



Report on Safety Evaluation Procedure – Chitetezo MBAULA

1. Introduction

This report shows the results of the safety test that was performed on the portable Chitetezo MBAULA during the Malawi Cleaner Cooking Camp by Christa Roth of Food and Fuel Consultants¹ and Maarten Kleijn - Renewable Energy Advisor for SNV. Testing procedures and safety evaluation criteria were taken from a publication by Nathan G. Johnson². The test was performed on March 12th 2014 at the Cooking Camp venue Sol Farm in Lilongwe. Attention was paid to using the stove in the way it is most commonly used for cooking in Malawi. The test took place outdoors; the stove was placed on sand. The weather conditions were partly cloudy, with little wind at a temperature of 30^oC. Further specifications of materials and equipment used for the test can be found in the table below.

Table 1: Equipment and Tools used for the Safety Test

SN	Test Materials and Equipment	Specification/Purpose
1	Cookstove	Locally produced ceramic Chitetezo MBAULA stove
2	Cookpot	
3	Fuel	
4	Calculator	For calculation of numbers
5	Cloth	
6	Charcoal	For drawing grid lines on the stove body and surrounding
7	Thermometer	For measuring ambient air temperature
8	Measuring Tape	For taking measurements of stove height
9	Non-contact infrared thermometer	For measuring cookstove surface temperature and environment surface temperature.

2. Details of Safety Tests Conducted and Results

2.1. Sharp Edges and Points

For this test a piece of cloth was rubbed along the entire exterior surface of the (unloaded) stove, to test the stove for sharp edges that might cause the stove to tip over. The cloth did not catch. This test result gave a *best* rating as can be seen in table 2.

Table 2: Results for Sharp Edges and Point Test

Rating	No. of catches
Poor	four or more
Fair	three
Good	one or two
Best	none

¹ To contact Christa Roth please email christa-roth@foodandfuel.info

² Risk Analysis and Safety Evaluation of Household Stoves in Developing Nation, Nathan G. Johnson, 2006 (<http://www.bioenergylists.org/stovesdoc/Johnson/safety.htm>)



3.2. Cookstove Tipping

The stove was now filled with firewood, but not yet lighted. To test how easily the stove can be tipped, the cookstove tipping test was performed. For the tipping measurement, the initial height at the edge of the stove was written down. Then the stove was moved to the tipping point and the tipping height (distance from edge of stove to ground) was written down. The result is displayed in the table below. The ratio of the height difference was taken and compared with the table. This test result gave a *best* rating.

Run	Starting Height	Tipped Height	Ratio
1	23,5	11	0,47

Rating	Ratio
Poor	$R > 0,978$
Fair	$0,961 < R < 0,978$
Good	$0,940 < R < 0,961$
Best	$R < 0,940$

3.3. Containment of Fuel

To test the containment of the fuel, the number of areas through which the fuel can be seen was measured. The stove was still loaded with fuelwood but not ignited. For this test a pot was placed on top of the stove. Given the diameter of the pot, the fuel could not be seen from above the stove. The only area through which the fuel could be observed was the fuel inlet (picture). The height (h) of this opening was 10 cm. The width (w) of the opening was 11 cm. Area = $h \times w = 110 \text{ cm}^2$. This test result gave a *good* rating.

Table 5: Results for Containment of Fuel Test

Rating	Area exposed (cm ²)
Poor	$A \geq 250$
Fair	$150 \leq A < 250$
Good	$50 \leq A < 150$
Best	$A < 50$



3.4. Obstructions near Cooking Surface

No obstructions surround the cooking surface of the Chitetezo MBAULA stove. The handles do not reach the height of the cooking surface. In the absence of obstructions, a *best* rating is given.

Table 6: Results for Obstructions near Cooking Surface

Rating	Difference (cm)
Poor	$D \geq 4$
Fair	$2,5 \leq D < 4$
Good	$1 \leq D < 2,5$
Best	$D < 1$

3.5. Surface Temperature

To prepare for tests 5 to 7, the air temperature was measured with a thermometer. At a point in the shade, close to the location of the stove, the air temperature was 30,4°C. This number was added to the numbers in the reference tables for nonmetallic stoves below the child-line for test 5-7.

On the outside of the stove an 8x8cm grid was drawn with charcoal. The top horizontal line was called 'A', the bottom line was called 'B'. The intersections were numbered from 1-8, counterclockwise, with 1 on the left side of the fuel opening. Afterwards the fuelwood was ignited and a pot containing water was placed on top. New fuelwood was added when necessary and the stove was kept lit for 30 minutes until the maximum temperature of the stove was reached. Now the non-contact infrared thermometer was unpacked. At the intersections of gridlines the temperature was measured. The temperature was highest on the points closest to the fuel inlet. The maximum temperature was **133°C**. This results in a *poor* rating.

Table 7: Results for Cookstove Surface Temperature

Run	Temp. on intersection (°C)	
	A	B
1	48	129
2	83	133
3	75	123
4	90	105
5	81	68
6	61	71
7	60	55
8	50	52

Table 8: Rating for Cookstove Surface Temperature

Below child-line (< 0,9 m)	
Rating	Nonmetallic
Poor	$T \geq 88$
Fair	$82 \leq T < 88$
Good	$76 \leq T < 82$
Best	$T < 76$



3.6. Heat Transmission to Surroundings

After the surface temperature of the stove was measured, the stove was removed from its original location. Immediately after, the temperature of the floor where the stove had been standing was measured with the infrared thermometer. Attention was paid to measure the temperature of the sand and not that of the bits of charcoal and wood lying around. The temperature of the sand was determined to be **50 °C** at max. Resulting in a *best* rating.

Table 9: Results for Heat Transmission to Surroundings

Run	Temp. on floor (°C)
1	50
2	44
3	31
4	48

Table 10: Rating for Heat Transmission to Surroundings

Rating	Floor
Poor	$T \geq 95$
Fair	$85 \leq T < 95$
Good	$75 \leq T < 85$
Best	$T < 75$

3.7. Handle Temperature

To be able to move the cookstove while ignited, the temperature of the handles should not be too high. The temperature of the handles was measured with the infrared thermometer at several different points, after the stove had been lit for 30 minutes. The maximum temperature of the handles was found at the point where the handle and stove exterior meet. This temperature was **50 °C** and gives a *best* rating for handle temperature.

Table 11: Results for Handle Temperature

Run	Temp. on handle (°C)	
	A	B
1	44	43
2	47	38
3	50	42

Table 12: Rating for Handle Temperature

Rating	Non-Metallic
Poor	$T \geq 70$
Fair	$64 \leq T < 70$
Good	$58 \leq T < 64$
Best	$T < 58$

3.8. Chimney Shielding

The Chitetezo stove does not have a chimney. According to the evaluation procedures, stoves without chimney receive a *best* rating.



3.9. Flames Surrounding Cookpot

When the cookstove was lit and the pot was placed on top, the flames were carefully observed for 30 minutes. No uncovered flames were observed to touch the cookpot. This result leads to a *best* rating.

Table 13: Results for Flames Surrounding Cookpot

Rating	Amount of Uncovered Flames Touching Cookpot
Poor	entire cookpot and/or handles
Fair	most of cookpot, not handles
Good	less than 4 cm up the sides, not handles
Best	none

3.10. Flames Exiting Fuel Chamber, Canister, or Pipes

For 30 minutes the fuel chamber of the Chitetezo stove was carefully observed while lit. The flames were nicely 'sucked into' the stove. No flames protruded. A *best* rating was awarded.

Table 14: Results for Flames Exiting Fuel Chamber

Rating	Occurrence of Fire
Poor	Flames protrude
Best	Flames are contained



3.11. Overall Cookstove Safety Rating

An overall cookstove safety rating was determined after calculating safety ratings for each individual criterion from the previous steps. After multiplying the individual ratings with their respective weight and adding all outcomes together, a total point score of 91,5 was found. The overall safety rating of the stove is *good*.

Table 15: Individual rating

Individual Rating	Value
Poor	4
Fair	3
Good	2
Best	1

Table 16: Overall rating

Overall Rating	Total point score
Poor	$25 \leq S \leq 75$
Fair	$76 \leq S \leq 83$
Good	$84 \leq S \leq 92$
Best	$93 \leq S \leq 100$

Table 17: Overall Safety Test Results

Test	Value		Weight		Total
1	4	x	1,5	=	6
2	4	x	3	=	12
3	3	x	2,5	=	7.5
4	4	x	2	=	8
5	1	x	2	=	2
6	4	x	2,5	=	10
7	4	x	2	=	2
8	4	x	2,5	=	10
9	4	x	3	=	12
10	4	x	4	=	16

SUM **91,5**