DOCUMENT DESPATCH ADVICE
Ref: ME 04/T-13 Date: 31 01 2013

NON CONVENTIONAL ENERGY SOURCES SECTIONAL COMMITTEE ME 04
TO:

The interested members of Mechanical Engineering Division Council, MEDC
All members of Non Conventional Energy Sources Sectional Committee, ME 04 and Biomass: Bio-energy systems & devices, improved chulhas, biomass plant and biomass gasifier systems subcommittee MED 04:2
All others Interested

Dear Sir(s),

Please find enclosed the following document:

Doc:ME 04 (1157)C Draft Indian Standard Portable Solid Bio-Mass Cookstove (Chulha) Part 1 [First revision of 13152(Part 1):1991] (ICS 97.040.20)

Kindly examine the draft Indian standard and forward your views stating any difficulties which you are likely to experience in your business or profession, if these are finally adopted as Indian standard.

Last date for receipt of comments**: 05 March 2013.**

Comments, if any, may please be made in the format as given overleaf and mailed to the undersigned at the above address.

In case no comments are received or comments received are of editorial nature, you will kindly permit us to presume your approval for the above document as finalized. However, in case of comments of technical in nature are received then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional committee for further necessary action if so desired by the Chairman, Sectional Committee.

The document is also hosted on BIS website www.bis.org.in.
Thanking you,

Yours faithfully

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Doc:MED 04(1157)C
February 2013

Draft for Comments Only

Draft Indian Standard

Portable Solid Bio-Mass Cookstove (Chulha)

[First revision of 13152(Part 1):1991]

ICS 97.040.20

Last date for receipt of comments: 05 Mar 2013

FOREWORD

(Formal clause to be added later on)

This standard was first published in 1991. In 2009, the Ministry of New and Renewable Energy (MNRE) launched National Biomass Cookstoves Initiative (NBCI) with an aim to enhance the availability of clean and efficient energy for the energy deficient and poorer sections of the country. Under the initiative, a series of pilot scale projects were undertaken using several commercially available better cookstoves and different grades of process biomass fuel. The cookstoves technology has improved considerably in the past few years and those efforts need to be continued to further improve the designs to make them efficient and cost effective. The revision has been prepared for all types of portable biomass cookstoves (both family and community size). New designs of cookstoves have been added in this revision. Design B (HARSHA Multi-fuel cook stove) was developed by Institute of Minerals and Materials Technology (IMMT), Council of Scientific and Industrial Research, Govt of India, Bhubaneswar, Odisha and Design C (OORJA Cookstove) was developed by the Indian Institute of Science, Bangalore. Extensive tests were conducted by MNRE supported test centres at IIT Delhi, IMMT-CSIR, Bhubaneswar and MPUAT, Udaipur to streamline the process of performance testing particularly testing methodologies for emissions and particulate measurements. Joint testing on cookstoves including the conventional chulha made up with bricks were conducted in order to ensure uniform methods for performance testing and accuracy in measurements. US EPA(5G) method for wood heaters were followed for designing and developing test facilities at three Test Centres supported by MNRE. Keeping in view the international practice for measuring the emissions and particulates emanating from the combustion of biomass and responsible for health hazards, the standard has been modified by replacing the performance parameters CO/CO_2 ratio and TSP by CO and TPM, respectively. The limit of moisture content has been suggested as 5(±1)%. Further, the standard performance parameters of thermal efficiency, CO and TPM have been evolved on the basis of performance testing results obtained on the various cookstove models developed by India industry and tested at Test Centres, and keeping in view the guidelines being followed by the Global Alliance on Advance Cookstove.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (*revised)*'. The number of significant places retained in the rounded off value shall be the same as that of the specified value in this standard.

1 SCOPE

This standard covers requirements of different designs and types of solid bio-mass portable cookstove (chulha) for domestic and community/commercial applications

2 REFERENCES

The standards given below contain provisions, which through reference in this text constitute provisions of the standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No	***Title***
210:2009	Grey iron castings – Specification (*Fifth revision*)
280:2006	Mild steel wire for general engineering purposes (*Fourth revision*)
302(Part 1): 2008	Safety of household and similar electrical appliances : Part 1 General Requirements
302(Part 2 : Sec 202):1992	Safety of household and similar electrical appliances: Part 2 Particular requirements, Section 202 Electric stoves
513:2008	Cold rolled low carbon steel sheets and strips (*Fifth Revision*)
737:2008	Wrought aluminium and aluminium alloy sheet and strip' for' general engineering purposes (*Fourth revision*)
941 : 1985	Blower and Exhauster for Fire Fighting
1293 : 2005	Plugs and socket- outlets of rated voltage up to and including 250 volts and rated current up to 16 amperes - Specification
2062:2011	Hot rolled low medium and high tensile structural steel (*Seventh revision*)
2480(Part1): 1983	General purpose glass thermometers: Part 1 Solid stem thermometer (*Second revision*)
5522: 1992	Stainless steel sheets and strips for utensils (*Second revision*)
7358 : 1984	Thermocouples (*first revision*)
7775 : 1975	Ceramic grinding media and lining
10555 : 2002	Exfoliated Vermiculite - Specification
12107 : 1987 (Part 3)	Methods of chemical analysis of alumino-silicate refractory materials Part 3 Determination of aluminium
12292 : 1988	Lead sub oxides (lead oxide) for lead-acid storage battery

3 TERMINOLOGY

For the purpose of this standard the nomenclature of different parts of the cookstove (chulha) shall be as given in Fig. 1 to Fig. 4.

4 DESIGNS

The commonly used designs of the solid bio-mass portable cookstoves (chulhas) are given below for guidance:

a) Design A (*see* Fig.1 & 2 ; Type of Chulha shown in figure is Natural Draft Side Fed)
b) Design B (*see* Fig. 3 ; Type of Chulha shown in figure is Natural Draft Side Fed)
c) Design C (*see* Fig. 4 ; Type of Chulha shown in figure is Forced Draft Batch Top Fed Gasifier based)

5 TYPES

The cookstove (chulha) may be of different types as given below:

a) Natural Draft Side Continuous Fed
b) Natural Draft Top Continuous Fed
c) Natural Draft Top Batch Fed
d) Forced Draft Side Continuous Fed
e) Forced Draft Top Continuous Fed
f) Forced Draft Top Batch Fed, and
g) Forced Draft Self Power Generating

6 SIZE

The cookstove (chulha) shall be of the following sizes based on the corresponding heat and power output rating:

A Domestic cookstove (chulha)

Power Output Rating 0.5 to 3.0 kW

Size	**Power Output Rating kW**
Small	Above 0.5 and up to 1.0
Medium	Above 1.0 and up to 2.0
Large	Above 2.0 and up to 3.0

B Community/commercial cookstoves (chulha)

Power Output rating **Above 3 to 10 kW**

7 MATERIALS

7.1 Different parts of the cookstove shall be made from the materials by referring relevant Indian Standards to meet the required performance parameters and 5000 h of burning cycles or 5 years of durability whichever is higher. Relevant Indian standards of materials are given in Table 1 which is for guidance only.

8 DIMENSIONS AND TOLERANCES

8.1 Some typical designs of solid biomass cookstoves are given in Fig. 1 to Fig. 4 for reference.

8.2 Tolerance

Dimensional tolerances shall be ± 3 percent, where not specified. However, for cast iron and ceramic components, if the value comes less than 1 mm then the tolerance shall be ± 1mm.

9 MANUFACTURE AND WORKMANSHIP

9.1 Various components of the cookstoves shall be manufactured as per standard engineering practices.

9.2 The construction of the cookstoves shall be sturdy so that while in actual use on level floor they can not get shaky or yield at any point.

9.3 Electric/Battery and other components shall conform to Indian standards or equivalent International Standards available for similar components.

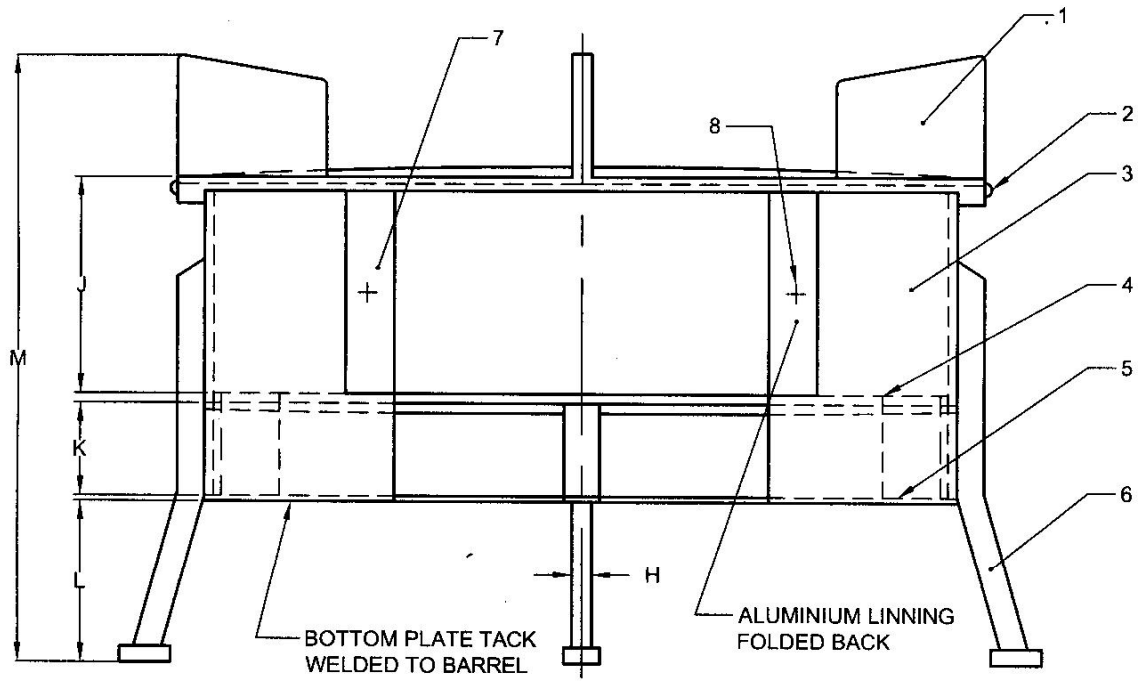
9.3.1 Battery:

a) Shall not be more than 3 W/kW input power of the stove
b) Shall be usable for a minimum 4 hours without recharging

9.3.2 Charging:

a) Charging time shall not be more than 6 hours
b) Connecting plug pins of the charging unit shall conform to the Indian standards.

9.4 All electric components shall be high temperature (200^0C) resistant



DIMENSIONS	H	J	K	L	M
MEDIUM SIZE TYPE 2	8	88	33	67	246
TYPE 1	8	88	33	67	242
LARGE SIZE TYPE 1	10	110	40	85	299

PART No.	QNTY.	DESCRIPTION
8	2	RIVET
7	1	ALUMINIUM LINNING
6	3	LEG
5	1	BOTTOM PLATE
4	1	GRATE
3	1	BARREL
2	3	SCREW
1	1	TOP PLATE

All dimensions in millimetres

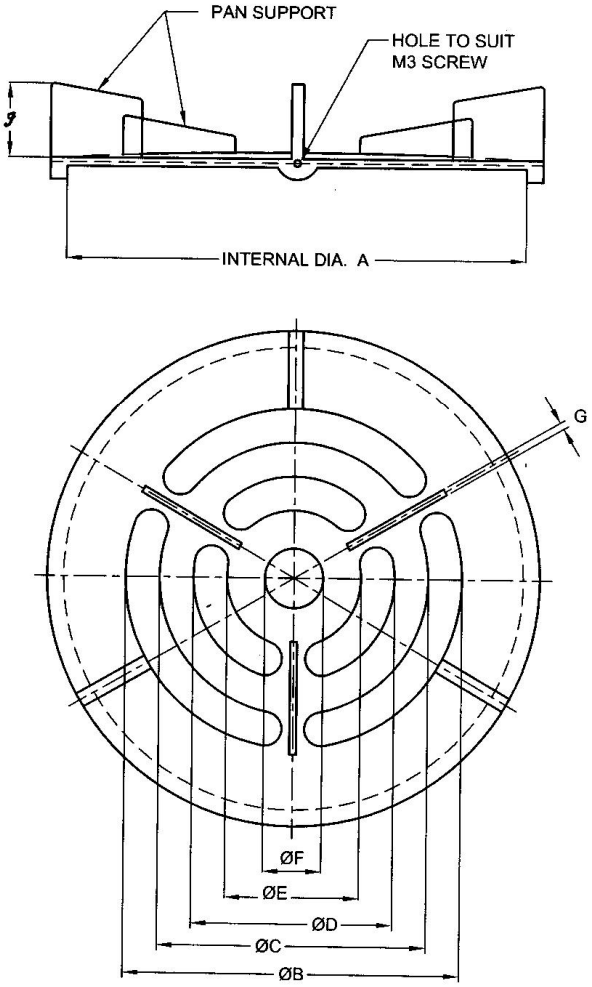
FIG. 1 SOLID BIO-MASS COOK STOVE DESIGN 'A'

NOTE:

1 Avoid sharp edges, slots shall be rounded off suitably.

2 Cast iron top plate shall be made in cup shape and shall be fixed from outside to the barrel. Appropriate pan support shall be provided in casting to accommodate smaller/larger and round/flat shapes of pots. The total area of slot opening shall be kept overall height of the outer pot support to be kept as per dimensions.

3 Legs of Chulha and the legs of cast iron grate shall be 120º apart

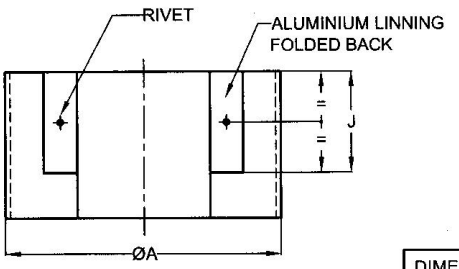


DIMENSIONS	A	B	C	D	E	F	G	I
MEDIUM SIZE TYPE 2	240	160	128	96	64	28	12	40
TYPE 1	240	160	128	96	64	28	12	40
LARGE SIZE TYPE 1	300	200	160	120	80	35	16	50

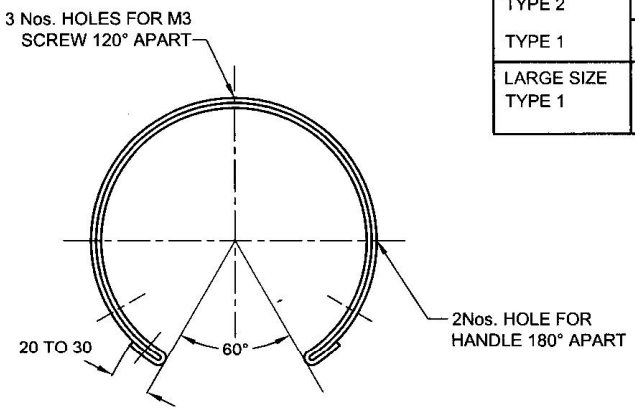
a) TOP PLATE

All dimensions in millimetres

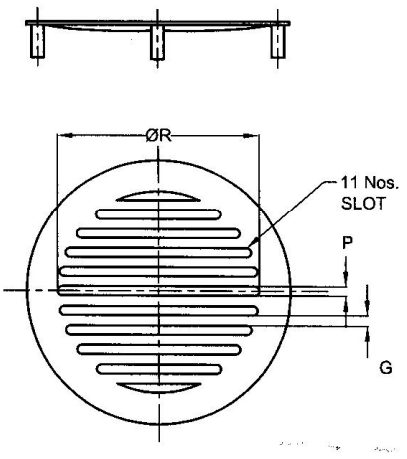
FIG. 2 DETAIL OF SOLID BIO-MASS COOK STOVE DESIGN 'A' (Contd.)



DIMENSIONS	A	J
MEDIUM SIZE TYPE 2	240	88
TYPE 1	240	88
LARGE SIZE TYPE 1	300	110



b) BARREL

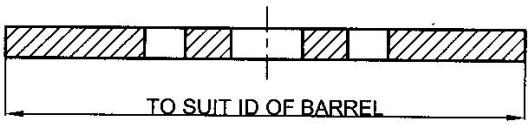


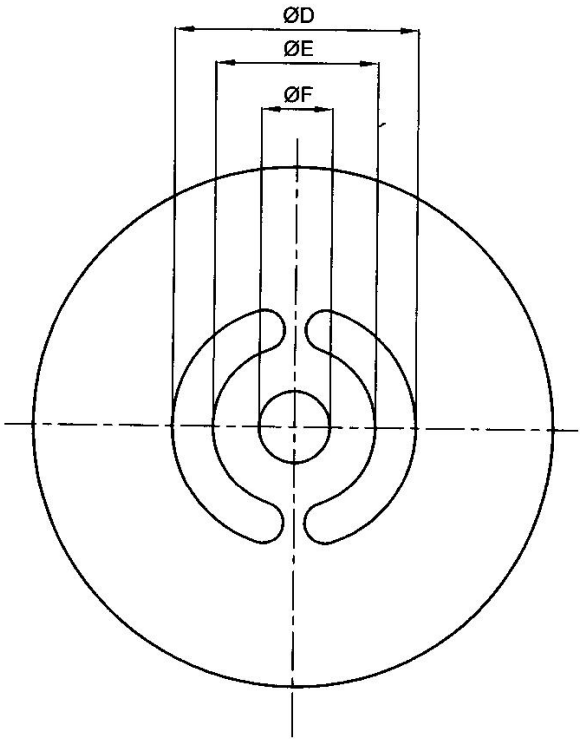
DIMENSIONS	K	P	Q	R
MEDIUM SIZE TYPE 2	33	8.5	9.5	188.5
TYPE 1	33	8.5	9.5	188.5
LARGE SIZE TYPE 1	40	11	12	241

c) GRATE

All dimensions in millimetres

FIG. 2 DETAIL OF SOLID BIO-MASS COOK STOVE DESIGN 'A' (Contd.)



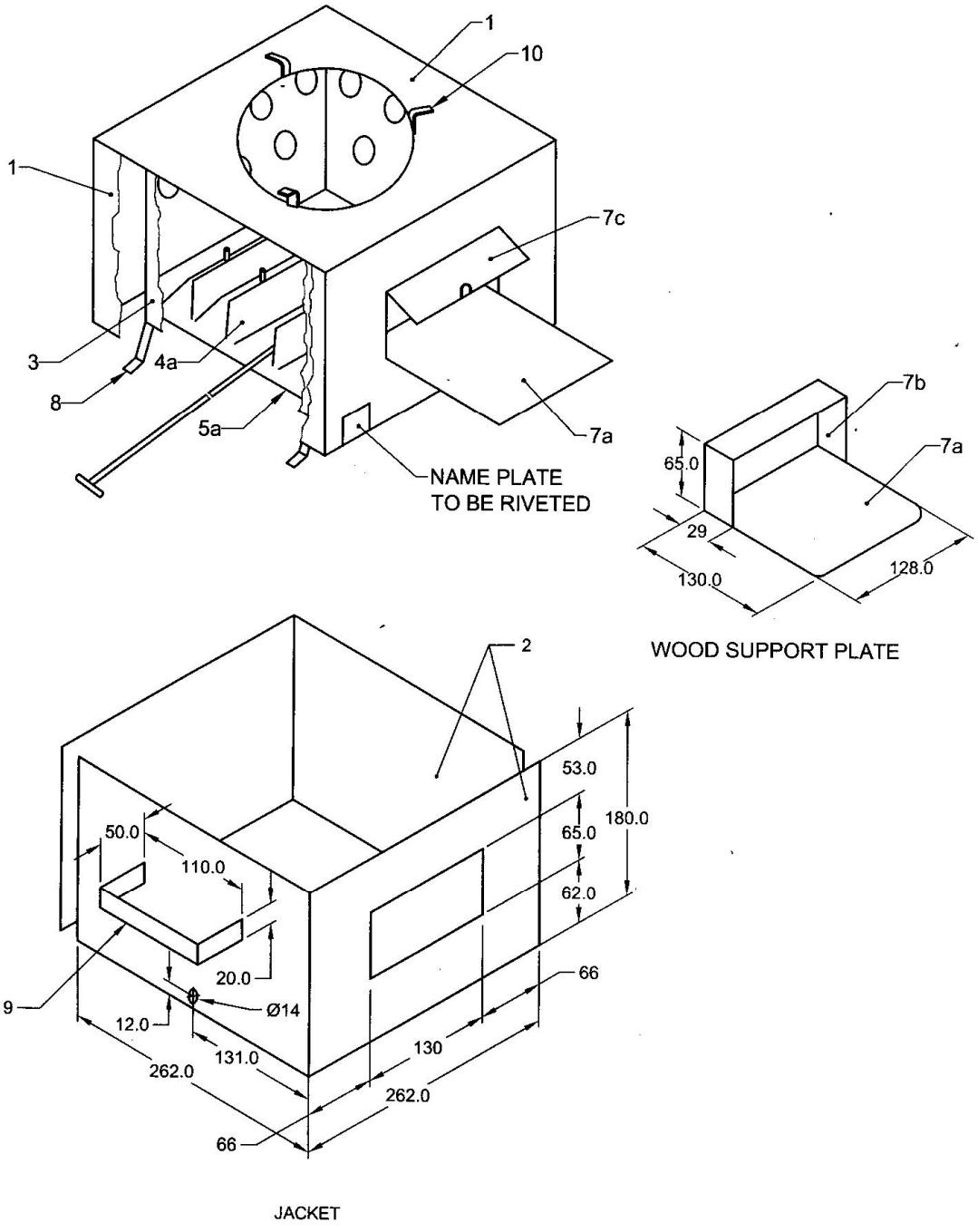


DIMENSIONS	D	E	F
MEDIUM SIZE TYPE 2	96	64	28
TYPE 1	96	64	28
LARGE SIZE TYPE 1	120	80	35

d) BOTTOM PLATE

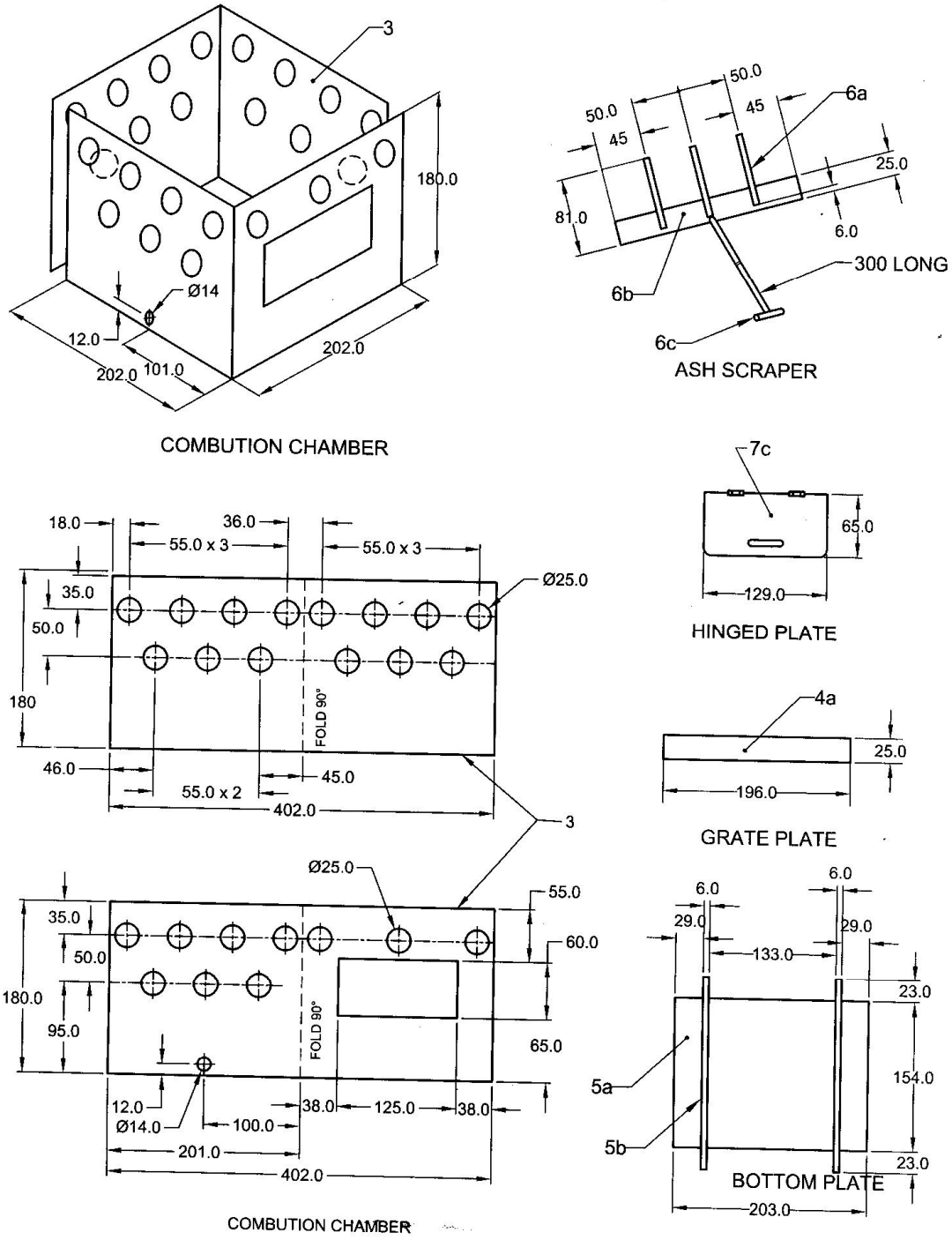
All dimensions in millimetres

FIG. 2 DETAIL OF SOLID BIO-MASS COOK STOVE DESIGN 'A' (Contd.)



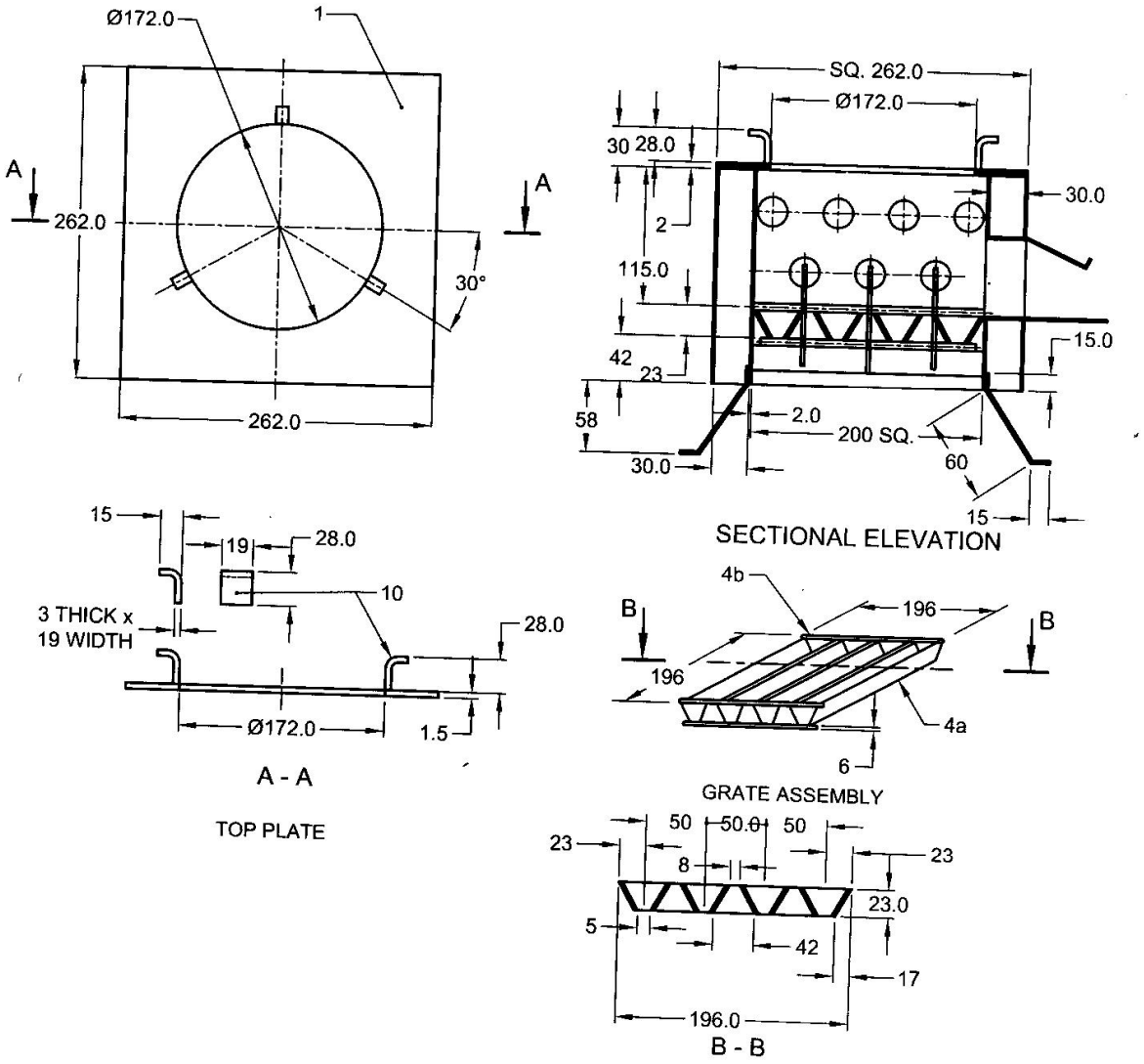
All dimensions in millimetres

FIG. 3 SOLID BIO-MASS COOK STOVE DESIGN 'B' (Contd.)



All dimensions in millimetres

FIG. 3 SOLID BIO-MASS COOK STOVE DESIGN 'B' (Contd.)



All dimensions in millimetres

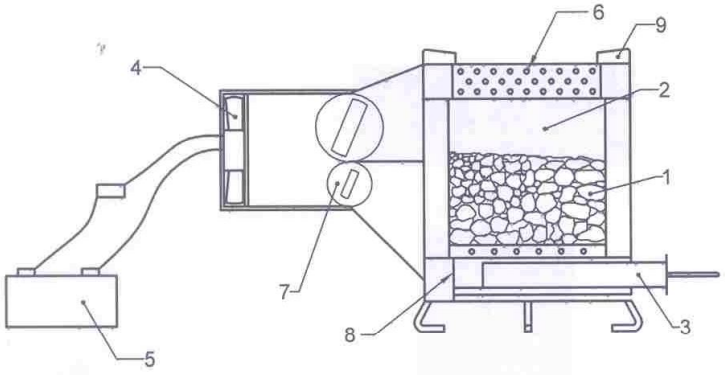
FIG. 3 SOLID BIO-MASS COOK STOVE DESIGN 'B'

Nomenclature for Fig 3:

PART NO.	DESCRIPTION	No. reqd	THICKNESS mm
10	VESSEL SUPPORT	3	3 x 19 FLAT
9	HANDLE (INSULATED)	2	3 x 19 FLAT
8	LEG	4	3 x 19 FLAT
7c	HINGED PLATE	1	1
7b	PLATE	1	1
7c	WOOD SUPPORT PLATE	1	1.6
6c	ROD(FOR ASH SCRAPER)	1	Ø 6
6b	PLATE	1	2
6d	ASH SCRAPPER FINGER	3	Ø 6
5b	ROD	2	Ø 6
5d	BOTTOM PLATE	1	1
4b	ROD	4	Ø 6
4d	GRATE PLATE	8	3
4	GRATE	1	3
3	COMBUSTION CHAMBER	1	1.6
2	JACKET	1	1
1	TOP PLATE	1	1.6

NOTE –

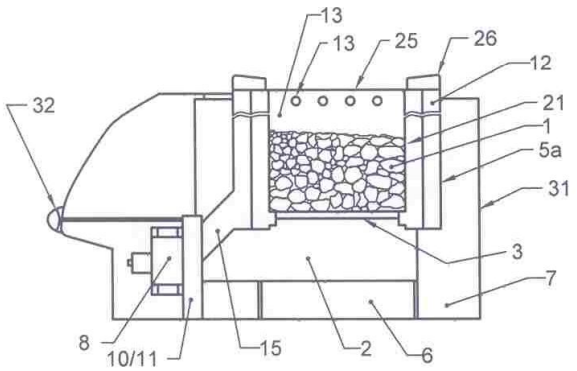
1. ALL DIMENSIONS ARE IN mm
2. APRROX WEIGHT OF FINISHED CHULHA: 5.7 kg
3. SCALE: NOT TO SCALE
4. MATERIAL:MILD STEEL (M.S)
5. ASH SCRAPER TO BE PROVIDED IN RIGHT SIDE OF CHULA
6. WELDING: MINIMUM FILLET:3.5mm, LENGTH: 6mm
   DISTANCE BETWEEEN WELDING SPOTS:40mm
7. HANDLES SHALL BE INSULATED
8. POWER OUTPUT RATE: WOOD = 1.5 kW/Hr, DUNGCAKE = 1.65 kW/Hr



LEGEND :-

1) BIOMASS
2) COMBUSTION CHAMBER
3) ASH TRAY
4) FAN
5) POWER SUPPLY
6) SECONDARY AIR HOLES
7) POWER VALVE CONTROL
8) PERFORATED SHEET
9) VESSEL STAND

a) SOLID BIO-MASS COOK STOVE DESIGN 'C' WITH BATTERY



b) SOLID BIO-MASS COOK STOVE DESIGN 'C' WITHOUT BATTERY

FIG. 4 SOLID BIO-MASS COOK STOVE DESIGN 'C'

Nomenclature for Fig 4(b):

Part No.	**Description**
1.	Fuel
2.	Air flow chamber
3.	Variable height grate
4.	Combustion Chamber
5.	Outer chamber
5a	Outer chamber with annular space
6.	Ash removal tray
7.	Stove
8.	Fan
9.	Rechargeable battery
10.	Secondary air Valve
11.	Primary air Valve
12.	Air manifold or annular chamber
13.	Secondary Air holes
14.	Regulator
15	Duct
18	Top of the chamber
20	Potentiometer
21	Ceramic block Insulation
25.	Top plate with a central hole
26.	Vessel support
30	Stove Stand
31	Outer container
51	Ash tray handle

Table 1-A

Illustrative Materials of Different Part of Solid Bio-Mass Cookstove – Portable
(*Clause* 7.1)

Part Name	**Material**	**Conforming to**
(1)	(2)	(3)
Top Plate	Cast Iron, 6mm, min Thick Stainless steel, Mild steel 1.6 mm, Min, Thick (See Note 1)	IS 210 IS 5522 IS 513
Grate	Cast Iron, Stainless steel, Mild steel, 6mm, min Thick	IS 210 IS 513
Barrel/Combustion Chamber	Mild Steel, 1.6 mm, min Thick (See Note 2) Cast Iron 6mm, min Thick Stainless Steel, 1.0mm, min Thick Ceramic, Pottery, 15mm thick Metallic Alloys	IS 513 IS 210 IS 5522 - -
Bottom Plate	Mild Steel 1.6mm, Min, Thick Cast Iron, 6mm, Min, Thick Stainless steel 0.63mm, Thick	IS 513 IS 210 IS 5522
Lining	Stainless Steel 0.63 mm, min Thick Ceramic, Pottery, Metallic Alloys	IS 316 IS 7775 - -
Perforated Sleeve	Mild Steel 2.0mm, Min Thick Stainless Steel 1.0 mm, Min Thick	IS 513 IS 5522
Insulation	Vermiculite, Aluminium Silicate	IS 10555 IS 12107 : Part 3
Outer Jacket Clading	Mild Steel 1.5 mm min. thickness	IS 513
Handles	Mild Steel Round/Flats 3.15mm, Min, Thick with insulation	IS 280
Pan Support	Mild Steel Sheet 2.0mm, Min, Thick Mild Steel Flat 5.0mm, Min, Thick Mild Steel Rod 8mm, Min, dia Cast Iron 6mm, Min, Thick Stainless Steel 2.0mm, Min, Thick	IS 513 IS 2062 IS 2062 IS 210 IS 5522
Legs	Mild Steel Rod 12 mm, Min, dia Mild Steel Sheet 2.6 mm, min Thick Cast Iron 6 mm, Min, Thick (see Note 2)	IS 2062 IS 513 IS 210

1. Insulation: High Alumina Ceramic sheet, granules, powder etc (Al_2O_3 = 95%) may be used.
2. Pottery: Terracotta, to be made from red clay and sintered at 800^0C temperature and 15 mm wall thickness.

NOTE:

1 The thickness of the material used for different component of community/commercial chulhas are to be higher for providing adequate strength and life.

2 The legs of cast iron shall be made by extending the barrel to form legs.

10. MARKING

10.1 Each Cookstove shall be marked by stamping with the following information:

a) Serial number and date of manufacture
b) Model Name
c) Type, Input and output Power ratings with specifications of all component and accessories
d) Weight of the Cookstove
e) Name and address of the manufacturer, and
f) Mention best performance for Fuel type, size and feeding rate and igniting procedure in the manual to be supplied with the Cookstove.

10.2 Identification of the source of manufacture of the Cookstoves shall be affixed on all the detachable and cast iron components.

10.3 Each Cookstove may be marked with the Standard Mark.

10.3.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a license for the use of the Standard Mark may be granted to the manufacturers or producers may be obtained from the Bureau of Indian Standards.

11. PERFORMANCE PARAMETERS

11.1 Thermal Efficiency

Thermal efficiency for each Cookstove *when* tested in accordance with the method described in Annex A shall not be less than 25 percent for all types of designs and sizes of solid bio-mass natural draft Cookstoves. For forced draft types it shall not be less than 35 percent.

11.2 Emissions

11.2.1 CO & CO_2

When tested in accordance with the method described in **B-1,** the carbon monoxide of exhaust gases of chulha shall not exceed 5 g/MJ_d for both natural draft and forced draft cookstoves. The test report shall also mention average absolute values of CO and CO_2 during the test period.

11.2.2 Total Particulate Matter (TPM)

When tested in accordance with the method described in **B-2**, the total particulate matter shall not exceed 350 mg/MJ_d for natural draft cookstoves, and for forced draft the same shall not exceed 150 mg/MJ_d.

11.3 Surface Temperature ~~Test~~

Surfaces which in normal use have to be touched for short periods (for example, handles, etc) shall not have a temperature exceeding 60°C when measured in accordance with Annex C. The temperature of synthetic rubber/plastic components, if used, shall also not exceed 60°C.

11.4 Quenching Test of Cast Iron Components

When tested in accordance with the method described in Annex D, the grate, top plate and any other cast iron component shall withstand the test without any crack or deformity.

11.5 Stability Test

Cookstove 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.

11.6 Electric Appliances Test

Blowers, condensers/storage battery, wires, plugs, thermopile shall be as per Indian Standards mentioned below:

IS 12292, IS 941, IS 7358, IS 1293, IS 302 (Part 1) ,IS 302, (Part 2 : Sec 6), IS 302 (Part 2 : Sec 202)

ANNEX A
(Clause **11.1***)*
TEST FOR THERMAL EFFICIENCY

A-1 THERMAL EFFICIENCY

A-1 Thermal efficiency of a Cookstove may be defined as the ratio of heat actually utilized to the heat theoretically produced by complete combustion of a given quantity of fuel (which is based on the net calorific value of the fuel).

A-2 CONDITIONS FOR CARRYING OUT THERMAL EFFICIENCY TEST

A-2.1 Test Conditions

A-2.1.1 The thermal efficiency and emission tests will be carried out by keeping the solid biomass cookstove in a standard fume hood of dimensions: 1000mm W × 750mm D × 2820 mm H. The schematic of hood is given in Figs.5. Considering that practically there is always certain amount of moisture in the biomass fuel used for burning in cookstoves, the performance testing shall be conducted with moisture 5% (±1).

A-2.1.2 The air of the test room housing the fume hood shall be free from draught likely to affect the performance of the Cookstove. The room temperature shall be maintained at 25±5°C using systems as may be necessary.

A-2.1.3 At the start of the test, the Cookstove and the wood being used shall be at room temperature.

A-3 EQUIPMENT

A-3.1 Instruments and other Accessories

a) Digital Bomb calorimeter with Printer.

b) Mercury in glass thermometers (range 0-100°C) [see IS 2480 (Part 1):1983] with solid stem/other temperature measuring device like thermocouples with the accuracy of ± 0.1 °C. Devices for higher range of temperature, say 0-1300^{o}C to measure the flame temperature.

c) Digital balance 15 kg capacity (dial type/digital with least count of 1 g) to weigh the cookstoves, fuel and the water in vessels, etc and higher capacity balance of 100Kg with least count of 10gm to weigh the Cookstove, the water in vessels etc depending upon size of the Cookstove to be tested.

d) Measuring jars; 2 l and 5 l capacity.

e) Digital Stop watch with memory or time measuring device.

f) Pairs of tong, metallic tray, high temperature gloves, matches, etc.

g) Pieces of clean cloth.

h) Moisture Meter with microwave or infrared heating facility

i) Clean vessels for holding water to be placed on the Cookstove for heating as per Table 2.

A-3.2 Fuel and its preparation

The fuel shall be wood like Kail/Deodar/Mango/Accasia/Eucalyptus cut from the same log into pieces of 3 cm × 3 cm square cross-section for domestic/family size cookstove and 4cm X 4cm square cross-section for community size cookstove and length of half the diameter/length of combustion chamber so as to be housed inside the combustion chamber or the briquettes/pellets/loose bio-mass as specified by the Cookstove manufacturer. Determine the moisture content of the fuel using a microwave/infrared heated moisture meter and the value shall not exceed 5 (±1)%. If the moisture content is less than 4%, then the fuel is not suitable for testing. If the moisture content is more than 5 (±1) %, the fuel shall be dried in an electric oven by the following method:

a) Weigh total quantity of fuel (say 'M' kg)

b) Pick up one piece/pouch of fuel and mark 'X' and take its mass (say 'm' g),

c) Raise the temperature of electric oven up to 105°C,

d) Stack the fuel in a honey comb fashion and in case of loose biomass spread it to a 10 mm thickness in a tray and put inside the fuel oven,

e) Maintain the oven temperature at 105°C,

f) After one hour, remove the marked 'X' piece/pouch, weigh it and note reduction in mass from 'm' g, if any. Measure the moisture content again. If it is more than 5 (±1) %, put the marked piece/pouch in the oven again and repeat the weighing of 'X' marked piece/pouch after every subsequent hour durations till the moisture content measured is within the limits of 5 (±1) %.

g) At this, weigh the total quantity of fuel and note loss of mass from 'M' kg.

h) Determine the calorific value of the prepared fuel with the help of digital bomb calorimeter.

A-3.3 Determination of Burning Capacity Rate

If the fuel burning rate is not given by the manufacturer, the cookstove is operated with method described below and the same shall be used to estimate the burning capacity of the Cookstove.

A-3.3.1 Stack the fuel in a honey comb fashion in combustion chamber as given in **A-3.2** up to 3/4 of the height for continuous feeding type Cookstove, or in a pattern recommended by the manufacturer.

A-3.3.2 Weigh the Cookstove with fuel, let the mass be M_1 kg.

A-3.3.3 Sprinkle 10 to 15 ml of kerosene on the fuel from the top of Cookstove /fire box mouth.

A-3.3.4 After half an hour of lighting weigh the chulha with fuel residues again and let the mass be M_2 kg.

A-3.3.5 Then calculate the burning capacity of the Cookstove as heat input per hour as follows:

Burning capacity rating = 2 (M1 – M_2) kg/hr
Heat input per hour = 2 (M1 – M_2) × CV kcal/hr

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.

A-3.4 Vessels

The size of the vessel and the quantity of water to be taken for the thermal efficiency test shall be selected from Table 2 depending upon the burning capacity rating of the Cookstove as determined in **A-3.3** , or in a pattern recommended by the manufacturer.

Table 2 Aluminium Vessels for Thermal Efficiency Test
***(Clause* A-3.4)**

Sl. No.	Heat Input Rate kcal/h	Vessel Diameter (Ext) mm (± 5%)	Vessel Height (Ext) mm (± 5%)	Total Mass with Lid g (±20%)	Mass of water in Vessel kg
1.	Up to 2000	180	100	356	2.0
2.	2001 to 2800	205	110	451	2.8
3.	2801 to 3200	220	120	519	3.7

4.	3201 to 3800	245	130	632	4.8
5.	3801 to 4200	260	140	750	6.1
6.	4201 to 4800	285	155	853	7.7
7.	4801 to 5400	295	165	920	9.4
8.	5401 to 6000	320	175	1100	11.4
9.	6001 to 6600	340	185	1200	12.5
10.	6601 to 7200	350	195	1310	14.0
11.	7201 to 7800	370	200	1420	16.00
12.	7801 to 8400	380	210	1530	18.00
13.	8401 to 9000	400	215	1640	20.00
14.	9001 to 9600	410	225	1750	22.00
15.	9601 to 10200	420	230	1860	24.00
16.	10201 to 10800	435	240	2000	26.50
17.	10801 to 11400	450	245	2130	29.00
18.	11401 to 12200	460	250	2240	31.00
19.	12201 to 12800	470	255	2320	33.00
20.	12801 to 13600	480	260	2440	35.00
21.	13601 to 14400	490	265	2520	38.00
22.	14401 to 15400	500	270	2650	41.00
23.	15401 to 16400	510	275	2720	44.00
24.	16401 to 17400	530	280	3050	47.00
25.	17401 to 18600	540	285	3190	50.00
26.	18601 to 19800	550	290	3330	53.00
27.	19801 to 21000	560	300	3480	57.00

A-4.1 (a) The Batch fed Type Cookstove shall be filled with the fuel as specified by the manufacturer. The thermal efficiency and the emission test shall be carried out without adding any additional fuel. The test shall be repeated and average taken.

A-4.1 (b) For continuous fed Cookstove, take the test fuel according to burning capacity rating for one hour. Divide the test fuel in 10 equal lots. Let the mass be 'X' kg.

A-4.2 For continuous fed chulhas, stack the first lot of test fuel in the combustion chamber in honey comb fashion or as indicated by the manufacturer.

A-4.3 Put the vessel with lid in accordance with Table 2. Minimum two such vessels sets shall be required. Put the recommended quantity of water at 23± 5^{o}C (t_1)

A-4.4 Sprinkle measured quantity *'x'* ml (say 10-15 ml) of kerosene for easy lighting on the test fuel and light. Simultaneously start the stop watch.

A-4.5 For continuous fed Cookstove, feeding of fresh test fuel lot shall be done after every 6 minutes.

A-4.6 The water in the vessel shall be allowed to warm steadily till it reaches a temperature of about 95°C. Note down time taken to heat the water up to final temperature t_2°C.

A-4.7 Remove the vessel of **A-4.6** from the Cookstove and put the second vessel immediately on the Cookstove . Prepare the third vessel for subsequent heating.

A-4.8 Repeat the experiment by alternatively putting the two or more vessels taken in **A-4.3** till there is no visible flame in the combustion chamber of the Cookstove. Note down the temperature of the water in the last vessel. Let it be t_3 ºC.

A-5 CALCULATION

A-5.1 Thermal efficiency of the cook stove shall be calculated as follows.

A-5.1.1 Notations and formulae

w = mass of water in vessel, in kg.
W = mass of vessel with lid in kg.
X_{fuel} = mass of solid fuel consumed, in kg
H_{fuel} = calorific value of wood (or solid fuel), in kJ/kg
X_k = mass of kerosene used for ignition (kg)
H_k = calorific value of kerosene, in kJ/kg
t_1 = initial temperature of water in °C
t_2 = final temperature of water in °C
t_3 = final temperature of water in last vessel at the completion of test in °C
n = total no vessel used
C_w = specific heat of water (= 4.186kJ/kg/°C)
C_v = specific heat of the material of the vessel (aluminium) (=0.896kJ/kg/°C)
H_{out} = heat output of the stove (heat utilized) in kJ
H_{in} = heat input into the stove (heat produced) in kJ
η = thermal efficiency in percent

$$H_{out} = [(n-1) \times (W \times C_v + w \times C_w) \times (t_2-t_1)] + [(W \times C_v + w \times C_w) \times (t_3-t_1)]$$

$$H_{in} = (X_{fuel} \times H_{fuel}) + (X_k \times H_k)$$

$$\eta = 100 \times H_{out}/H_{in}$$

$_{MJd}$ = Mega joules of energy delivered to the pot

A-5.2 Power Output Rating

The power output rating of cookstove is a measure of total useful energy produced during one hour by the fuel. It shall be calculated as follows:

Power output rating, $Po = F \times H_{fuel} \times \eta$ / 360000 kW

Where, Po = Power output
F = rate of consumption of fuel wood (kg/h)
H_{fuel} = calorific value of wood (or solid fuel), in kJ/kg
η = thermal efficiency of the *chulha* in percent

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ANNEX B
(*Clause* 11.2)
TESTS FOR EMMISSIONS AND PARTICULTES

B-1 Test for Emissions (CO & CO_2) Measurement

B-1.1 Equipment

B-1.1.1 The Cookstove shall be tested for its emissions simultaneously along with the testing of thermal efficiency by using stack monitoring, multi component gas analyzer, Non-Dispersive Inra-red(NDIR) based detector system connected on line for continuous measurement of CO and CO_2. In addition oxygen (O_2) and other hydrocarbons could also be measured if so required by installing/ adding appropriate monitors for the same. The preferable range of measurement recommended is 0 to 1000 ppm with resolution of 1 ppm for CO, 0 TO 20 volume percent resolution of 10 ppm for CO_2, 0 to 25 volume percent with resolution of 100 ppm for O_2. The multi component gas analyzer must be fitted with a sample conditioning unit to control/ regulate the conditions like humidity, temperature, pressure, flow rate, moisture, dust, etc. of the sample for proper measurement. The Cookstove shall be placed in a collecting hood (see Fig.5) suitable for Cookstove under examination.

B-1.1.2 The hood shall be such that it collects all the flue gases without interfering in any way with the normal combustion of the Cookstove . The hood shall be closed on all sides except the front which carries a vertical rising counter balance sash (shutter), transparent and made of toughened float glass (6 mm thick) to facilitate smooth operation. The clear openable height of sash could be 1500 mm to allow Cookstove to move in and out of the hood easily. However, it should be possible to open the sash to any desired height to minimize the effect of unfiltered air entering the hood when fire needs tending. The effect of the enclosed hood is to ensure slight negative pressure in the hood at all times, thus no emissions can leave the hood. The air is pulled through the fume hood by a constant volume pump. The speed is controlled by a frequency variable drive (VFD) The actual amount of air pulled by the fan depends on the density of the air, which is affected by the temperature and pressure. The hood shall be fitted with the emission measurement systems such that the sample collected represents the whole of combustion gases (diluted homogeneous combustion gas) and not those from one particular point. This can be best done by drawing the sample for emission measurements from the top of the hood after thorough mixing of combustion gas with ambient air. The flue gases are drawn through a circular duct made of corrosion free steel with inside diameter typically 150 mm integrated with Frequency Variable Drive (FVD) in the power supply and the blower installed at the end of the duct to maintain duct velocity. The ratio of the average mass flow rate of diluted gas in duct to the average fuel burn rate in cookstove should be within a rage 150:1to 50:1 for domestic and community stoves, respectively. Rate of fuel burning of domestic cookstoves will be considered up to 2kg/hr, while rate of burning for community cookstoves will be considered in the range above 2 but less than 10Kg/hr. Appropriate duct velocity will be fixed for typical size of cook stove to maintain the required ratio of dilution air to kg per hour of fuel consumed. A hotwire anemometer could be used at appropriate place in the duct to counter check velocity of mixture of flue gases. A stainless steel sample probe, inserted

perpendicular to the gas flow, is used to sample gas emissions. The probe is constructed as per standard method. Also standard methods are used to determine the proper location of the sample probe in the flow of gases with in the pipe. The probe is placed at a minimum five pipe diameters downstream of any flow disturbances. The basic sampling units provides the pump, filters, thermo electric cooler, flow meters and other components required to clean, dry and regulate the flow of sample gas to the analyzer module.

B-1.2 Procedure for Emissions Measurement

B-1.2.1 With the hood in position and the Cookstove under testing placed inside the hood, the procedure as given in **A-4.1** to **A-4.8** shall be followed and a continuous measurement of CO, CO_2 and O_2 samples shall be carried out.

B-1.2.2 Non Dispersive Infrared (NDIR) sensor module using dual beam non dispersive infrared absorption method for CO and CO_2 and Magnetic-pneumatic analysis method for O_2 shall be followed to measure these gases.

B.2 Test for Total Particulate Matter (TPM) Measurement

B-2.1 Equipment

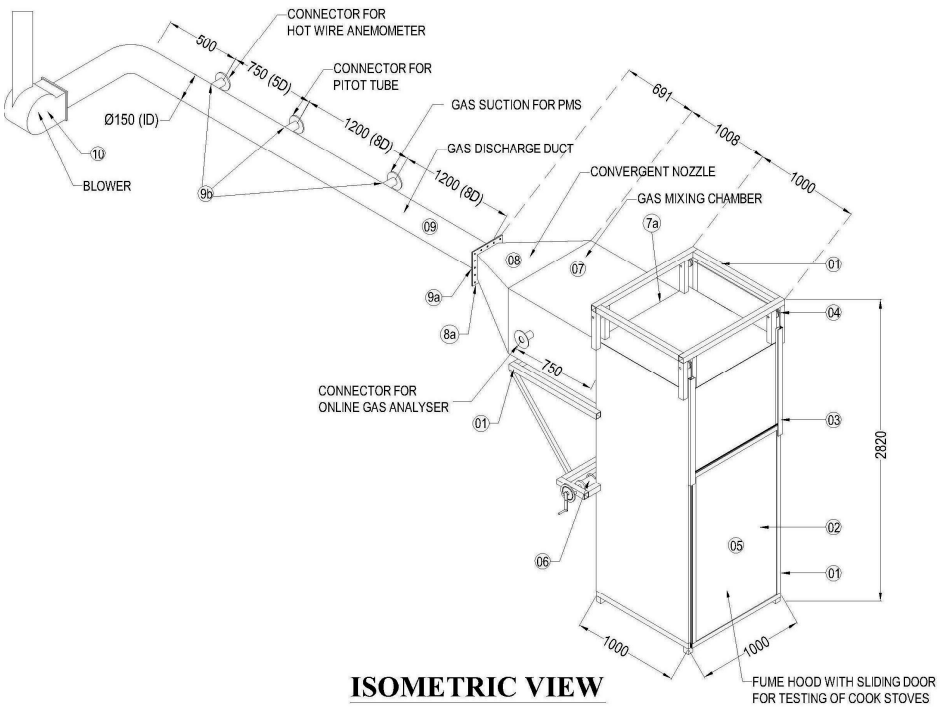
B-2.1.1 The cookstoves shall be tested for its total particulate matter emanating from biomass combustion in cookstoves simultaneously along with the testing of thermal efficiency and gaseous emissions using gravimetric method. The gravimetric measurement equipment consists of a cyclone for 2.5 micron cutoff and an s-type pitot. This pitot tube is attached to a digital pressure transducer, which in conjunction with the thermocouple, can be used to calculate the velocity of the exhaust. The velocity measurement is used to calculate the rate at which sample pumps shall pull sample gas through the probes to ensure that there is no change in velocity from the duct to the sample port. Ports are welded into the exhaust pipe as per the drawing given in Fig. 5(a, b &c). The filter paper/specifications Glass Microfiber Filters,GF/A 47 mm dia Circles Cat No 1820-047 Whatman will be used for sampling. In order to ensure accurate measurements, care should be exercised while assembling the various components, particularly the alignment of probes should be provided with a guide ensuring the direction of flow of flue gases matching with the sample nozzle. The sample nozzle and the anemometer mounting should be located at the centre axis of the duct. The flow meter should be NABL calibrated.

The samples need to be taken in Iso-mass-velocity condition (also called isokinetic sampling). To ensure Iso-mass-velocity, the velocity at the probe is maintained at the duct velocity

B-2.2 Procedure-Filter Weighing Method

B2.2.1 The PM filter weighing procedure is a multistep process. The filters must be allowed to equilibrate in the measurement lab for at least 2 hours before being weighed. This equilibration time, allows for the filters to come to a uniform temperature and humidity with their, surroundings. The measurement lab needs to remain at a constant relative humidity due to the fact that the filters

will gain mass in a more humid environment which will register on the balance being used. Once the filters have equilibrated they are measured on a balance (1μg resolution). The same calibration weight is used before each series of measurements to ensure the balance is consistent from day to day. Each filter is measured three times with the filter removed and balance doors closed between each measurement. Once the filter is weighed it is placed in a new Petri dish, marked with a filter ID number and the three measurements are recorded on a filter ID log sheet. Once the filters have been used they are returned to the measurement lab where they are again allowed to equilibrate before the measurement process happens again.



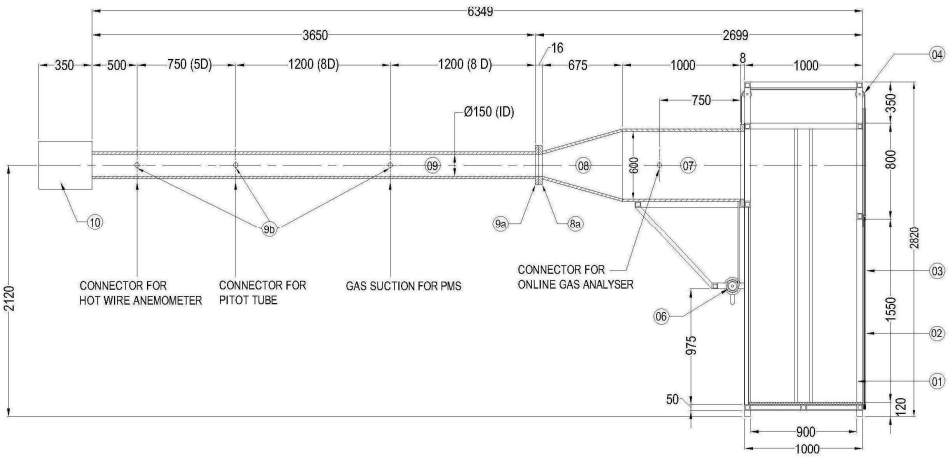
ISOMETRIC VIEW

HOOD WITH DILUTION TUNNEL
FOR TESTING OF COOK STOVES

PART LIST				
10	Suction Blower	Fitted with FVD/ Damper, Max.delivery=1600cu.M/hr		1 set
9b	Connector for fixing instruments withGas duct	As per Drawing	M.S	3 sets
9a	Flange of Gas duct	As per Drawing	M.S	1 set
09	Gas discharge duct	Ø 150mm I.D x 2 mm thick	S.S	1 set
8a	Flange of Convergent nozzle	As per Drawing	M.S	1 set
08	Convergent Nozzle	As per drawing	M.S	1 set
7a	Flange of gas mixing chamber	As per Drawing	M.S	3 sets
07	Gas mixing chamber	As per Drawing	M.S	1 set
06	Drum arrangement for hoisting of door of hood	As per Drawing	M.S	1 set
05	Toughen glass of door	As per Drawing	Glass	1 set
04	Hoisting arrangement of door of hood	As per drawing	M.S	1 set
03	Guide for vertical movement of door	As per drawing	M.S	1 set
02	Sliding door with roller arrangement	As per drawing	M.S	1 set
01	Chassis of Hood	50 x 50x 2.9 mm square hollow Section. As per drawing	M.S	1 set
PART No.	PART NAME	DESCRIPTION	MAT.	Nos. Req.

Drawing No.1 of 3

Fig.5(a)



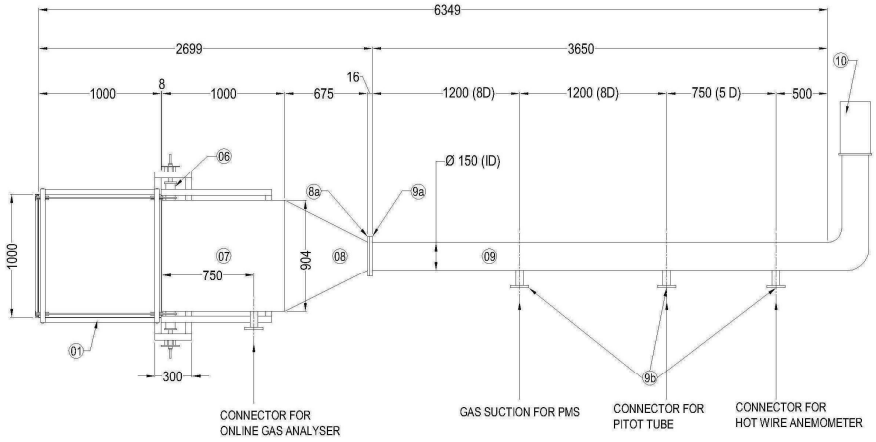
PART LIST				
10	Suction Blower	Fitted with FVD/ Damper, Max.delivery=1600cu.M/hr		1 set
9b	Connector for fixing instruments withGas duct	As per Drawing	M.S	3 sets
9a	Flange of Gas duct	As per Drawing	M.S	1 set
09	Gas discharge duct	Ø 150mm I.D x 2 mm thick	S.S	1 set
8a	Flange of Convergent nozzle	As per Drawing	M.S	1 set
08	Convergent Nozzle	As per drawing	M.S	1 set
7a	Flange of gas mixing chamber	As per Drawing	M.S	3 sets
07	Gas mixing chamber	As per Drawing	M.S	1 set
06	Drum arrangement for hoisting of door of hood	As per Drawing	M.S	1 set
05	Toughen glass of door	As per Drawing	Glass	1 set
04	Hoisting arrangement of door of hood	As per drawing	M.S	1 set
03	Guide for vertical movement of door	As per drawing	M.S	1 set
02	Sliding door with roller arrangement	As per drawing	M.S	1 set
01	Chassis of Hood	50 x 50x 2.9 mm square hollow Section. As per drawing	M.S	1 set
PART No.	PART NAME	DESCRIPTION	MAT.	Nos. Req.

FRONT SECTIONAL VIEW

HOOD WITH DILUTION TUNNEL FOR TESTING OF COOK STOVES

Drawing No. 2 of 3

(b)



PART LIST				
10	Suction Blower	Fitted with FVD/ Damper, Max.delivery=1600cu.M/hr		1 set
9b	Connector for fixing instruments withGas duct	As per Drawing	M.S	3 sets
9a	Flange of Gas duct	As per Drawing	M.S	1 set
09	Gas discharge duct	Ø 150mm I.D x 2 mm thick	S.S	1 set
8a	Flange of Convergent nozzle	As per Drawing	M.S	1 set
08	Convergent Nozzle	As per drawing	M.S	1 set
7a	Flange of gas mixing chamber	As per Drawing	M.S	3 sets
07	Gas mixing chamber	As per Drawing	M.S	1 set
06	Drum arrangement for hoisting of door of hood	As per Drawing	M.S	1 set
05	Toughen glass of door	As per Drawing	Glass	1 set
04	Hoisting arrangement of door of hood	As per drawing	M.S	1 set
03	Guide for vertical movement of door	As per drawing	M.S	1 set
02	Sliding door with roller arrangement	As per drawing	M.S	1 set
01	Chassis of Hood	50 x 50x 2.9 mm square hollow Section. As per drawing	M.S	1 set
PART No.	PART NAME	DESCRIPTION	MAT.	Nos. Req.

TOP VIEW

HOOD WITH DILUTION TUNNEL FOR TESTING OF COOK STOVES

Drawing No. 3 of 3

Fig. 5(b & c)

ANNEX C

(*Clause* 11.3)

METHOD OF MEASUREMENT OF SURFACE TEMPERATURE

C-1 PREPARATION OF CHULHA

C-1.1 The Cookstove shall be operated at the full output for one hour before starting the measurement of temperature, with the vessel containing water placed over it.

C-2 PROCEDURE

C-2.1 The temperature of all parts of the Cookstove which may be necessary to touch during its operation shall be measured by using a thermometer or any other suitable device for measuring the surface temperature. The temperature of each such part shall be measured thrice every 30 minutes until equilibrium is reached. While measuring the temperature the thermometer shall be covered with a felt pad, asbestos or aluminium foil and kept in contact with that part for sufficient foil and kept in contact with that part for sufficient period of time until the maximum temperature is reached.

ANNEX- D
(*Clause* 11.4)
PROCEDURE FOR QUENCHING TEST ON CAST IRON COMPONENTS OF PORTABLE CHULHA

D-1 PROCEDURE

D-1.1 Before each quenching, Cookstove will be burnt for 45 minutes duration and the feeding of fuel would be done at the rate of 1/4th of the burning rate of fuel every 15 minutes.

D-1.2 Quenching of grate and top plate only to be done. The top plate and grate will be de-linked from the Cookstove and put in water.

D-1.3 Top plate and grate will be put in Water in separate vessels.

D-1.4 Water will be changed after every immersion.

D-1.5 Water to be taken shall be in the temperature range of 20^{o}C to 30°C.

D-1.6 Top plate and grate will be put in water in one stroke in horizontal position and submerged.

D-1.7 Each vessel will contain 5 litres of water every time.

D-1.8 The cast iron components will be left in water for duration of 10 minutes.

D-1.9 The cast iron components will be taken out of water after the duration given in **D-1.8** and then wiped and examined for any possible cracks.

D-1.10 The above process of heating and quenching shall constitute one cycle.

D-1.11 The above cycle shall be repeated for eight times first and further 2 times more (total 10 times). If there is no crack at the end of 10th cycle the sample may be considered to withstand the test. If a hairline crack develops at the end of eighth cycle and do not widen at the end of 10th cycle the part shall be further subjected to two more cycles and there shall be no further widening of the crack, otherwise the sample shall be considered not to withstand the test

ANNEX

FORMAT FOR SENDING COMMENTS ON BIS DOCUMENTS

(Please use A4 size sheet of paper only and type within fields indicated. Comments on each clauses/sub-clauses/table/fig. etc be started on a fresh box. Information in Column 4 should include reasons for the comments and suggestions for modified wording of the clauses when the existing text is found not acceptable. Adherence to this format facilitates Secretariat's work)

Doc. No.: _____ TITLE: _____

LAST DATE OF COMMENTS: _____

NAME OF THE COMMENTATOR/ORGANIZATION: _____

Sl. No.	Clause/Subclause/ para/table/fig. No. commented	Commentator/ Organization/ Abbreviation	Type of Comments (General/Editorial/ Technical)	Justification	Proposed change