DUS 761

DRAFT UGANDA STANDARD

Second Edition
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Biomass stoves — Requirements

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Foreword

Uganda National Bureau of Standards (UNBS) is a parastatal under the Ministry of Trade, Industry and Cooperatives established under Cap 327, of the Laws of Uganda, as amended. UNBS is mandated to co-ordinate the elaboration of standards and is

(a) a member of International Organisation for Standardisation (ISO) and

(b) a contact point for the WHO/FAO Codex Alimentarius Commission on Food Standards, and

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The work of preparing Uganda Standards is carried out through Technical Committees. A Technical Committee is established to deliberate on standards in a given field or area and consists of key stakeholders including government, academia, consumer groups, private sector and other interested parties.

Draft Uganda Standards adopted by the Technical Committee are widely circulated to stakeholders and the general public for comments. The committee reviews the comments before recommending the draft standards for approval and declaration as Uganda Standards by the National Standards Council.

The committee responsible for this document is Technical Committee UNBS/TC 4, *Mechanical Engineering and Metallurgy*.

This second edition cancels and replaces the first edition (US 761:2007), which has been technically revised.

Biomass stoves — Requirements

1 Scope

This Draft Uganda standard specifies the classification, technical requirements, performance requirements safety requirements, test methods and inspection procedure of biomass cookstoves.

This draft standard is applicable to cookstoves using solid biomass in its natural or densified form.

2 Normative references

The following referenced documents referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18125, *Solid biofuels — Determination of calorific value*

ISO 4224, *Ambient air — Determination of carbon monoxide — Non-dispersive infrared spectrometric method*

ISO 25597, *Stationary source emissions — Test method for determining $PM_{2.5}$ and PM_{10} mass in stack gases using cyclone samplers and sample dilution*

ISO 9096, *Stationary source emissions — Manual determination of mass concentration of particulate matter*

ISO 12039, *Stationary source emissions — Determination of carbon monoxide, carbon dioxide and oxygen — Performance characteristics and calibration of automated measuring systems*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
biomass cookstove
stoves with cooking function, burning solid biomass in its natural or densified form

3.2
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

3.3
useful energy
energy absorbed by the water in the pot including the energy that raises the temperature and that evaporates water from the pot during the test

3.4
cooking power
useful energy per unit time.

3.5
cooking thermal efficiency
the ratio of useful energy to the energy of fuel consumed.

3.6
emission factor
the ratio of the mass of a pollutant emitted to the energy of fuel consumed

3.7
$PM_{2.5}$
particulate matter with an aerodynamic diameter of less than or equal to a nominal 2.5 µm, as determined in Annex C

3.8
Energy of fuel consumed
amount of heat released during the combustion of a specified amount of biomass

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Classification

Biomass stoves shall be classified as W-XX-Y, where:

a) W represents of fuel type (for example C for charcoal, B for briquettes, among others);

b) XX represents nominal cooking power of the stove, kW; and

c) Y specifies class in accordance with Table 1.

Table 1 — Performance indicators of biomass stoves

Class	Efficiency, η_c %	Emission factor		Safety %	Durability %
		$PM_{2.5}$ mg/MJ	CO g/MJ		
Class 1	＞50	＜60	＜5	≥95	≥94
Class 2	41 - 50	60 - 99	5 - 8	76-94	80 - 93
Class 3	30 - 40	100 - 250	8 - 12	≥75	70 - 79
NOTE The values are determined in accordance with the test methods in the annexes (Annex D for safety and Annex E for durability). These values should be corrected to nearest whole number.					

5 Technical requirements

5.1 Basic requirements

The stove shall have good finish without burrs (rough or sharp edges) or rust outside.

5.2 Manufacturing requirements

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

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

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

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

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

5.2.6 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.

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

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

5.3 Performance requirements

5.3.1 The cooking power shall not be less than the stove nominal value when tested in accordance with Annex B.

5.3.2 The stove shall have a minimum efficiency of 30 %, maximum $PM_{2.5}$ of 250 mg/MJ, maximum CO emission level of 12 g/MJ, minimum safety of 75 % and minimum durability of 70 %.

6 Safety requirements

6.1 When the stove is in use, the surface temperature shall be less than 60 ℃ when tested in accordance Annex D.

6.2 The stove shall be stable on a flat surface and shall score a minimum of 0.94 when tested in accordance with D.1.2.

6.3 Surfaces which in normal use have to be touched for short periods e.g. handles, the difference between maximum temperature and air temperature shall not exceed 38 ℃ when tested in accordance with Annex D.1.7.

6.4 Flames touching the cookpot shall be concealed and not able to come into contact with hands or clothing.

6.5 Flames or fuel shall not protrude from any fuel loading area, storage container, or flow-pipes during use.

6.6 If the cookstove with a chimney fails a test in D.1.8 (a), a shield shall be employed to increase safety. The chimney shielding shall pass the test in D.1.8 (b).

6.7 For a stove with a chimney, the chimney shall exit outside the dwelling, and ensure the smooth flow of exhaust.

6.8 For a stove with a chimney, there shall be no smoke leakage

6.9 The stove with electrical fans shall have electricity safety controls.

7 Durability requirements

7.1 When subjected to the durability test, as specified in Annex E, the stove shall maintain its basic structure and stability and shall not have broken parts, cracks and warping.

7.2 The cookstove shall have a lifespan of at least 2 years under normal use and a warranty of 1 year shall be given.

8 Tests for cookstoves

8.1 Manufacturer/supplier description

The manufacturer/supplier shall provide documentation giving a detailed description corresponding to the stove provided. Information to be provided shall include:

a) parts and assembly instructions, where applicable,

b) user instructions,

c) dimensions,

d) cooking power; and

e) fuel type

8.2 Visual inspection

Prior to the testing, a detailed visual inspection of the cookstove shall be conducted, noting the features in relation to the tests to be done. Observations shall be recorded on a data sheet as given in Annex F. Photographs taken shall be attached to the data sheet. A ruler should be included in photographs, as a point of reference.

8.3 Test procedures

8.3.1 Cookstoves shall be subjected to the following tests in accordance with their respective annexes:

a) thermal performance, Annex B

b) emissions, Annex C

c) safety, Annex D

d) durability, Annex E

8.3.2 Results from the tests shall be reported in a test report given in Annex A.

9. User instructions and safety precautions

The cookstove shall be supplied with a suitable form of user instructions and safety precautions.

10 Marking and packaging

10.1 Marking

The stove shall be legibly and indelibly marked with the following information on the cookstove:

a) Name of the manufacturer and or trademark;

b) Country of origin;

c) Classification;

d) Serial/ Batch number; and

e) reference to this Uganda Standard.

10.2 Packaging

Stoves shall be packaged in a suitable package in order to protect them while in storage and transportation. The package shall contain the following information/documentation;

a) name and address of manufacturer

b) user instructions;

c) safety instructions;

d) Parts list; and

d) Gross and net weight.

Annex A
(normative)

Test report

The format of the stove performance test report is provided in Table A.1**.**

Table A.1 — Test report of cookstove

Name and type of the stove:		Manufacturer:		
Fuel type and water content:		Lower heating value, as received:		
Test site:		Test date:		
Standard referred:		Fan power (kW):		
Test environment conditions:				
Test equipment and number of test repetitions				
Test items		Unit	Average	Standard deviation
Thermal performance	P_c	kW		
	η_c	%		
Emission factor	$PM_{2.5}$	mg/MJ		
	CO	g/MJ		
Notes				
Test institution:		Tester:		
Examine and verify:		Sign and issue:		

Annex B
(normative)

Thermal performance tests

B.1 Thermal performance test

B.1.1 Test equipment and instruments

a) Weighing balance with a resolution of 5 g and an accuracy of 1.0 g;

b) Stopwatch;

c) Thermometers with an accuracy of ± 1 °C and resolution of 0.2 ℃;

d) Humidity measuring device ;

e) Wind speed measuring device with a resolution of 0.5m/s.

f) Moisture content measuring device, of accuracy to 1 %

g) Fuel removing device

h) Bomb calorimeter

B.1.2 Pot size and water quantity

The size of pot and water quantity used is determined according to the cooking power, as listed in Table B.1.

Table B.1 — pot size and the water quantity

Cooking power(kW)	Diameter of pot (mm)	Initial water(kg)
≤2.0	240	5
>2.0	280	7

B.2 Test conditions

a) Ambient air temperature: 10℃ - 35℃;

b) Relative humidity:<85%;

c) Wind speed:<1.0 m/s;

d) The test stove should be far away from other heat and combustion sources. If multiple stoves are to be tested in the same room, the distance between each stove should be greater than 3 m.

B.3 Test preparation

B.3.1 The tester shall be familiar with the operation of the stove and have sufficient experience in testing stoves.

B.3.2 The instruments shall be calibrated.

B.3.3 Use appropriate fuel types according to the stove instructions.

B.3.4 Weigh and record the mass, B of enough biomass fuels, based on a burning duration of 1 h.

B.3.5 Measure the low calorific value of biomass fuel according to ISO 18125.

B.3.6 Weigh the water and then pour it into the pot. Record the initial mass of water, G_1 and initial water temperature T_1.

B.3.7 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.

B.4 Test steps

B.4.1 Light the fire and record the time as t_1

B.4.2 When the water temperature has increased to the boiling point, record the temperature of the water T_2 and the time as t_2, and continue with the testing during the water evaporation phase.

B.4.3 During the evaporation phase, record water temperature every 5 minutes.

B.4.4 When the water temperature has dropped 5℃ below the boiling point, end the test, record the time t_3, and weigh and record the water mass in the pot as G_2.

B.5 Calculation

B.5.1 Useful energy

$$Q_1 = 4.18 * G_1 * (T_2 - T_1) + (G_1 - G_2)\gamma \quad \ldots 1)$$

Where;

Q_1 the useful energy, kJ;

G_1 the initial mass of water in the pot, kg;

G_2 the final mass of water in the pot, kg;

T_1 the initial temperature of water,℃;

T_2 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.5.2 Cooking power

$$P_c = \frac{Q_1}{t_3 - t_1} \quad \ldots 2)$$

Where;

P_c cooking power, kW;

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

B.5.3 Cooking thermal efficiency

$$\eta_c = \frac{Q_1}{BQ_{net.ar}} \times 100 \quad \ldots 3)$$

Where;

η_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)

Emissions tests

C.1 Emission measurements of $PM_{2.5}$ and CO

C.1.1 Test preparation

C.1.1.1 The test procedure shall depend on whether or not the stove has a chimney.

C.1.1.2 For a stove with a chimney, locate the hood over the stove chimney exhaust (see Figure C.1). Operate the blower at the flow rate that will be used during the test. Measure the static pressure imposed on the stove by the dilution tunnel (i.e., the difference in the draft measured with and without the dilution tunnel operating) at a location no greater than 0.3m above the flue connector. Adjust the distance between the top of the stove chimney and the hood so that the induced static pressure of the dilution tunnel is less than 1.25Pa. During this check and adjustment activity, no fire shall be in the stove.

C.1.1.3 When the stove is burning at high burning rates, make sure that all emissions are captured by the hood system by adjusting the dilution tunnel flow rate or adjusting the distance between the top of the stove chimney and the hood, or both. The gas flow rate in the dilution tunnel should be no less than 5m/s. If the distance between the top of the stove chimney and the hood decrease, recheck the static pressure imposed on the stove by the dilution tunnel according to C.1.1.2.

C.1.1.4 When testing stoves with low emissions, in order to ensure sufficient capture of emissions in the form of mass collected on filters, additional dilution as shown in Figure C.1 should not be applied. When testing stoves with high emissions, additional dilution may be used to prevent overloading filters and to prevent instrument ranges from being exceeded. If increased air flow causes an excessive increase in hood face velocity, dilution air should be used to reduce hood face velocity. Dilution air may be filtered.

C.1.1.5 For a stove without a chimney, locate the stove under the hood (see Figure C.2).

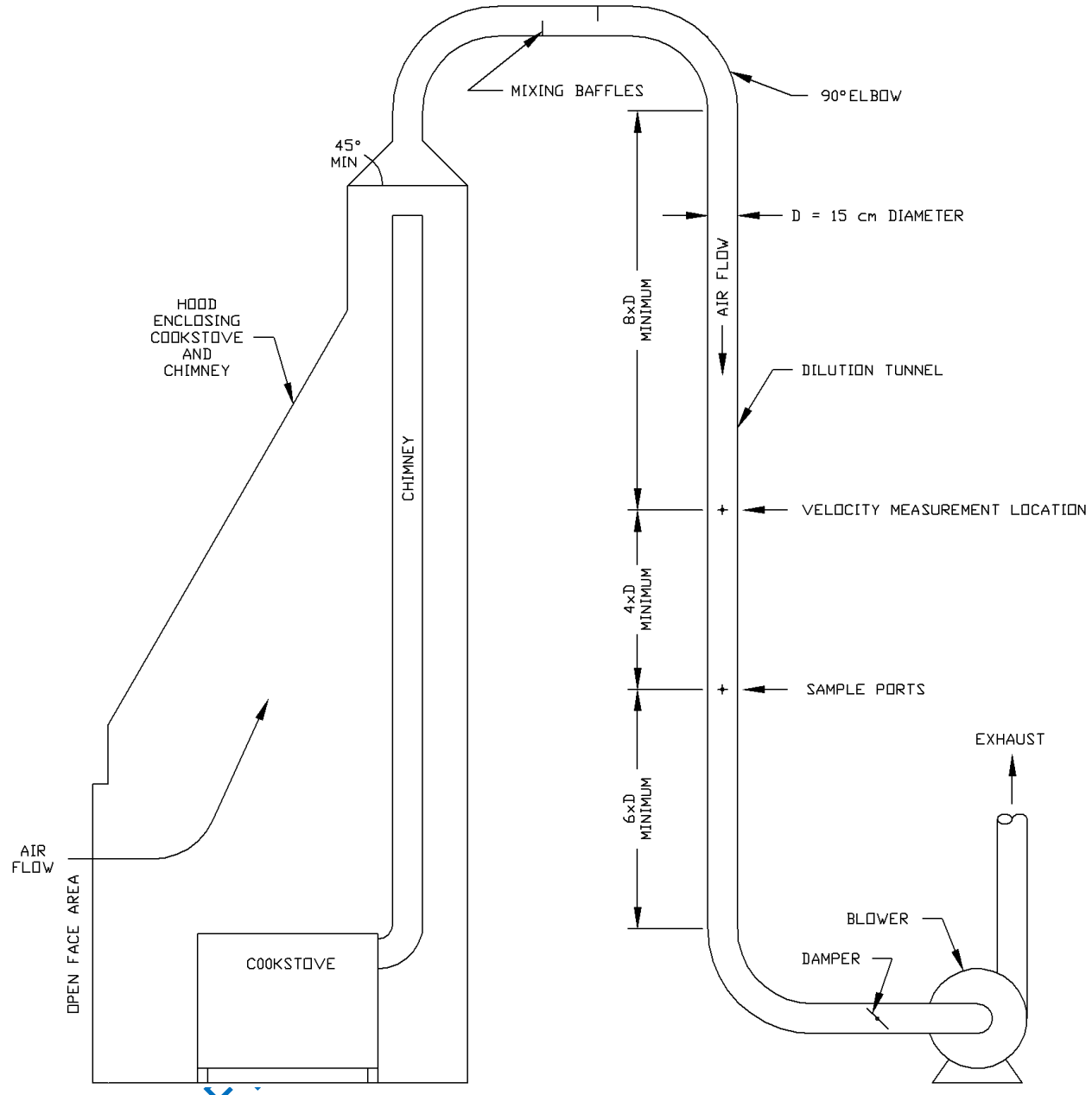

Figure C.1 — Hood and dilution tunnel apparatus for collecting total emissions from cookstoves with chimneys

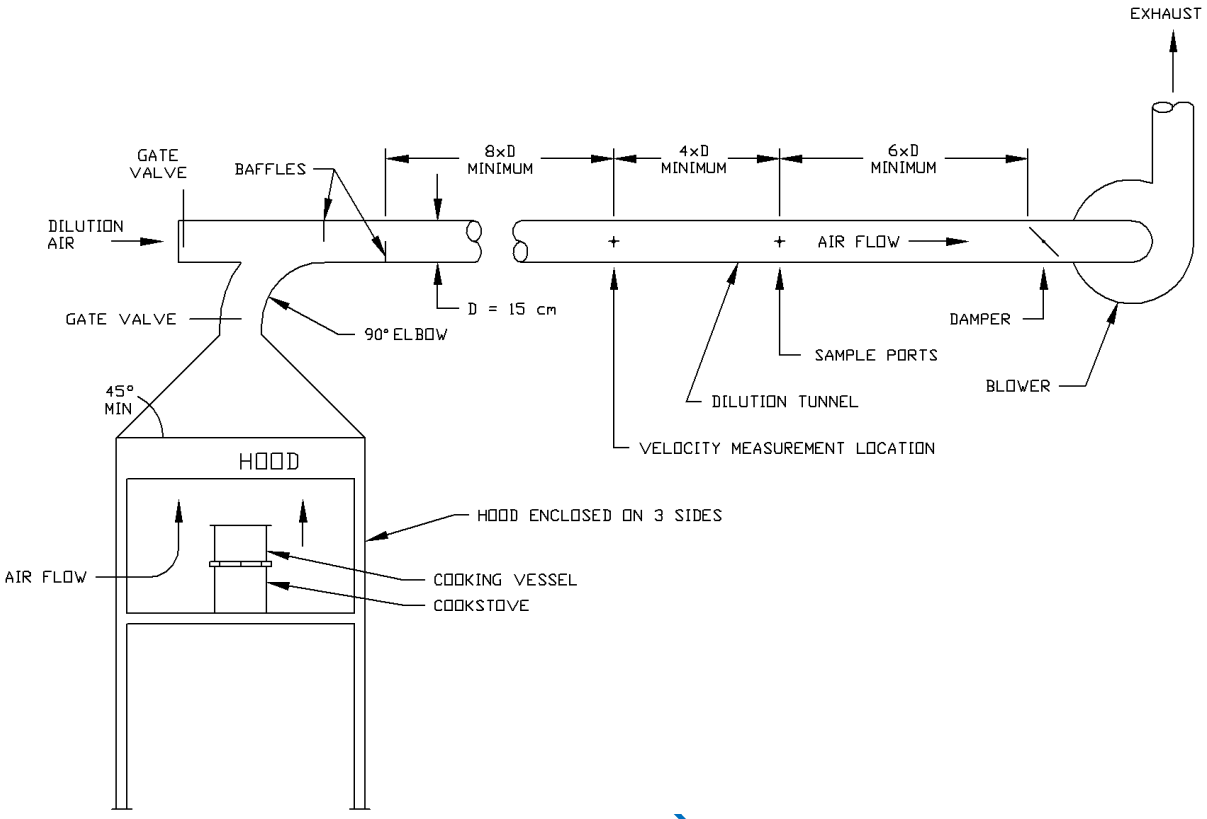

Figure C.2 — Hood and dilution tunnel apparatus for collecting emissions from cookstoves without chimneys

C.1.2 Test method

C.1.2.1 Locate the stove under the hood, and place the stove chimney just below the hood (See Figure C.1).Flue gas emitted from the stove during the test is diluted and cooled by the ambient air, and then passes through the hood, the duct, the blower, and is discharged into the atmosphere. Measure the flow velocity in the duct according to the ISO 9096

C.1.2.2 The sampling of $PM_{2.5}$ (See Figure C.3) shall be in accordance with ISO 9096, and the instruments and filter analysis procedure shall be in accordance with ISO 25597. The sampling and testing of CO procedure refer to the ISO 12039.

C.1.2.3 When ambient air is used as the dilution air, sample and analyse ambient $PM_{2.5}$ and CO according to the ISO 25597and ISO 4224.

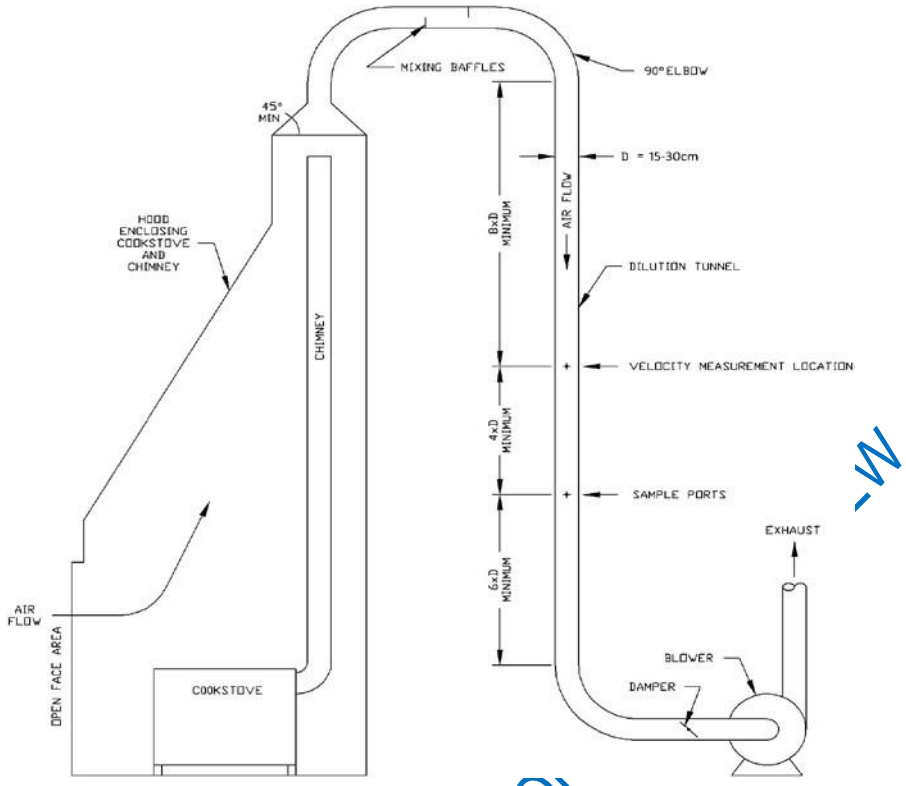

Figure.C.3 — Dilution sampling test for emission

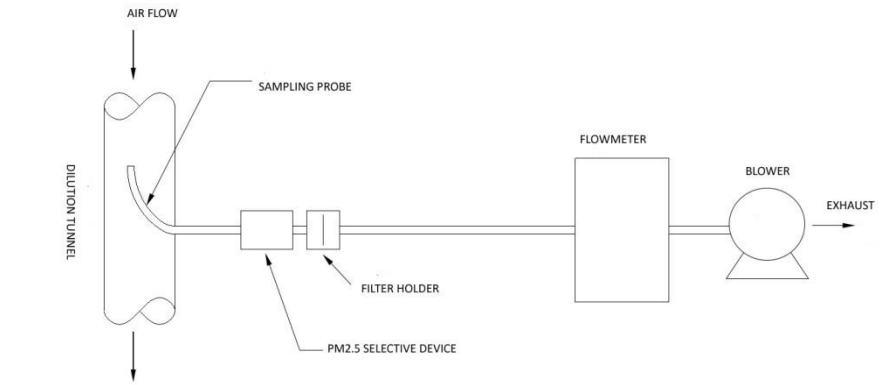

Figure C.4 — $PM_{2.5}$ sampling test

C.1.3 Test steps

C.1.3.1 Locate the stove below the hood, turn on the blower, measure the flow rate and adjust the valves to be sure that all emissions are captured and the flow rate is no less than 5 m/s.

C.1.3.2 Start to sample both $PM_{2.5}$ and CO at the same time point as the fire is ignited. When the water temperature in the pot drops 5℃ below the boiling point, end the sampling and turn off the blower.

C.2 Calculation of Emission Factors

C.2.1 $PM_{2.5}$

$$EF_{PM2.5} = \frac{M_{PM\,2.5}}{Q_1} \times 1000 \quad \ldots 4)$$

$$M_{PM2.5} = \frac{V_t}{V_s} \times M_s \quad \ldots 5)$$

$$M_s = \left(\frac{M'_s}{V_s} - \rho_{PM\,2.5}\right) \times V_s \quad \ldots 6)$$

Where

$EF_{PM2.5}$ PM2.5 emission factor, mg/MJ;

$M_{PM2.5}$ the mass of PM2.5 emitted during the sampling period, mg;

V_t volume of total exhaust in the dilution tunnel during the sampling period, m3;

V_s volume of gas sampled during the sampling period, m3;

M_s the mass of PM2.5 collected on the filter corrected for background, mg (if the dilution air passes through the High Efficiency Particulate Absorber (HEPA), and PM is removed efficiently, the correction is not necessary);

M'_s the mass of PM2.5 collected on the filter, mg;

$\rho_{PM2.5}$ the concentration of PM2.5 in ambient air, mg/m3.

C.2.2 CO

$$EF_{CO} = \frac{(\rho'_{CO} - \rho_{CO}) \times V_t}{Q_1} \quad (7)$$

(7)

Where:

EF_{co} CO emission factor, g/MJ

ρ'_{co} the concentration of CO in the dilution tunnel, mg/m^3

ρ_{co} the concentration of CO in the ambient air, mg/m3

C.3 Testing repeats

Repeat the test at least three times using the same method. Average the results for thermal efficiency and emission factors as the final reported value

Annex D
(normative)

safety tests and scoring tables

D.1 Safety tests

D.1.1 Sharp edges and points test

D.1.1.1 Equipment

Piece of cloth, rag, or loose clothing

D.1.1.2 Procedure

A piece of cotton cloth shall be rubbed gently over the entire exterior surface of the cookstove to find areas that catch or tear the cloth.

The safety rating for this hazard shall be determined by adding together the number of times the cloth becomes caught or entangled. The sum shall then be applied to the metric in Table D 1.

Table D.1 — Scoring system for sharp edges and points test

Number of catches	Rating	Score
None	Best	4
One or two	Good	3
Three	Fair	2
Four or more	Poor	1

D.1.2 Cookstove tipping test

D.1.2.1 Equipment:

a) fuel;

b) ruler / tape measure; and

c) calculator.

D.1.2.2 Procedure

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

b) Pick a side to tip towards and measure the height of its tallest point and record it as a standing height, H (see figure D 1)

Slowly tip cookstove in the outward direction from the side chosen until the stove begins to tip on its own

Note For the case of firewood stoves in which fuel is fed from the side and protrudes outside, do not tip the stove from that side.

c) Hold stove tilted where it can overturn and measure new height, h (see figure D 1).

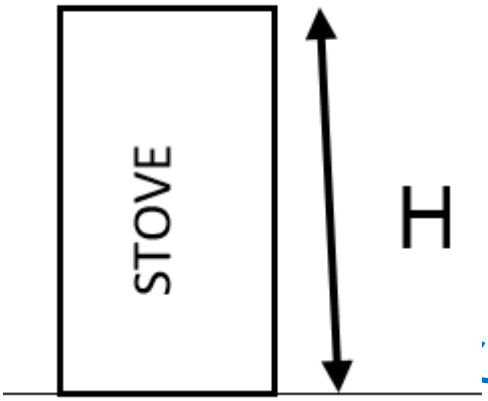

Figure D.1a) — Measurement of H

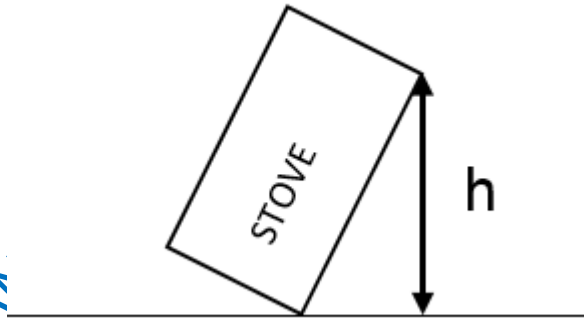

Figure D.1b) — Measurement of h

Figure D.1 — Showing how to measure stove standing height and tipped height

d) Calculate the ratio, R as per equation

$$R = \frac{h}{H} \quad \ldots 8)$$

e) Repeat process as many times as there are legs on the stove (or four times for a circular base)

f) Apply the result to table D.2

Note If the stove is fixed in position it automatically gets the best rating.

Table D.2 — Scoring system for cookstove tipping test

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**

D.1.3 Containment of fuel test

This test provides a method for determining the likelihood for stoves to release burning fuel whether standing upright or after being overturned. Enclosure of the combustion chamber or fuel canister is important to restrict the uncontrolled movement of fuel during use.

D.1.3.1 Equipment

a) fuel,

b) ruler / tape measure,

c) cookpot

D.1.3.2 Procedure

a) stock the cookstove with fuel but do not ignite

b) place the cooking pot onto the cooking surface

c) visually observe the gaps through which fuel can be seen;

d) measure these gaps to determine their approximate areas.

e) calculate the sum of these approximate areas

f) use the summation of area, A, to find the rating as per table D 3

Table D.3 — Scoring system for containment of fuel test

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

D.1.4 Obstructions near cooking surface test

D.1.4.1 Equipment

Ruler / tape measure

D.1.4.2 procedure

a) Inspect the cookstove for presence of the skirt; do not perform the test if skirt is present

b) Measure height difference between the cooking surface and obstructions surrounding the cooking surface

c) Use the largest height difference, D, to find the rating according to table D.4.

Note Stoves with skirts get good rating

Table D.4 — Scoring system for obstructions near cooking surface test

Maximum height difference (D) cm	Rating	Score
D ≤ 1	Best	4
1 > D ≥ 2.5 or cookstove with skirt	Good	3
2.5 > D ≥ 4	Fair	2
D > 4	Poor	1

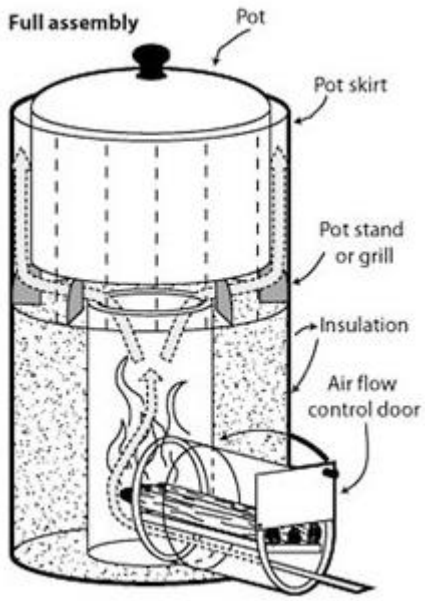

Figure 2 — schematic diagram of a stove with a skirt

D.1.5 Surface temperature test

This test is employed with the intention that burns should not occur if the cookstove surface is touched for a short duration. This short duration is the time it takes for the body to react after touching something warm.

D.1.5.1 Equipment

a) fuel

b) igniter

c) chalk,

d) ruler / tape measure,

e) hand-held thermocouple

f) cookpot

D.1.5.2 Procedure

a) Chalk 8 x 8 cm grid onto the cookstove. For horizontal marking the measurement shall start from the top of the cookstove.

b) mark the grid intersections with a letter or number.

c) Operate the cookstove at full output for 1 h before starting the measurement of temperature, with the cooking pot containing water placed over it

d) Measure ambient air temperature

e) measure and record temperature at grid intersections every after 10 minutes until a nearly constant surface temperature is attained.

f) compute and record the temperature difference, T between air temperature and the highest recorded value of each intersection in (e).

g) use the maximum value of T in (f) to find the rating as per table D 5

Table D.5 — Scoring system for surface temperature test

Difference between maximum temperature and air temperature (T)	Rating	Score
T ≤ 35	Best	4
35 < T ≤ 45	Good	3
45< T ≤ 50	Fair	2
T > 50	Poor	1

D.1.6 Heat transfer to the environment test

Large amounts of heat transmission to surroundings may ignite combustibles or construction in the area of the cookstove. Therefore cookstoves should not cause elevated temperatures on surrounding surfaces in the environment

D.1.6.1 Equipment

a) fuel,

b) igniter,

c) chalk,

d) ruler / tape measure; and

e) hand-held thermocouple

D.1.6.2 Procedure:

The following test 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.

Note For cookstoves that are designed to be attached to the floor or wall, the procedures of this test should be omitted. Instead the highest surface temperatures on the stove near where (5 cm from the wall or floor) it attaches to the ground or wall are used for evaluation in this test.

a) place the cookstove in its normal operating location and orientation

b) sketch an outline of the cookstove on the ground when looking from above.

c) sketch an outline of the cookstove on the wall while looking at the cookstove from the side, towards the wall.

d) remove the cookstove and draw 8 x 8 cm approximate squares in a horizontal-vertical grid inside the outlines on the floor and wall.

e) return the cookstove to its normal operating location and orientation.

f) measure ambient air temperature

g) operate the cookstove at full output for 1 h before starting the measurement of temperature, with the cooking pot containing water placed over it

h) move the cookstove away to take temperature measurements for up to one minute at grid intersections on the floor and the wall,

i) return the cookstove for at least five minutes.

j) repeat steps (j) and (k) until all the grid intersections have been measured.

k) compute the temperatures difference, *T*, of the wall or floor with that of the ambient air

l) use the maximum value of T in (k) to find the rating as per table D 6

Table D.6 — Scoring system for heat transfer to the environment test

Surface	Difference between maximum temperature and air temperature (T)	Rating	Score
Floor	T ≤ 45	Best	4
	45 < T ≤ 55	Good	3
	55 < T ≤ 65	Fair	2
	T ≤ 60	Poor	1
Wall	T > 80	Best	4
	60 < T ≤ 70	Good	3
	70 < T ≤ 80	Fair	2
	T > 65	Poor	1

D.1.7 Handle temperature test

D.1.7.1 Equipment

a) fuel,

b) igniter,

c) chalk,

d) ruler / tape measure,

e) hand-held thermocouple/infra-red thermometer

f) cookpot of appropriate size according to manufacturer's instructions

D.1.7.2 Procedure

a) operate the cookstove at full output for 1 h before starting the measurement of temperature, with the cooking pot containing water placed over it

b) measure ambient air temperature

c) measure and record the temperature of all the parts of cookstove which may be necessary to touch during its operation every after 10 minutes until equilibrium is reached.

Note while measuring the temperature the thermometer shall be covered with a felt pad or aluminium foil and kept in contact with that part for sufficient period of time until the maximum temperature is reached.

d) compute and record the temperature difference, T between air temperature and the recorded value in (c).

e) use the maximum value of T in (d) to find the rating as per table D 7

Table D.7 — Scoring system for handle temperature test

Difference between maximum temperature and air temperature (T)	Rating	Score
T ≤ 32	Best	4
32 < T ≤ 38	Good	3
38 < T ≤ 44	Fair	2
T > 44	Poor	1

D.1.8 Chimney test

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.

a) the ambient air and chimney surface temperature are taken and applied against Table D.5 to determine a safety rating.

b) if a shield is being used, measure the average area, A of the gaps.

c) use the value obtained in (b) to find the rating as per table D 8

Table D.8 — Scoring system for chimney shielding test

Hole area (A) (cm^2)	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		

D.1.9 Flames surrounding cooking vessel test

During this test the stove shall be loaded with fuel and fully ablaze. The typical cookpot for the stove shall be placed in its normal operating position to simulate how the stove is most often used. Amounts of uncovered flames surrounding the cookpot shall be observed and applied to the metric given in Table D.9.

Table D.9 — Scoring system for flames surrounding cooking vessel test

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

D.1.10 Flames exiting fuel chamber test

a) with the cookstove fully ablaze and a cooking pot on top, visually inspect the amount, if any, of flames coming out of the fuel chamber, canister, or pipes and record if flames do or do not protrude

b) rate the result in accordance with Table D.10

Table D.10 — Scoring system for flames exiting fuel chamber test

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

D.1.11 Overall safety score

To calculate the overall safety score, the score from each of the 10 procedures is multiplied by a weighting factor based on Table D.11, and then summed for a total score:

Table D.11 — Overall safety scoring system

Procedure	Parameter*	Weight
1	Sharp edges	1.5
2	Tipping	3
3	Containment of fuel	2.5
4	Obstructions near cooking surface	2
5	Surface temperature	2
6	Heat transfer to the environment	2.5
7	Handle temperature	2
8	Chimney	2.5
9	Flames surrounding cooking vessel	3
10	Flames exiting fuel chamber	4
*For any stove to pass the safety test, the minimum rating in each parameter shall be Good		

For procedures with multiple values, the minimum value is used to calculate the overall score. The total point score will be between 25 and 100.

Annex E
(normative)

Durability tests and scoring

E.1 Durability tests

Under normal circumstances durability test shall include inspection, extended run, impact test, corrosion, temperature resistance and quenching tests. However a simplified assessment may be based on an inspection after thermal and safety tests as well as a quenching test.

E.1.1 Visual examination after thermal performance and safety tests

Durability assessment of the cookstove shall be made by inspecting its state after thermal performance, emissions and safety tests. These shall be compared to it's the state prior to testing. If durability test is to be conducted, without the other tests, then the stove shall be inspected after it has been in operation at maximum power for six hours with a cooking pot on top.

A detailed visual inspection of the cookstove shall be conducted, including documentation with photographs. Observations should be recorded on a data sheet. Whenever possible, a ruler should be included in photographs. Any signs of defects such as instability, discoloration, cracks, twisted metal, broken components, warping etc. shall be noted.

The scoring system for the quenching test is provided in Table E.1.

Table E.1 — Scoring system for inspection

Level	Examples	Risk factor	Score
No change	N/A	+0	10
Minor	Discolouration, minor abrasion, etc.	+1	8
Major	Cracks < 2 cm in length, twisted metal, etc.	+3	4
Critical	Broken components, cracks > 2 cm in length, cloudy/hazy reflectors or glass, etc.	+5	0

E.1.2 Quenching test

E.1.2.1 Equipment

Equipment required for this test is as follows:

a) representative fuel – enough for 5 h of operation;
b) high temperature safety gloves and protective sleeves;
c) safety glasses;
d) cooking vessel with a diameter that is 20% less than the diameter of the cooking surface;
e) ruler; and
f) water container or pitcher appropriate for pouring.

E.1.2.2 Procedure

a) prior to testing, a detailed visual inspection of the cookstove should be conducted, including documentation with photographs. Observations should be recorded on a data sheet. Whenever possible, a ruler should be included in photographs, as a point of reference.

b) fill a cooking vessel with water to within 10 mm of the brim. The cookstove should be run for 1 h. If cookstove power can be controlled, then the cookstove should be run at the maximum possible firepower.

c) quickly pour an additional amount of water into the cooking vessel, causing overflow of water into the cookstove.

d) allow at least 16 h for the cookstove to dry completely.

e) repeat steps b) to d) four times, for a total of five tests.

f) post-testing observations and photographs should be taken and noted on the data sheet.

NOTE It is understood that some cookstove manufacturers specify the firepower for optimum performance. However, for this test the cookstove is operated at its maximum firepower, to model a worst-case scenario.

WARNING The tester should wear safety glasses, high temperature safety gloves, and protective sleeves.

WARNING There is a risk of water overflowing the container and/or hot cookstove components. Extreme caution should be taken while conducting these tests.

E.1.2.3 Scoring

The scoring system for the quenching test is provided in Table E.2.

Table E.2 — Scoring system for quenching test

Level	Examples	Risk factor	Score
No change	N/A	+0	10
Minor	Discolouration or cracks < 2 cm in length	+1	8
Major	Warped components or cracks > 2 cm in length	+3	4
Critical	Broken or missing components, cloudy or hazy reflectors or glass, etc.	+5	0
NOTE The score is obtained by multiplying by 2 and subtracting the risk factor from 10. The formula used is 10–2 x (Risk factor)			

E.1.2.4 Overall durability score

To calculate the overall durability score, the score from each of the 2 procedures is multiplied by a weighting factor based on Table E.3, and then summed for a total score.

Table E.3 — Overall durability scoring system

Procedure	Weight
1	3
2	7

Annex F
(normative)

Features for visual inspection

Name and type of the stove:		Inspector:
Product identity:		Inspection site:
Manufacturer:		Date:
Feature	**Condition**	**Comment**
Cooking surface		
Liner		
Body (metal cladding)		
Handles		
Stands		
Pot rests		
Doors		
Air holes (if any)		
Combustion chamber		
Shelf		
Chimney		
Others		
NOTE Condition shall either be G – Good, or B – Broken, or C – Cracked/Scratched		

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[1] DKS 1814-1:2017, Biomass stoves — Part 1: Performance requirements

[2] GB/T 34021-2016 Clean biomass cookstove

[3] IS.13152, Solid Bio-mass CHULHA-Specification, Part 1, Portable

[4] Risk Analysis and Safety Evaluation of Household Stoves in Developing Nations by Nathan G Johnson

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