Nepal Interim Benchmark for solid biomass Cookstoves

(NIBC, 2016)

Government of Nepal

Ministry of Population and Environment

Alternative Energy Promotion Centre

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List of Abbreviation

AEPC	Alternative Energy Promotion Centre
NEEP	Nepal Energy Efficiency Programme
NRREP	National Rural and Renewable Energy Programme
NAST	Nepal Academy of Science and Technology
RETS	Renewable Energy Test Station
RTKC	Regional Testing and Knowledge Centre
ISO	International Organization for Standardization
IWA	International Workshop Agreement
BIS	Bureau of Indian Standards
CDM	Clean Development Mechanism
ICS	Improved Cooking Stoves
NIBC	Nepal Interim Benchmark for solid biomass Cookstoves
PM	Particulate Matter
CO	Carbon Monoxide
MJ	Megajoule
MJ_d	Megajoule delivered to the pot
L	Liter
g	Gram
mg	Milligram
min	Minute

Background

Alternative Energy Promotion Centre (AEPC) is the focal agency of the Government of Nepal (GoN) under the Ministry of Population and Environment (MoPE). With the mandates of policy and plan formulation, programme/project execution, technology dissemination, resource mobilization and coordination and quality assurance, the mission of AEPC is to make renewable energy a mainstream resource through increased access thereby contributing for the improved living conditions of people in Nepal.

AEPC has been disseminating different models of Improved Cooking Stove (ICS) right from its inception, under different programmes supported by various external development partners. The recently conducted 'National Living Standard Survey' has shown that still more than 3 million households of the country qualify for improving their traditional stoves to improved cooking stoves.

AEPC is implementing the National Rural and Renewable Energy Programme (NRREP) with support from a number of external development partners in a single programme modality for the promotion and dissemination of renewable energy technologies under various sub/components and units from mid-July 2012 to mid-July 2017.The Biomass Energy Sub-Component (BESC) of AEPC/NRREP aims to improve living standards of rural people and increase employment through introduction of affordable, efficient and appropriate biomass technologies.

The development of the interim benchmark for solid biomass burning cookstoves is aimed to recognise and certify stoves that have optimized performance in terms of efficiency, total emissions, indoor emissions, user safety and durability. Further, the recognized stoves can qualify for participation in government subsidies, Clean Development Mechanism (CDM) or other carbon market schemes.

The Nepal Interim Benchmark for solid biomass Cookstoves (NIBC, 2014) document was the outcome of rigorous interaction and consultative meeting with the Nepal Alliance for Clean Cookstoves (NACC) members, national and international experts, and the Stakeholders' Meeting for Benchmark Setting on Biomass Cookstoves. The first revision of the NIBC is intended for updating the standard based on the feedback from the test results of various types of stoves tested at the national laboratories (RETS, CRT/RTKC), feedback from the stakeholders and the international practice updates on stove testing. Series of meetings has been held between the Nepali stove testing laboratories, advisers from GIZ under the NEEP and concerned stakeholders during the revision process and this update (NIBC, 2016) has been developed.

1. Terms and Definitions

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

Biomass cookstove
A device which is used to cook food and/or provide warmth and/or boil water through the conversion of biomass, typically combustion in household level.

Batch type stove
A stove in which fuel is loaded one time per burn cycle.

Continuous type stove
A stove in which fuel is loaded continuously over its burn cycle.

Cooking and heating stove
A stove which is used to cook food as well as heat the space through a heat radiating metallic surface (temperature reaching $\geq$ 400oC) or the stove with large thermal mass specifically designed for room heating purpose.

Institutional stove
A stove which is used for cooking and/or heating purpose for a large number of people (more than 20 people per batch or greater than 8 kW fire power) and/or used in institutions or commercial applications.

High-power
Operation of a stove at maximum (or nearly maximum) rate of energy use.

Low-Power
Operation of a stove at minimum (or nearly minimum) rate of energy use.

Water boiling test
A test in which the performance of a stove is evaluated through the heating of a known quantity of water across a specified range of temperature following a defined protocol.

Natural draft stove
A stove in which the flow of exhaust gas occurs naturally due to the difference in the pressure created by temperature difference between the inside of the stove and the outside environment.

Force draft stove
A stove that uses a fan to assist the flow of exhaust gas.

Chimney stove
A stove that uses a chimney is used to assist creating a positive draft for the flow of the exhaust gas from inside of the stove body to the outside of the concerned household/building.

Chimneyless stove
A stove that uses no chimney to assist the flow of exhaust gas from inside of the stove body to the outside environment.

2. Testing Protocol/Methods

The below mentioned testing protocols/ methods shall be followed by the respective testing laboratories. The documents can be downloaded from the AEPC webpage.

- The ISO-IWA recommended Water Boiling Test Version 4.2.2 and above shall be followed for testing the solid biomass based continuous feeding cookstoves. The stoves shall be tested under high power and low power phases.
- The BIS recommended IS 13152 standard testing procedure shall be followed for the thermal efficiency test of batch fuel feeding biomass cookstove (including charcoal stoves, beehive briquette stoves, brown briquette/pellet stoves and gasifiers).
- For institutional stoves (batch feeding or continuous feeding), the standard pot selection method and quantity of water required for testing shall be selected as per the procedure defined in Annex I.
- Biomass Stove Safety Protocol - Version 1.1 or above (developed at Iowa State University and recommended by ISO-IWA) shall be followed for safety performance measurement.
- Cookstove durability testing protocol 2014, prepared by the Center for Energy Development and Health at the Energy Institute at Colorado State University and recommended by GACC shall be followed for cookstoves requiring the durability test.

3. Minimum Requirements for Testing Facilities

The following equipment is required for certified testing of emissions, performance, indoor emissions, safety and durability:

a. For carbon monoxide emissions or room measurement: non-dispersive infrared or electrochemical cell.
b. For particulate matter emission or indoor air quality measurement:
    a. Real-time measurement of a particulate matter proxy via light scattering, and
    b. PM 2.5 gravimetric measurement system
c. For emissions exhaust gas flow: constant volume pump or flow grid both with real time temperature and pressure correction.
d. For temperature measurement: Type K thermocouple or equivalent.
e. Computer data logging of all measurements with a minimum time resolution of one measurement per ten seconds.
f. For measuring fuel and water masses: a calibrated digital scale with 1 gram resolution or better.
g. Test accessories for durability testing as per requirement of the recommended testing protocol.

4. Technical Standard for Performance and Safety of Solid Biomass Cookstoves

All biomass cookstoves including household and institutional stoves shall fulfill technical standards for performance and safety parameters. For institutional cookstoves larger than 20 kW firepower, the emission testing requirements are optional.

4.1 Chimney Stove (Natural Draft)

S.N.	Test Parameter	Standard Value	
Thermal Efficiency and fuel use			
1	High Power Thermal Efficiency (%)[a]	≥20*	
2	Specific Fuel Consumption (MJ/min/L)	≤0.039	
Total Emission			
		Indoor	**Indoor + chimney**
3	High Power PM 2.5 (mg/MJ_d)	≤41*	≤979
4	Low Power PM 2.5 (g/min/L)	≤1	≤8
5	High Power CO (g/MJ_d)	≤8*	≤16
6	Low Power CO (g/min/L)	≤0.09	≤0.20
Indoor emission rate*			
7	PM2.5 (mg/min)	≤5	
8	CO (g/min)	≤0.42	

** Mandatory values.*

***Fugitive emission value only, excluding emission from the chimney outlet.*

[a] *For cooking and heating chimney stoves, the High Power Thermal Efficiency (cooking efficiency only) shall be ≥18% and emission parameters shall remain the same as mentioned in above table.*

4.2 Chimneyless Stove (Natural Draft)

S.N.	Test Parameter	Standard Value
Thermal Efficiency and fuel use		
1	High Power Thermal Efficiency (%)	≥25*
2	Specific Fuel Consumption (MJ/min/L)	≤ 0.039
Total Emission		
3	High Power PM 2.5 (mg/MJ_d)	≤513*
4	Low Power PM 2.5 (g/min/L)	≤4
5	High Power CO (g/MJ_d)	≤10 *
6	Low Power CO (g/min/L)	≤0.09
Indoor emission rate		
7	PM2.5 (mg/min)	≤40
8	CO (g/min)	≤0.49

** Mandatory values.*

4.3 Forced Draft Stove (Fan Stove)

S.N.	Test Parameter	Standard Value
Thermal Efficiency and fuel use		
1	High Power Thermal Efficiency (%)	≥35*
2	Specific Fuel Consumption (MJ/min/L)	≤0.039
Total Emission		
3	High Power PM 2.5 (mg/MJ_d)	≤386*
4	Low Power PM 2.5 (g/min/L)	≤ 4
5	High Power CO (g/MJ_d)	≤8*
6	Low Power CO (g/min/L)	≤ 0.09
Indoor emission rate		
7	PM2.5 (mg/min)	≤30
8	CO (g/min)	≤0.42

** Mandatory values.*

4.4 Safety Performance

Stove category	Metallic body cooking and heating stove	Metallic body cooking stove	Mud/ composite body cooking stove
Safety assessment calculation	>=45	>=75	>=88

5. Technical Standard for the Durability of Metallic/Composite Body Solid Biomass Cookstoves

5.1 Material Durability Conformity Requirements

S.N.	Structure	Standard Value for Chimneyless stove	Standard Value for Chimney stove
1	Combustion Chamber		
	• Stainless Steel	≥ 1 mm thickness	≥ 1 mm thick
	• Mild Steel	≥ 3 mm thickness	≥ 2 mm thick side plates; 4 mm top plate
	• Other material (alloy, composite, ceramic, others)	Need to pass durability conformity test	Need to pass durability conformity test
2	Grate (where applicable)		
	Rod structure		
	• Cast Iron structure	≥ 4 mm thickness	≥ 4 mm thickness
	• Stainless Steel	≥ 4 mm thickness	≥ 4 mm thickness
	• Mild Steel	≥ 6 mm thickness	≥ 6 mm thickness
	Plate structure		
	• Cast Iron structure	≥ 4 mm thickness	≥ 4 mm thickness
	• Stainless Steel	≥ 1 mm thickness	≥ 1 mm thickness
	• Mild Steel	≥ 2 mm thickness	≥ 2 mm thickness
3	Top plate with pot riser		
	• Cast Iron	≥ 3 mm thickness	≥ 6 mm thickness
	• Stainless Steel	≥ 1 mm thickness	≥ 2 mm thickness
	• Mild Steel	≥ 2 mm thickness	≥ 4 mm thickness
	• Other material (alloy)	Need to pass durability conformity test	Need to pass durability conformity test

Note: Galvanized material or non temperature resistive paint or coating in fire grate, top plate and combustion chamber are not accepted in NIBC.

For mud based stoves, the critical structural parts like fire gate, fire tunnel, chimney tunnel and alike structures shall be reinforced sufficiently with metallic parts during construction.

5.2 Durability Conformity Tests

S.N.	Test Method	Risk Factor	Remarks
1	Extended Run Test	≤1	Test required for stove materials not covered in Section 5.1

Note: Durability conformity test is not required for stoves confirming to material durability conformity requirements.

6. Validity of Document

This interim benchmark will be applicable for all solid biomass cookstoves promoted by the GoN. This document will be effective from November 2016 and shall remain valid until a new version or National Benchmark for Solid Biomass Cookstoves formally replaces it.

This document shall be revised based on the feedback from the concerned stakeholders upon requirement.

Annex I

Standard Pot Selection Procedure for Testing Institutional Stove

The pot shape and size for testing the stove shall be selected based on the information provided with the stove or from the manufacturer/designer.

The amount of water to be used during WBT testing shall be determined based on the burning capacity of the stove provided by the manufacturer/designer.

In case the manufacturer is unable to provide the burning capacity of stoves, the following process shall be used to calculate the burning capacity of the stove.

A. Steps for calculating the burning capacity of the stove

I. Weight one bundle of fuel (approximately 2 kg). Let the mass be M_1 kg.
II. Stack the fuel in a honey comb fashion in combustion chamber up to 3/4 of the height for continuous feeding type cookstove, or in a pattern recommended by the manufacturer.
III. Put the pot on the stove as recommended by the manufacturer with 10 liters of water.
IV. Sprinkle 10 to 15 ml of kerosene on the fuel from the top of the cookstove and ignite the fire.
V. After half an hour of burning the fuel, weigh the remaining fuel and let the mass be M_2 kg.
VI. Calculate the burning capacity of the cookstove as heat input per hour as follows:-

Burning capacity rating = $2 (M_1 – M_2)$ kg/hr
Heat input per hour = $2 (M_1 – M_2) \times CV$ kcal/hr or $2 (M_1 – M_2) \times CV \times 0.001163$ kW
Where,
M_1 = the initial mass of the cookstove with test fuel in kg,
M_2 = the mass of the cookstove with fuel residues, after burning the test fuel for half an hour in kg, and
CV = Calorific value of the test fuel in kcal/kg.

B. Selection of the vessel and mass of water for testing

The size of the vessel shall be selected as per the design recommended by manufacturer (or vessel provided by manufacture). If the manufacturer has not provided details of the vessel, an appropriate vessel size for testing shall be determined by the test station based on the mass of water for testing. To minimize retention of heat by pot, mass of vessel shall be kept as low as possible and the specification of the vessel used for testing shall be reported in the certificate.

The mass of water to be taken for the test shall be selected from the Table as shown below.

S.N	Heat Input rate (kW)	Mass of water in Vessel (Kg)
1	8 to 10	10
2	Above 10 to 15	15
3	Above 15 to 20	20
4	Above 20 to 25	25
5	Above 25 to 30	30
6	Above 30 to 35	35
7	Above 35 to 40	40
8	Above 40	50

Note: While selecting the size of the vessel, the volume of water should not exceed 70% of the total volume of the vessel.