fuel leaks and pose great risk.

Equipment: None

Procedure:

- Remove cookpot from stove.
- Keep cookstove fully ablaze from previous procedures.
- Visually inspect the amount, if any, of flames coming out of the fuel chamber, canister, or pipes.
- Record your observations of whether or not flames protrude in the Entry Form.
- Select the rating that most closely describes your observations in the RESULT 10 box. Rating “Poor” if you observe flames protruding and “Best” if flames are contained

Occurrence of fire	Rating	Score
Flames are contained	Best	4
Flames protrude	poor	1

Table 12: Scoring system for flames exiting fuel chamber, canister or pipe

**ANNEX E**

**(Normative)**

**Thermal shock/stress resistance**

**Test method**

To test whether the ceramic liners/stoves made from particular clay are thermal shock resistant the liner/stove shall be heated to temperature ranging 800C° to 900C° and then immersed in cool water at room temperature. Repeat this procedure five times and each procedure following the prior one immediately. The ceramic liner/stove shall withstand 5 cycles of heating and cooling without cracking due to thermal stress.



## 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 1998.

### ESA's objectives are:-

- ❖ Develop Ethiopian standards and establish a system that enable to check whether goods and services are in compliance 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 organizations, 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 available freely and can be accessed from our website.

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### 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 International 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).

### More Information?

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