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Improved Biomass Cooking Stoves – Performance Requirements and Test Methods for Household Biomass Cooking Stoves

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Forward

This Ethiopian Standard has been prepared under the direction of the Technical Committee for Manufacturing Engineering (TC 49) and published by the Ethiopian Standards Agency (ESA).

In preparing this standards reference has been made to Kenya standards KS 18141:2005 Biomass stoves performance requirements and test methods part1: House hold cooking stoves, China standards DB11/T540:2008 General specifications for household biomass cooking stoves, Indian standards IS 13152(part1):2013 Portable biomass cooking stove first revision). This 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.

ESA acknowledges the organization for its concern to contribute to the efforts national standardization.

Improved Biomass cooking stoves – Performance requirements and test methods for Household Biomass cooking Stoves

1. Scope

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

This Standard specifies the performance requirements and test methods for household biomass cooking stoves.

Application: This standard is applicable to household cooking stoves using solid biomass in its natural or densified form and charcoal.

2. Normative References.

The following referenced documents are referred for the application of this document. For dated references, only the edition cited applies. For undated references, the latest editions of the referenced document (including any amendments) apply.

3. Terms and Definitions

For the purposes of this standard, the following definitions shall apply:

3.1.

improved household biomass cooking stove

a device where biomass fuel is burnt to produce heat for cooking purposes and accord the pollution emission limited by this standard.

3.2.

reduction over base line / Traditional

reduction in biomass fuel use, energy consumption & an air pollutants emitted by improved stoves (CO_2, CO, $PM_{2.5}$) in comparison to traditional stove.

3.3.

thermal efficiency (Percentage Heat Utilized - PHU)

the ratio of energy transferred to the cooking vessel to the energy generated by the burning fuel (ratio of useful energy delivered to fuel energy used).

3.4.

useful energy delivered

energy transferred to the content of cooking vessel, including sensible heat that raises the temperature of the content of cooking vessel and latent heat that evaporates water from the vessel.

3.5.

cooking power

rate of energy delivered to a content of cooking vessel over the period of cooking task

3.6.
efuel (fuel energy used)
product of the heating value of the fuel and the mass of the fuel consumed.

3.7.
fire power
rate of energy released from the combustion of the fuel over the period of cooking task, in KW.

3.8.
specific energy consumption Sec
the biomass fuel energy consumed Efuel per mass of cooked food (MJ/Mfood) for single cooking events.

3.9.
thermal conductivity
heat flow per unit area developed under unit temperature gradient.

3.10.
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.

3.11.
emission rate
mass of an air pollutants emitted per unit time.

3.12.
gravimetric measurement
quantification of sample of particulate matter through the direct measurement of mass.

3.13.
biomass
Plant materials and animal waste used especially as a source of fuel.

3.14.
charcoal
It is a dark or black porous carbon prepared from plant substance (as from woody by charring in a kiln from which air is excluded).

3.15.
grog
any clay which has been fired and well-crushed to particle sizes.

3.16.
insulator
A material used to reduce heat dissipation from the stove combustion chamber to the surrounding.

3.17.
liner
molded and fired clay or made from mortar (cement plus scoria/sand/pumice that reduces heat loss to the surrounding.

3.18.
ash
the solid residue left when combustible material is thoroughly burned.

N.B. Types of cook stove:

Biomass cook stove can be classified based on the type of fuel used

a. charcoal stove
b. non charcoal stove

4. General Requirement

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

4.2. Stove should have attractive appearance with smooth surface, without burr or rust outside. Insulation materials should not be exposed

4.3. All component parts of the cooking stove shall be protected against corrosion by a suitable anticorrosion coating and shall be smooth and free from defects such as cracks, sharp edges or burrs.

4.4. The stove and its component parts shall be free of defects that adversely affect the appearance, performance and safety aspects during use.

4.5. The liner shall not be painted.

4.6. The biomass stoves shall be supplied with an instruction leaflet

5. Specific Requirement

5.1. Material requirements

5.1.1. 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.

5.1.2. Pot rests –

Pot rests for charcoal stoves shall be made from durable material (like, mild steel 6.00 mm diameter mild steel round bar, cast iron). Pot rests for complete ceramic cooking stoves shall be of same material.

5.1.3. 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.).

5.1.4. The ceramic liners/stoves

The ceramic liners/stoves used in the manufacture of household biomass cooking 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.

5.2. Thermal performance requirements

Thermal efficiency – The stove shall have a minimum of 15 % thermal efficiency, and shall be computed in accordance with Annex A – (A&B). The level of service based on thermal efficiency shall be as shown in table 1.

Table 1: the minimum thermal efficiency requirements for natural draft cooking stoves

S.N^{o}	Type	Thermal efficiency (minimum) in%				
		Tier-0	Tier -1	Tier-2	Tier-3	Tier-4
1.0	Charcoal	η <28	28≤ η≤35	35< η ≤42	42<η ≤49	η >49
2.0	Non charcoal	η <15	15≤ η≤25	25< η ≤35	35<η ≤45	η >45

5.2.1.**Specific Fuel Consumption** (Sfc)–

The stove shall have a minimum Specific fuel consumption of 0.050(MJ/min/L) and shall be computed in accordance with Annex A – (A&B).

Table 2- The minimum Specific Fuel Consumption requirements for natural draft cooking stoves

S.N^{o}	Specific fuel consumption (minimum) in (MJ/min/L)				
	Tier-0	Tier -1	Tier-2	Tier-3	Tier-4
1.0	Spc≥0.050	0.05≥Sfc>0.039	0.039≥Sfc>0.028	0.028≥Sfc>0.017	Sfc≤0.017

5.3. **Emission limits of air pollutants.**

5.3.1.The maximum emission limits of air pollutants for CO (g/MJ) shall be 16 and PM =979 mg/MJ.

5.4. **Manufacturing requirements**

5.4.1. Sheet metal parts shall be smooth without burrs, fissure or wrinkle.

5.4.2. Machined surfaces shall not be dented, scratched or corroded.

5.4.3.Riveting, welding and seaming should be firm enough.

5.4.4.The combustion chamber shall be thermally-stable with the temperature of 800^{0} c.

5.4.5.Heat insulation materials shall be thermally-stable

5.4.6.Stamped parts should not be fissured or wrinkled..

5.5. **Assembling/installing**

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

5.6. **Safety use requirement**

The design and production of cooking stoves shall ensure the following safety requirements:

5.6.1.**Sharp edges and points**

Sharp edges and points present on the exterior surfaces of a cook stove shall not catch or tear any article of clothing or cut hands during normal use.

5.6.2. **Cooking stove tipping**

Cook stove shall be stable enough to maintain an upright orientation when in operation.

5.6.3. **Containment of fuel**

Embers/burning fuel shall not have a chance of being expelled from the combustion chamber.

5.6.4.**Flames surrounding cook pot**

Flames touching the cook pot should be concealed and not able to come into contact with hands or clothing.

5.6.5.**Flames exiting fuel chamber**

Flames or fuel should not protrude from any fuel loading area and combustion chamber during use.

5.6.6. Cook stoves with chimney shall have smoke discharge outlet of 50cm or higher from the outdoor.

5.6.7. When a biomass cooking stove is working normally, the minimum permissible surface temperature which allows touching without safety concern during operation shall be 60^{o}c.

5.6.8. **Chimney shielding:**

5.6.9. Insulation shall be placed around the chimney where the chimney has contact with the roof/ wall and shall have a cap at the tip.

5.6.10. A cage should be utilized to “shield” people from accidental contact.

6. Test methods

a. Requirements 6, 7.1.2., 7.1.3., 7.4. (Except 7.4.4.) And 7.5. Can be checked by the naked eye.
b. Requirements 7.1.4 can be checked per Annex B
c. Requirements 7.2 can be checked per Annex A
d. Requirements 7.1.1. can be checked by caliper meter
e. Requirements 7.4.4 can be checked by thermometer/infrared.
f. Requirement 7.3 should be tested using either IWA interim agreement testing or Following Shell Foundation Households Energy Program’s testing protocols simultaneously along with thermal performance test Annex A.
g. The safety of the baking stove test shall be as per the safety test protocol of Annex D

7. Warranty

The manufacturer/ supplier shall provide at least six month warranty from the date of end users invoices.

8. Labeling

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

h. Name of the manufacture
i. Name of product
j. Trademark if any
k. model and Serial number if any
l. Cooking thermal efficiency
m. Production Date
n. Manufacturer shall be declared the cooking power of the stove

9. Laboratory-based biomass cooking stove performance test

9.1. Test equipment requirements

For testing method the equipment required shall be as listed on annex A –A1

9.2. Testing conditions and preparation

Testing conditions and preparation shall be conducted according to the criteria of Annex A – A2

9.3. Testing Procedures

The testing procedure shall be conducted according to the criteria of Annex A – A3

9.4. Method of computing test result.

After completing the test, the computation for evaluation of cooking power & Thermal Efficiency test results shall be conducted according to Annex A – A5 (A&B).

9.5. **Data sheet**

Data recording/collection shall be conducted according to Annex C

9.6. Performance test report

Performance Test Reporting shall be conducted according to Annex E – E1

9.7. Safety Test Report

Safety Test Reporting shall be conducted according to Annex E – E2

10. Inspection rules

10.1. Inspection Method

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

10.2. Delivery inspection

Each biomass stove should be tested before leaving the factory.

10.3. Approval test

An approval test should be conducted in the following situations and at least 2 biomass cooking 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 shut down, 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.

ANNEX A

(Normative)

Biomass cooking stove thermal performance test

A1. 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

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

g) Charcoal container, tong and spatula for charcoal handling

h) Safety equipment

A2. 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 ºC ～ 35 ºC

e) Wind speed, <1.0 m/s

f) The local boiling point shall be determined as per the test procedure annexed

A3. 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 PM2.5 by the gravimetric;

j) mass of emissions of CO;

k) mass of emissions of CO2.

A4. Test procedures

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 1 h.

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, G1 and initial water temperature T1.

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.

A5. Test steps

Light the fire and record the time as t1

When the water temperature has increased to the boiling point, record the temperature of the water T2 and the time as t2, 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 drop6℃ below the boiling point, end the test on 45 minute, record the time t3, and weigh and record the water mass in the pot as G2.

Calculation

A. Useful energy

Q1 = 4.18*G1 *(T2 −T1) + (G1 −G2) γ …1)

Where;

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, ℃;

T2 the boiling point of the water, ℃;

γ the latent heat of water vaporization at boiling point, kJ/kg; and

4.18 The specific heat capacity of water, kJ/ (kg·℃).

B. Cooking power

$$Pc = \frac{Q1}{t3 - t1}$$

Where;

Pc cooking power, kW;

Q1 is useful energy, KJ;

(t3 − t1) test duration, s.

Cooking thermal efficiency

$$\eta c = \frac{Q1}{BQnet.ar} X\ 100$$

Where;

ηc cooking thermal efficiency;

B mass of biomass fuel, kg;

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

Sfc- Specific fuel consumption: Specific consumption can be defined for any number of cooking tasks and should be considered “the fuel required to produce a unit output” whether the output is boiled water, cooked beans, or loaves of bread. In the case of the cold-start high-power WBT, it is a measure of the amount of wood required to produce one liter (or kilo) of boiling water starting with cold stove. It is calculated as:

Sfc =Bcd /Gcr

Where, Sfc, specific fuel consumption, Bcd- equivalent dry fuel consumed, Gcr-The effective mass of water boiled

SfcTc – Temperature corrected specific fuel consumption: This corrects specific consumption to account for differences in initial water temperatures. This facilitates comparison of stoves tested on different days or in different environmental conditions. The correction is a simple factor that “normalizes” the temperature change observed in test conditions to a “standard” temperature change of 75 ºC (from 25 to 100). It is calculated in the following way:

$$SfcTc = Sfc. \frac{75}{T1cf - T1Ci},$$

Where, SfcTc – temperature corrected specific fuel consumption, T1cf- Water temperature at end of test (ºC), T1ci- Water temperature at start of test (ºC)

SEcTc – Temperature corrected specific energy consumption: Similar to the temperature corrected specific fuel consumption, this metric is a measure of the amount of fuel energy required to produce one liter (or kilo) of boiling water starting with cold stove. It is the temperature corrected specific fuel consumption multiplied by the energy content of the fuel:

SEcTc= SfcTc*LHV/1000

Where, SEcTc – Temperature corrected specific energy consumption, LHV- lower heating value

ANNEX B

(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^{o} to 900C^{o} 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.

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 guideline

1. SHARP EDGES AND POINTS

Overview: Sharp edges and points present on a cook stove can cut flesh or entangle clothes and overturn the stove. Consequently exterior surfaces of a cook stove 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.

a) Rub cloth gently over the entire exterior surface of the cook stove to find areas that catch or tear the cloth.

b) 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 (o)	Best
1 or 2	Good
3	Fair
4 and more	Pooor

2. **COOKSTOVE TIPPING**

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

Testing for this hazard is performed only if the cook stove 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 cook stove 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

a) Set stove on flat surface and load with fuel but do not ignite.

b) All cook stove covers and/or utensils are left in their normal positions during the Procedure.

c) 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.

d) Slowly tip cook stove 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).

e) 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.

f) 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.

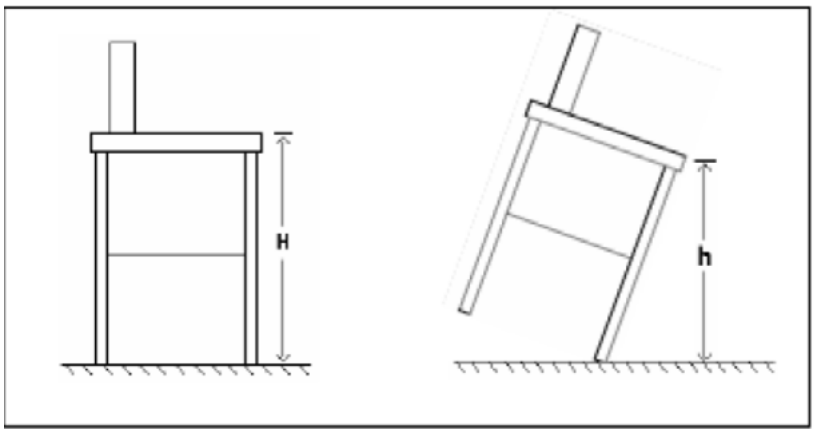

Figure 1: Diagram of height measurements for Cook stove Tipping Procedure 2.

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

Table 4: Scoring system for cook stove tipping

Maximum ratio (R)	**Rating**	**Score**
≤ 0.940	Best	4
0.940 < R ≤ 0,961	Good	3
0.961≤R<0.978	fair	2
R≥0.978	poor	1

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 cook stove when it is overturned and embers/burning fuel should have little chance of being expelled from the combustion chamber.

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

Procedure:

a) The cook stove should still be stocked with fuel from the previous procedure but not ignited.

b) Place a cook pot (one that is normally used with this stove) onto the burner surface.

c) 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)

d) 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.

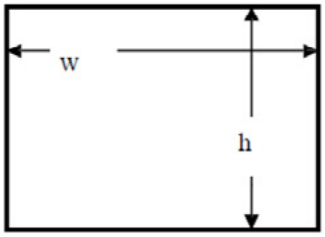

Fig 2: Area calculation method

Table 5: Scoring system for containment of fuel

Area exposed (A) (cm2)	Rating	Score
A ≤ 50	Best	4
50 < A ≤ 150	Good	3
150 < A ≤ 250	Fair	2
A > 250	Poor	1

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 cook stove 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.

a) Inspect cook stove 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)

b) Measure the “Height of Cooking Surface” and record Entry Form for Procedure 4.

c) 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)

Table 6: Scoring system for obstruction near cooking surface

Maximum height difference (D) cm	Rating	Score
D ≤ 1	Best	4
1 <D ≤2.5 for cook stove with skirt	Good	3
2.5 < D≤ 4	Fair	2
D > 4	Poor	1

5. SURFACE TEMPERATURE;

Table 7: Scoring system for surface temperature

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

6. HEAT TRANSFER TO THE ENVIRONMENT;

Table 8: Scoring system for heat transfer to the environment

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

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 cook stove surface is touched for a short duration. The importance of this test is apparent since children have a tendency to touch cook stoves 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 cook stove.

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 cook stoves. Therefore cook stoves should not cause elevated temperatures on surrounding surfaces in the environment. The following procedures are used if the cook stove 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 cook stove 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 cook stove, if the stove reaches that height measured from the ground.

d) Chalk 8 x 8 cm grid onto cook stove 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 cook stove on the floor if within 5 cm of undercarriage, and within an outline of cook stove 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 cook stove.

f) Ignite fuel and wait until cook stove 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 cook stove away to take measurements for up to one minute, then return the cook stove 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 cook stove 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 cook stove 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 h) through j) up to five times.

Difference between maximum temperature and air temperature (T)	Rating	Score
T ≤ 32	Best	4
32 < T ≤ 38	Good	3
38 < T ≤ 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)

a) If the chimney has no protective shielding, write the worst rating from RESULT 5 (Surface Temperature) in the RESULT 8 box.

b) If the chimney has protective covering, inspect it for any open holes.

c) 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 (cm2)” box.

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

Hole area (A) (cm2)	**Rating***	**Score**
A ≤ 10	Best	4
10 < A ≤ 50	Good	3
50 < A ≤ 150	Fair	2
A > 150	Poor	1
*Stoves without a chimney are scored best		

9. FLAMES SURROUNDING COOKPOT

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

Procedure:

d) Keep cook stove fully ablaze from previous Procedures.

e) Place cook-pot into cooking position.

f) Observe the amount of uncovered flames surrounding the cook-pot 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.

g) Cook stoves 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.

h) Select the rating that most closely describes your observation in the drop down menu in the RESULT 9 box or write in.

Table 11: Scoring system for flames surrounding cook-pot

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

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:

i) Remove cooking pot from stove.

j) Keep cook stove fully ablaze from previous procedures.

k) Visually inspect the amount, if any, of flames coming out of the fuel chamber, canister, or pipes.

l) Record your observations of whether or not flames protrude in the Entry Form.

m) 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

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

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

Annex E

Annex E1

Table 1: Performance test Report format

Stove Manufacturer:_____

Stove Model: _____ _____

Test Protocol: _____ _____

Fuel Used: _ _____

Test Dates: _____ _____

TEST RESULTS

1. Description	Unit	Average value
Thermal efficiency	%	_____

Firepower	watts	_____
Cooking power	watts	_____
Emission (Optional)		
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 E 2

Assessment Criteria	**Score 1-4**	**Multiplier**	**Subtotal**
Sharp Edges and Points		**1.5**	
Cook stove 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 Cook pot		**3.0**	
Flames/Fuel Exiting Fuel Chamber, Canister, or Pipes		**4.0**	
		Total	

Stove Rating	_____

Table 2: Safety test report format

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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 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 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 available 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 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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