
Draft Zambian Standard

BIOMASS PELLETS – Specification

Part 3: Gasifier Cook Stove

DRAFT STANDARD FOR PUBLIC COMMENTS

DATE OF PUBLICATION

This Zambian Standard has been prepared and published under the authority of the Zambia Bureau of Standards on

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This Draft Zambian Standard was prepared by the Renewable Energy Technical Committee, (TC 4/20), upon which the following organizations were represented:

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FOREWORD

The preparation of this Standard has been undertaken by the Renewable Energy Technical Committee (TC 4/20), in accordance with the procedures of ZABS. All users should ensure that they have the latest edition of this publication as standards are revised from time to time.

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This Draft Zambian Standards has been prepared with assistance drawn from: revision of this standard was necessary to ensure that the technological advancements in the sector are taken into consideration.

In the preparation of this standard, the following publication was consulted:

ISO 19867-1 (2018) Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols – Part 1: Standard test sequence for emissions and performance, safety and durability published by the International Organization for Standardization (ISO).

DB11/T 540 (2008) General specification for biomass household stoves published by the Quality and Technical Supervision Bureau of Beijing Municipality.

KS 1814 (2019) Biomass stoves – Performance requirements published by the Kenya Bureau of Standards.

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ZAMBIA BUREAU OF STANDARDS

Draft Zambian Standard

BIOMASS PELLETS - Specification

Part 3: Gasifier Cook Stove

1.0 SCOPE

This Zambian Standard specifies the performance requirements as well as provides technology, manufacturing and safety requirements, test methods and inspection rules of biofuel pellet stoves. This document applies to both commercial and residential stoves.

This standard is applicable to the biomass household cooking stove, heating stove, and cooking & heating stove.

2.0 NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid National and International standards can be obtained from Zambia Bureau of Standards.

ZS ISO 19867-1	Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Part 1: Standard test sequence for emissions and performance, safety and durability
Environment Management Act No. 12 of 2011	

3.0 DEFINITIONS

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

- 3.1. **Biomass cook stove:** apparatus that converts biomass into heat energy typically through combustion and its subsequent utilization.
- 3.2. **Biomass:** the organic products of agriculture and forestry systems used as primary sources of energy. It includes materials originating from:
 - a) Forestry and arboriculture;
 - b) Agriculture and horticulture;
 - c) Aquaculture;
 - d) Monocots;
 - e) Other organic material
- 3.3. **Insulation material:** a mixture of lagging and binding materials that is used between two stove components to hold the two together firmly to reduce heat loss.
- 3.4. **Thermal conductivity:** heat flow per unit area developed under unit temperature gradient.
- 3.5. **Ceramic liner:** moulded and fired clay that give heat retention properties to the stove.
- 3.6. **Ash:** residue remaining after combustion of a fuel under specified conditions, typically expressed as a percentage of the mass of dry matter in fuel.

- 3.7. **Biomass institutional stove:** a stove designed to hold and cook on a pot size of 20 litres and above.
- 3.8. **Emissions:** fuel gas, visible and invisible, occurring as a result of combustion of a fuel.
- 3.9. **Cooking vessel:** pot or container in which food is prepared, cooked or water is heated.
- 3.10. **Improved biomass cookstoves:** biomass cookstove that meets the set criteria of this standard on emission factors, fuel consumption, energy efficiency, durability, and/or safety.
- 3.11. **Useful energy delivered:** energy that provides the service desired by the biomass cookstove user, especially heating the contents of a cooking vessel.

NOTE 1: When biomass cookstoves are used for both cooking and space heating, the useful energy delivered may include the heat delivered to a living space.

NOTE 2: The determination of the useful energy delivered depends on the cooking practice and the purpose of the relevant performance metric. Depending on this factors, useful energy delivered may include all or a fraction of the energy transferred to the cooking vessel.

NOTE 3: Energy transferred to the contents of a cooking vessel includes the energy that raises the temperature of the contents and the latent heat of evaporation of water from the vessel.

- 3.12. **Fuel energy in:** product of the heating value of the raw fuel and the mass of the raw fuel as fired.
- 3.13. **Heating value:** energy per unit mass released in the complete combustion of a sample fuel.
- NOTE 1:** The state of the fuel, as defined by the as fired, as received, or dry fuel conditions, shall be recorded, and the heating value shall be stated as either higher heating value or lower heating value.
- 3.14. **As fired:** condition of a fuel as it is about to be tested in a biomass cookstove.
- 3.15. **Higher heating value:** measured value of the energy of combustion of a fuel burned in oxygen in a bomb calorimeter under such conditions that all the water of the reaction products is in the form of liquid water.
- 3.16. **Lower heating value:** Calculated value of the energy of combustion of a fuel burned in oxygen in a bomb calorimeter under such conditions that all the water of the reaction products remain as water vapour.
- NOTE:** the heating value at constant pressure is generally used.
- 3.17. **Emission factors:** ratio of the mass of a pollutant emitted to a defined measure that quantifies the activity emitting the pollutant.
- 3.18. **Energy/thermal efficiency:** ratio of the useful energy delivered to the fuel energy in.

NOTE 1: This metric is not appropriate by itself for calculating fuel savings when a biomass cookstove produces char that is conserved for use as fuel.

NOTE 2: The use of either lower heating value or higher heating value is recorded and should be specified by the protocol. It is essential to record this selection because it affects the calculation of efficiency.

NOTE 3: The firepower at which the efficiency is determined should be clearly specified.

- 3.19. **Char:** carbonaceous residue resulting from pyrolysis or incomplete combustion
- 3.20. **Durability:** ability of a biomass cookstove to continue to be operated for an extended period safely and with minimal loss of performance under conditions of the user
- 3.21. **Ash solid:** portion of the remaining solids that has negligible recoverable heating value.
- 3.22. **Burn Sequence:** Combustion of fuel in a biomass cookstove from ignition to an end point defined in a specific protocol.

- 3.23. **Reliability index:** corresponding to acceptable safety or serviceability for a given reference period, which can coincide with the design service life.
- 3.24. **Calorific Value:** synonym of heating value.
- 3.25. **Combustible mass:** portion of the fuel consisting of fixed carbon and volatile components, excluding ash and moisture, which can potentially be combusted.
- 3.26. **Conventional fuel:** fuel or fuels regularly employed by the users.
- 3.27. **Dry fuel:** fuel from which all moisture has been removed by heating to 3 °C above the local boiling point.
- 3.28. **Dry basis:** Basis for describing the compositing of a fuel sample as the ratio of the mass of a component to the mass of dry fuel, expressed in percent.
- 3.29. **Fly ash:** ash that is entrained in the exhaust.
- 3.30. **Exhaust:** gases and suspended particulate matter resulting from the combustion process.
- 3.31. **Ignition:** start of a period of combustion.
- 3.32. **Raw fuel:** mass of the unburned fuel supplied to a cookstove during the course of the burn sequence.
- 3.33. **Recovered fuel:** material that has a usable energy content that remains after a burn sequence is completed.
- 3.34. **Remaining solids:** solids (excluding fly ash) remaining at the completion of a burn sequence.
- 3.35. **Residual Fuel:** portion of the recovered fuel that is not reused fuel.
- 3.36. **Reused fuel:** material separated from the recovered fuel that has properties such that it can be employed in a subsequent burn sequence in the same biomass cookstove.
- 3.37. **Total fuel:** sum of the masses of the raw fuel and the reused fuel.
- 3.38. **Particulate matter:** solids and liquids of a sufficiently small size to be suspended in air.
- 3.39. **Cooking sequence:** operation of a cookstove that uses the heat released during a burn sequence for the preparation of food or the heating of water, with a recorded or prescribed series of power level settings, durations and cooking vessel utilizations.
- NOTE 1:** The cooking sequence commences with the placement of the first cooking vessel on the stove and ends when the last vessel is removed. The entire cooking sequence is normally embedded within a burn sequence, though in special cases retained heat cookers might continue cooking after the fire has been extinguished or while additional cooking tasks are undertaken.
- 3.40. **Gasifier cookstove:** type of cookstove that forces the gasses and smoke that result from incomplete combustion back into the cookstove's flame where the heat of the flame continues to combust the particles until combustion is nearly complete resulting in few emissions.
- 3.41. **Forced air cookstove:** type of stove using redirected air blown into the combustion chamber. The jets of air induce superior mixing of flame, gas and smoke, and create an extremely clean burn with negligible emissions.
- 3.42. **Natural draft cookstoves:** type of stove where air used for combustion is circulated naturally.
- 3.43. **Household biomass stoves:** household stove refers to stoves that have cooking or heating ability using biomass as fuel, and the power of stove is less than 50kW.

3.44. Rated heating capacity: the heating output within certain time when the biomass stove was working under optimal conditions. For cooking stove, it means cooking fire intensity.

3.45. Cooking power (fire intensity): average rate of energy delivered to the contents of a cooking vessel over any chosen period during the course of a cooking sequence or other task.

NOTE 1: The cooking power is expressed in kilowatts.

3.46. Maximum cooking power: highest cooking power (3.15) for which a cookstove (3.19) is designed

NOTE 1: The maximum cooking power is expressed in kilowatts.

3.47. Minimum cooking power: lowest cooking power (3.15) for which a cookstove (3.19) is designed

NOTE 1: The minimum cooking power is expressed in kilowatts.

3.48. Thermal efficiency: the ratio of thermal energy absorbed for temperature increase and evaporation of water in the pot over the thermal energy generated by fuel in the stove, indicating the percentage of energy can be used from the stove.

4.0 TECHNICAL REQUIREMENTS

4.1. Basic Requirements

4.1.1. Structural requirements

Stove structure should be reasonably designed for purpose, safe and convenient to use.

4.1.2. Manufacturing Requirements

4.1.2.1. All relevant component parts of the stove shall be constructed with corrosion resistant material or protected by a suitable anticorrosive coating and shall be smooth and free from defects such as cracks, sharp edges or burrs.

4.1.2.2. Materials used for structural support and assembly parts shall meet a supporting weight of at least 10kg for residential stoves and 20kg for institutional stoves.

4.1.2.3. Sheet metal parts shall be smooth without fissure or wrinkle. Machining surface should not be knocked, scratched or corroded.

4.1.2.4. The combustion chamber shall be manufactured from materials with heat and corrosion resistant properties (for steel minimum of 0.5 mm thickness) and meet the national environmental requirements.

4.1.2.5. The combustion chamber shall be thermally-stable and unbroken, the shape and thickness (unless otherwise stated) can be decided by the manufacturer.

4.1.2.6. Casting parts shall be smooth without fissure and sand hole.

4.1.2.7. Casting parts shall be uniform without burn through or protruding parts.

4.1.2.8. Stamping parts shall not be fissured or wrinkled. etc.

4.1.2.9. Riveting shall firmly join members.

4.1.2.10. The surface shall be stain proof.

4.1.2.11. Heat insulation materials shall be thermally-stable and meet the national environmental requirements.

4.1.2.12. A stove with surplus heat utilized for water heating shall have a water jacket free of leakages.

4.1.3. Appearance Requirements

The stove should meet aesthetic requirements and its component parts shall be free of defects that adversely affect the appearance, durability, performance and safety aspects during use.

4.1.4. Thermal Performance Requirements

The minimum thermal efficiency required for advanced combustion cookstoves, both residential and institutional, when tested in accordance with ZS ISO 19867-1 shall not be less than 30 %.

4.1.5. Emissions Requirements

When tested in accordance with ZS ISO 19867-1, all stoves shall meet all the requirements as given in Table 3 and Annex A.

Table 3 — Stove emission requirements

CO g/MJ _d	PM _{2.5} mg/MJ _d
≤4.4	≤62
≤7.2	≤218

4.2. Durability Requirements

4.2.1 The cladding used in the manufacture of household and institutional biomass stoves shall be from a steel sheet or materials of equal or higher performance requirements shall be used.

4.2.2 The ceramic liner used in the manufacture of stoves shall be made from suitable pottery clay and pottery sand where applicable that has been cured and uniformly fired at 700 °C - 900 °C in the firing facility.

4.2.3 Pot rests for cook stoves shall be made from steel members or materials of equal or higher performance, meeting strength requirements.

4.2.4 The cook stove shall have a working life of 3 years for household stoves and 5 years for institutional stoves.

NOTE 1: The thickness of the material used for different components of residential or commercial biomass cook stoves are to be higher for providing adequate strength and life.

4.2.5 The materials used in the production of cook stoves shall not pose health hazards. Hazardous materials as defined in Environment Management Act No. 12 of 2011 shall not be used.

4.3. Safety requirements

4.3.1 Insulation

Insulation shall be made of non-combustible materials and shall not be a known hazard to health in its applied position.

4.3.2 Sharp edges and points

Sharp edges and points on a cook stove that can cut flesh or entangle clothes and overturn the stove shall not be present.

4.3.3 Cook stove tipping

4.3.3.1. The construction of the cook stove shall be sturdy so that while in actual use on level floor they cannot get shaky or yield at any point.

4.3.3.2. Cook stove, both when full of fuel and when empty, shall be capable of being tilted in any direction to an angle of 15° from the vertical, without overturning at that inclination or on being released.

4.3.4 Containment of fuel

Burning fuel shall not be expelled from a combustion chamber or spilled when a stove is in use or when tilted at an angle of 15 degrees.

4.3.5 Obstructions near cooking surface

Areas surrounding the cooking surface shall 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.

NOTE Typical obstructions include handles perpendicular to the griddle that are used for removing the cooking surface during cook stove maintenance

4.3.6 Surface temperature

Surfaces, which in normal use have to be touched for short periods (for example, handles, etc), shall not have a temperature exceeding 45°C when measured in accordance with ZS ISO 19867-1.

4.3.7 Heat transmission to surroundings

Cook stoves shall not cause elevated temperatures on surrounding surfaces in the environment that would cause ignition, damage or harm.

4.3.8 Flames surrounding the cook pot

Flames touching the cook pot, when the right size of the pot is used, shall be concealed and not able to come into contact with hands or clothing.

4.3.9 Flames/fuel exiting fuel chamber

Flames shall not protrude from the fuel loading area during use. Minor flames associated with igniting material shall be excluded.

4.4. Marking, packaging, storage and usage

4.4.1 Marking

The following information shall be indelibly and legibly marked in a prominent position on a portable biomass stove.

- a) Name of manufacturer and/or trademark;
- b) Serial number or batch number;

- c) Model number;
- d) Production Date.

In addition to the above, all non-portable biomass stoves shall be legibly and indelibly marked with the details of the installer.

The indented parts shall have no defects such as cracks, wrinkles or flash.

4.4.2 Packaging

The packaging shall comply with the requirements of the user. The following shall be delivered with each biomass stove:

- a) Instructions manual in English and applicable local languages;
- b) Warranty.
- c) Manufacturers certificate
- d) Product specification
- e) Parts list

4.4.3 Storage

Products shall be stored in a cool, dry place.

5.0 TESTING

All tests shall be carried out in accordance with ZS ISO 19867-1

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ANNEX A (Informative)

Default values for PM_{2.5} and CO

Table A.1 - Default emission factors, rates, equivalent concentrations and % homes meeting specified criteria, for PM_{2.5}



Dimensions and tiers	Tier	RR	mg/MJ _a	Normalized Emission Rate (mg/min)	µg/m ³	Percentage of home meeting the tier level
Better 	5	≤1.0	≤5	≤0,2	≤10	≥90%
	4	≤1,5	≤62	≤2,7	≤50	≥50%
	3	≤2,5	≤218	≤9,5	≤170	≥50%
	2	≤3,0	≤481	≤21	≤400	≥50%
	1	≤3,15	≤1031	≤45	≤800	≥50%
	0	>3,15	>1031	>45	>800	<50%

Table A.2 – Default emission factors, rates, equivalent concentrations, and % homes meeting specified criteria, for CO

Dimensions and tiers	Tier	Emission factor g/MJ _a delivered	Emission Rate (mg/min)	24 hour concentration at 50% coverage mg/m ³ (ppm)	Cooking event concentration at 50% coverage mg/m ³ (ppm)	Percent of homes covered at 7 mg/m ³ daily average ^a	Percent of homes covered at 230 mg/m ³ during cooking ^b
Better 	5	≤3,0	≤133	2,3 (2,0)	13,6 (11,9)	≥90%	≥99,9
	4	≤4,4	≤190	3,2 (2,8)	19,3 (16,8)	≥80%	≥99,9
	3	≤7,2	≤315	5,4 (4,7)	32,6 (28,5)	≥60%	≥99,3
	2	≤11,5	≤500	8,8 (7,7)	52,5 (45,8)	≥40%	≥97,1
	1	≤18,3	≤800	14,0 (12,2)	84,1 (73,4)	≥20%	≥ 90
	0	>18,3	>800	>800	14,0 (12,2)	84,1 (73,4)	<20%

^a WHO 24-hour air quality guideline [8]
^b Concentration during cooking at which subjects experience slight headache and impaired judgement within 2-3 hours from start of exposure [22]