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REGIONAL WOOD ENERGY DEVELOPMENT PROGRAMME IN ASIA
GCP/RAS/154/NET

INDIAN IMPROVED COOKSTOVES: A COMPENDIUM

Ministry of Non-Conventional
Energy Sources
New Delhi, India

Indian Institute
of Technology
New Delhi, India

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Bangkok, July 1993

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FOREWORD

Most countries in Asia are giving an increasingly higher priority to energy conservation, both in the industrial/commercial and domestic sectors. As cooking in developing countries constitutes a large part of the total energy consumption in the domestic sector, conservation approaches have concentrated on the development and introduction of improved cooking stoves (ICS).

From its very beginning in 1985 the Regional Wood Energy Development Programme in Asia (RWEDP) has supported or initiated activities in the field of improved cookstoves development, with particular emphasis on information sharing and transfer of knowledge. The "Regional Expert Consultation on Improved Cookstove Development Programmes in South Asian Countries", which was held in Udaipur, India in 1991, recommended that national stove compendiums should be prepared and adopted as part of a regional cooperative commitment to sharing information. We are very pleased that, by preparing the present document, India has come forward in fulfilling this spirit of regional cooperation. In addition, India recently hosted the first international training course on improved cookstoves technology, management and development.

India's cookstove development and dissemination programme has had the strong support of the Government of India over a considerable period of time. Next to China, India is reported to have the largest number of improved cookstoves installed. Subsidies were provided for the installation of improved cookstoves and Technical Backup Centres were established in many States. With the recent decision of the Government of India to decentralize the ICS programme and to encourage commercialization, the present document will be also extremely useful within India.

We are very grateful to the Indian Institute of Technology Delhi and the Ministry of Non-Conventional Energy Sources for all the information provided and especially to the members of the editorial team, who compiled this comprehensive and informative overview, namely: Shri B.M.L. Garg and Shri Paramjeet Singh Rajpal. The final text editing and layout for publication were carried out by Dr. Aroon Chomcharn, Ms. Panpicha Issawasopon, Ms. Navaporn Liangcheevasontorn and Ms. Pimpa Molkul.

It is hoped that this report will be useful for all those officials and volunteers in India and elsewhere in Asia who are engaged in designing or implementing programmes for introducing energy saving cookstoves as part of an overall effort to improve life for the rural poor. Any comments or other feedback from readers will be highly appreciated.

Egbert Pelinck
Chief Technical Adviser

PREFACE

The Indian National Programme on Improved Chulhas (NPIC) is a little more than eight years old now. The major thrust of the programme has been the conservation of biofuel, reduction or elimination of smoke from the kitchen and alleviation of cooking drudgeries especially on women. By early 1992, over 12 million improved chulhas or improved cookstoves had already been disseminated all over the country. This number is expected to go up since the programme will be continued at least till March, 1997. By that time, it is anticipated that a coverage of about 25% of potential rural households will be achieved. New steps also are being undertaken for the development and adoption of quality standards by stove manufacturers and the commercialization of improved chulhas so that private participation can be further enhanced.

A technical publication on improved cookstove like this present Indian compendium has long been awaited. The compendium provides information on the historical backgrounds of the improved models popularly adopted, especially during the last few years, as well as of those advanced models recently developed. They comprise fixed and portable types and for use in family and community cookings. Technical details of each model is also provided.

This is perhaps the first time that an Indian improved cookstove compendium of international standard containing a large number of models has been brought out in a systematic manner. The collaboration of the FAO Regional Wood Energy Development Programme in Asia (FAO/RWEDP), based in Bangkok, was extremely important in realizing the compendium.

I wish to acknowledge with thanks the contribution of all the Technical Back-up Units, identified under the Indian NPIC, for their untiring development efforts to bring about beneficial change in rural kitchen practices and to further the cause of the rural poor.

It is hoped that the Indian lessons and experience of the programme described in this compendium are valuable to other Asian countries that have similar fuelwood/biomass energy problems.

The Ministry of Non-Conventional Energy Sources, Government of India, is grateful to the FAO/RWEDP for the advice and assistance rendered by its staff members in the preparation of this compendium.

L.M. Menezes
Secretary to the Government of India
Ministry of Non-Conventional Energy Sources

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1 INTRODUCTION

Energy is a vital input for economic and social development. In most of the developing countries, wood and other biomass fuels are still the primary source of energy for the majority of people, particularly the poor. In the last few decades, these developing countries have experienced a rapid depletion of natural forest resources that has resulted in hardship for the people living in rural areas, especially women and children who spend a considerable part of their time and energy in search of fuelwood and biofuels and often have to cover long distances. Besides, deforestation has also led to many negative ecological consequences.

The national pilot project for the demonstration of improved chulhas, therefore, was designed and launched in 1983 in India by the Department of Non-Conventional Energy Sources (DNES) with the following objectives:

- to conserve and optimize the use of fuelwood, especially in the rural and semi-urban areas,
- to help alleviate deforestation,
- to reduce the drudgery associated with cooking, especially on women, and the health hazards caused by smoke and heat exposure in the kitchen,
- to bring about improvements in household sanitation and general living conditions.

In view of the overwhelming response from the beneficiaries, the pilot project was subsequently converted into the "National Programme on Improved Chulhas" (NPIC) effective since April 1985. It now forms part of the Twenty Point and the Minimum Needs programmes of the Government of India, under the rural development drive.

Since its inception till March 1992, nearly 12 million improved cookstoves have been installed in target households. An additional target of 18 million units has been envisaged for the 8th Five Year Plan period (1992-1997). This would give a total coverage of about 25% of potential households. Figure 1.1 below provides an account of the total number of improved stoves installed during different periods.

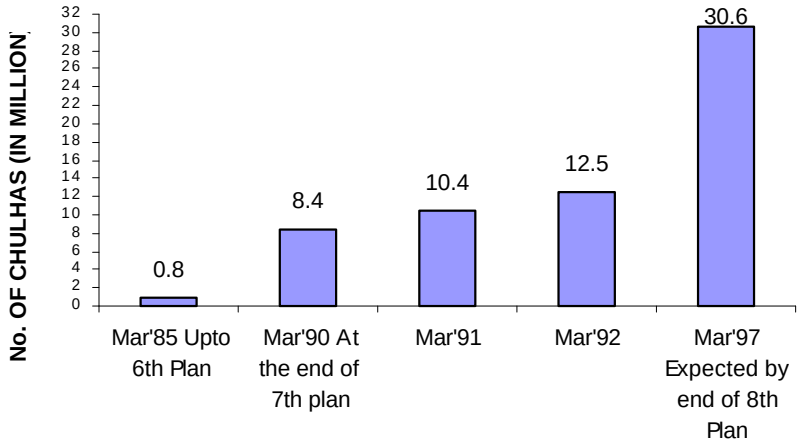


Figure 1.1: Number of improved chulhas installed during different periods

In principle an improved chulha can save 30-40% of fuelwood or other biofuels. Therefore, it is expected that fuel saving per chulha would be about 700 kg/year. On this basis, 12 million fully functioning improved chulhas would have a combined saving of about 8.4 million metric tons/year in wood equivalent with an estimated value of some Rs. 3,360 million/year (assuming fuelwood price at Rs. 400 per ton).

A multi-model and multi-agency approach has been adopted for the implementation of the programme. It is being implemented through state government agencies, autonomous bodies and voluntary organizations. The trained manpower, especially the Self-Employed Workers (SEWs) who are engaged in improved chulha construction on a contract basis, has been created under the NPIC. The SEWs are responsible for installation, maintenance, and obtaining feedback as well as following up the improved cookstoves installed for a period of one year.

The Ministry of Non-Conventional Energy Sources, Government of India (formerly DNES), has also undertaken steps for the commercialization of biomass-burning improved cookstoves, through standardization of designs and performance parameters and promotion and marketing of quality stoves by manufacturers and other marketing networks throughout the country. The users' financial involvement is also being gradually increased, depending on the status of the beneficiaries and their responses as well as the level of awareness already achieved. The details of the subsidy pattern for the improved chulha are given in annex 1.

To improve the functionality of improved chulhas installed or purchased and the programme's speedier extension, the government's new strategy has placed greater emphasis on:

- Greater financial participation of users,
- Participations of beneficiaries in selection of the models,
- Modification of the principal designs to suit user's local needs,
- More campaigns on users' education,
- Introduction of incentive schemes for field level functionaries, based on the percentage of functional stoves,
- Wider publicity through radio, TV, and other local media/modes,
- Easy access to various models of improved chulhas, and marketing liberalization, including decentralized registration of models etc.,
- Introduction of "ISI" mark (Indian Industrial Standard) on improved stoves.

The NPIC is a mix of R&D and its popularization through field extension/installation and commercialization. In order to provide sufficient technical back-up support for the implementation of the field programme, an institutional network, comprising 20 Technical Back-up Units (TBUs) mostly from well known research and training institutions, has been created throughout the country. These TBUs cater to the specific technical requirements of the programme in particular assigned areas and work in close consultation with both the national programme management and the implementing agencies at state and local levels. A list of TBUs is provided in chapter 4, section 4.2.

The technology of the improved chulha in India has passed through various stages of transformation since the inception of the NPIC. Initially improved chulhas with dampers having a minimum efficiency of 15% (against 5-10% for traditional chulhas) were approved for propagation during the demonstration phase of the NPIC. After intensive R&D efforts, more fuel-efficient

chulhas have emerged having an efficiency of 20% and above. Further concerted efforts resulted in the development of damperless designs whose thermal performance was comparable with chulhas with dampers. Besides the performance consistency obtained from both the lab and field tests, these damperless designs were more convenient to use and significantly reduced the cost of installation/construction. Simultaneously, the designs were diversified to suit the requirements of various sizes of families, different types of fuels, with or without chimneys, portable or fixed etc. At present, there are many models available for selection by the beneficiaries:

(a) Mud-built, fixed chulha with or without chimney,
(b) Mud-clad, pottery-lined fixed chulha with or without chimney,
(c) Portable metallic chulha without chimney,
(d) Portable metal-clad, ceramic-lined chulha without chimney, and
(e) Portable chulha with a separate hood chimney system.

With continuous and intensive R&D efforts, it is hoped that yet higher performance models can be achieved while ensuring that they meet the requirements of users.

2 ORGANIZATION OF NATIONAL PROGRAMME ON IMPROVED CHULHA

The NPIC is implemented through various national, state and local mechanisms. At the national level, the Ministry of Non-Conventional Energy Sources, Government of India, through the Improved Chulha Division, is responsible for setting the development policy and direction, securing the central government funding and providing support to various implementation networks. In addition, the programme planning, management/operation, monitoring and evaluation, overseeing R&D progress etc. are also mandated.

At state level, designated state nodal agencies are responsible for the dissemination of approved chulha models within the state or territory through various local implementing bodies, notably, state government departments, non-conventional energy development agencies, state agro-industry corporations, Khadia village industry corporations, women's organizations and concerned NGOs. Since the central government supporting fund is channelled through these state nodal agencies, they are responsible for the dissemination plan, providing support to the implementing bodies, coordinating field activities as well as monitoring of the programme. They also have responsibility for various administrative works.

NGOs are engaged in the implementation, at the national level by the MNES and at local level by the state governments. Village level administrative officials are also fully involved.

The actual installation of improved chulhas is carried out by a trained workforce of Self Employed Workers (SEWs) who are engaged on a contract basis and are responsible for chulha construction, repair and maintenance for a period of one year after installation, and users' education.

Twenty Technical Back-up Units (TBUs) have been created in various educational institutions, eg. engineering and agricultural colleges, autonomous agencies. They are responsible for carrying out R&D work including the development of appropriate models to suit local needs; decentralized testing of models to be promoted; training of the SEWs, potters, village artisans and various field functionaries; adoption of villages for demonstration and field trials of the models developed; conducting technical and need-based surveys as well as monitoring & evaluation and investigations on related activities etc. The TBUs work in close cooperation with the implementing agencies and provide technical input to the programme.

The organization flow chart of the NPIC is given below. Full lists of the programme officers in charge, TBUs, state nodal agencies, local implementing agencies and approved manufacturers of portable chulhas are given in chapter 4.

ORGANIZATION CHART OF THE NATIONAL PROGRAMME ON IMPROVED CHULHAS

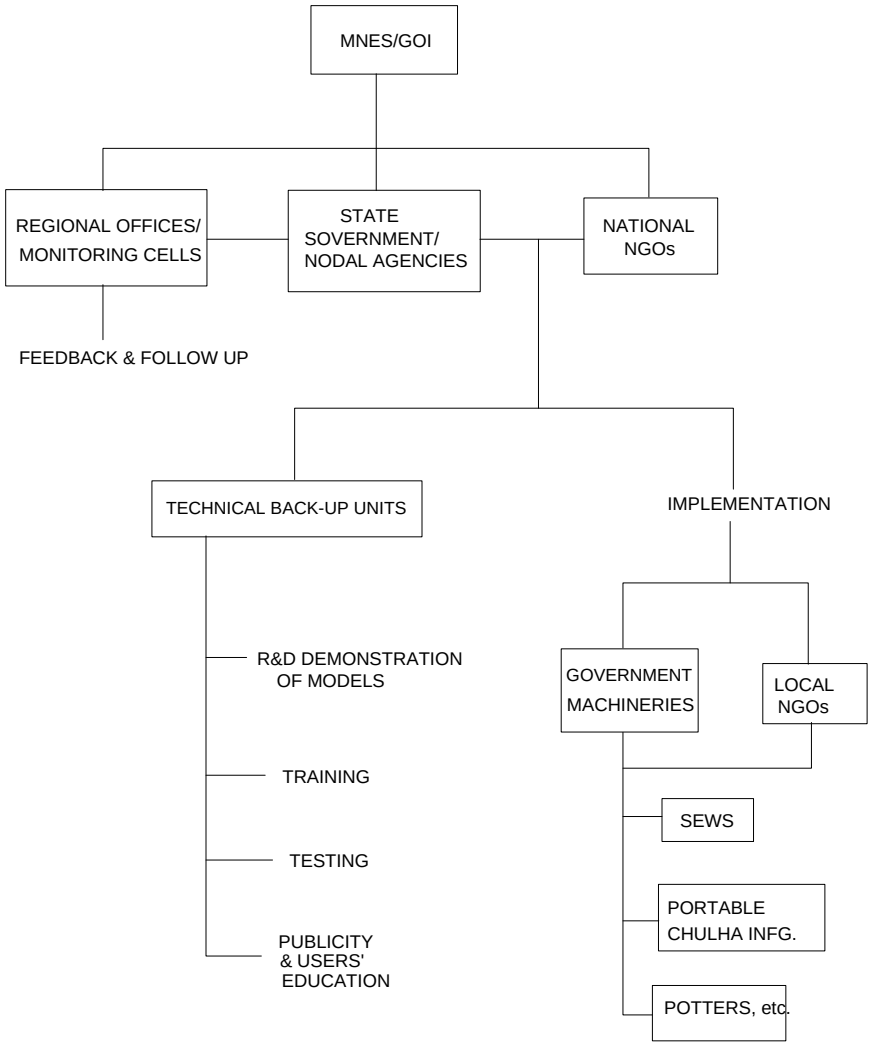


Figure 2.1: Implementation flow chart of national programme.

3 SELECTED MODELS OF IMPROVED CHULHA

The selection of improved chulha models covered in this compendium is based mainly on the most recent technical developments. Although many old models may still be operated by thousands of users they have been superseded by newer models that are more convenient to build and operate, more energy efficient and/or have better fuel flexibility etc. Notably, as will be seen in all the models presented in the compendium (with one exception) the two features most complained of or rejected by the users, that is, the tunnel baffle and the door damper, have been done away with by the newer designs. The models selected cover both portable and fixed stoves made from four types of basic construction materials, namely; mud, mud-brick, ceramics and metal and or combinations of these. The geographical distribution was also taken into consideration such that the models selected represent most of the States and Union Territories. The presentation is simply arranged in alphabetical order for convenience in reference.

3.1 ABHINAV/JETAN

The model was developed in 1987 at the Technical Back-up Unit, Energy Research Centre, Punjab University, Chandigarh - 160014.

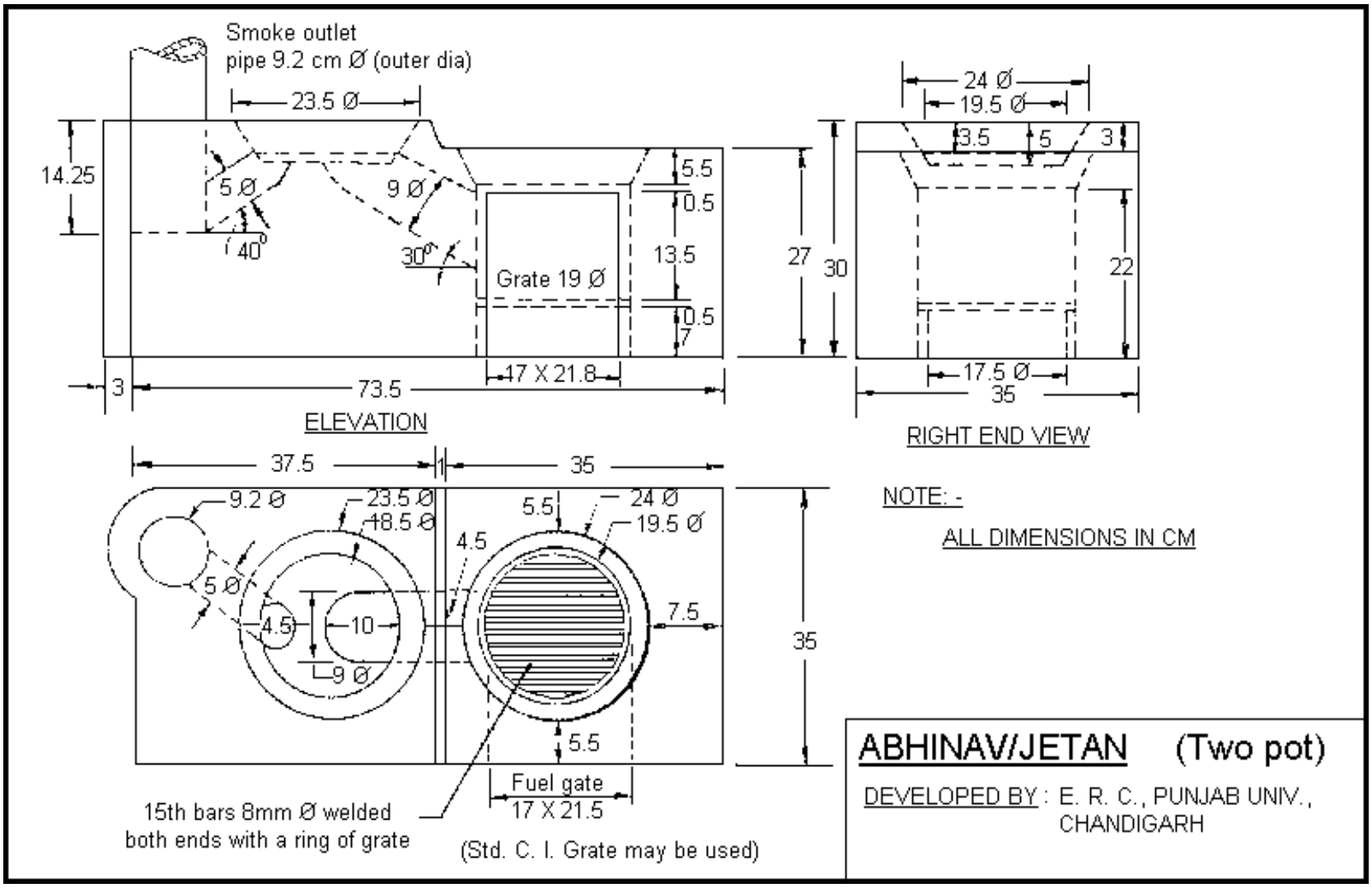
The Abhinav/Jetan is a fixed, two-pot mud stove with chimney, suitable for a variety of fuels, e.g., fuelwood, twigs, dung cake and agri-residues. It was the first damperless model designed under the NPIC. It was based on feedback from the field which revealed that the dampers were not being used because of incon-venience during the cooking operation. The thermal performance of this design is comparable to similar models with dampers. The field performance of the Abhinav/Jetan is very similar to the results obtained by the lab test.

The model is widely accepted in many States such as Haryana, Uttar Pradesh, Delhi, Rajasthan and Madhya Pradesh. So far, about one million units have been disseminated. The present design, called the Jetan is a slight modified version of the original Abhinav and normally can accommodate cooking utensils 24-25 cm. in diameter. The production cost estimate is Rs. 55-72 (US$ 2.2-2.9).

Special features: damperless; multi-fuel flexibility; simple construction.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


Smoke outlet
pipe 9.2 cm Ø (outer dia)
23.5 Ø
14.25
5 Ø
9 Ø
40°
30°
Grate 19 Ø
5.5
0.5
13.5
0.5
7
3
73.5
17 X 21.8
ELEVATION
24 Ø
19.5 Ø
3.5
5
3
27
30
22
17.5 Ø
35
RIGHT END VIEW
37.5
1
35
9.2 Ø
23.5 Ø
48.5 Ø
5.5
24 Ø
19.5 Ø
4.5
5 Ø
4.5
10
9 Ø
7.5
35
5.5
Fuel gate
17 X 21.5
15th bars 8mm Ø welded
both ends with a ring of grate
(Std. C. I. Grate may be used)
NOTE: -
ALL DIMENSIONS IN CM
ABHINAV/JETAN (Two pot)
DEVELOPED BY : E. R. C., PUNJAB UNIV., CHANDIGARH

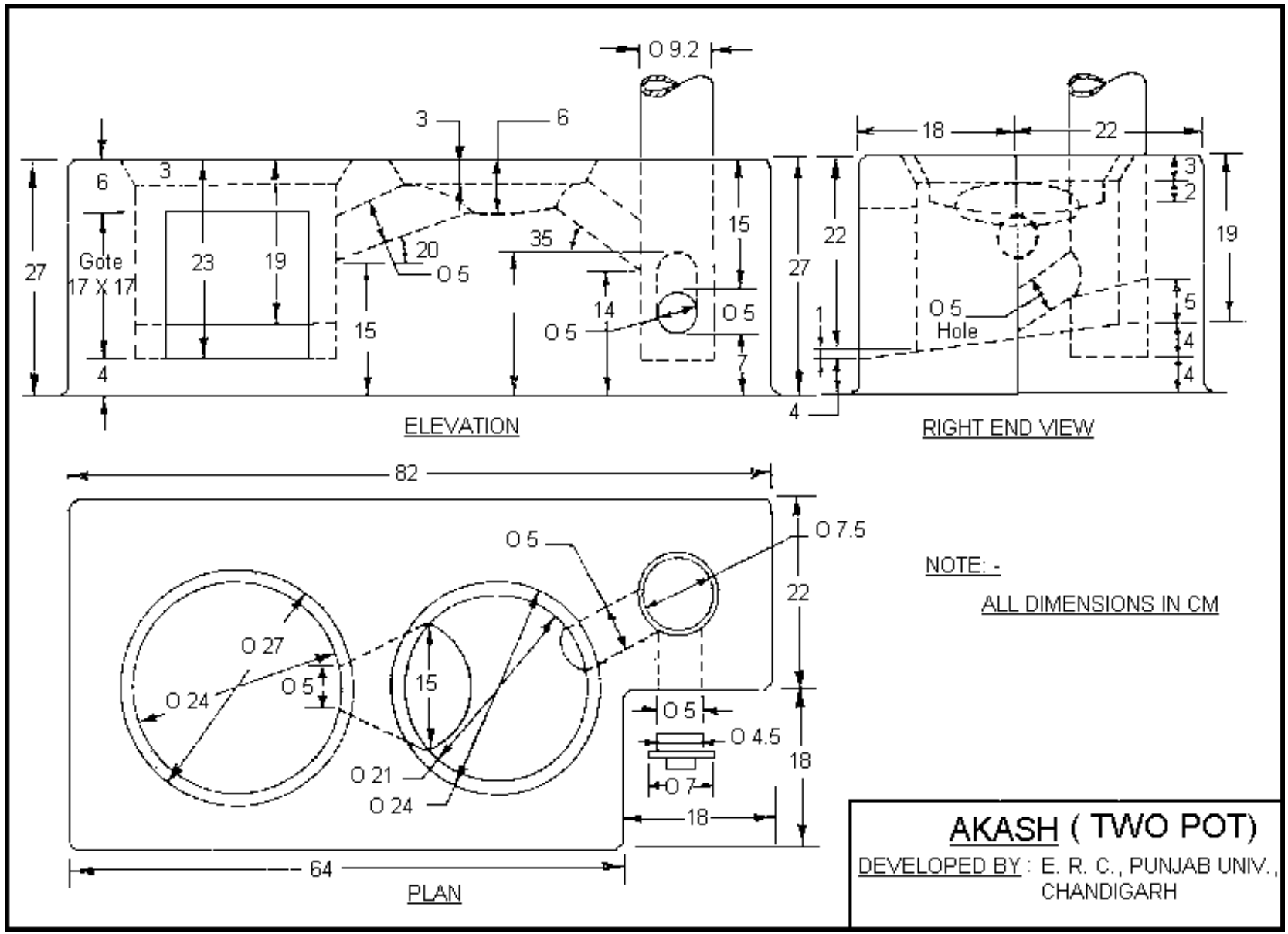
3.2 AKASH

The model was developed in 1991 at the Technical Back-up Unit, Energy Research Centre, Punjab University, Chandigarh - 160014.

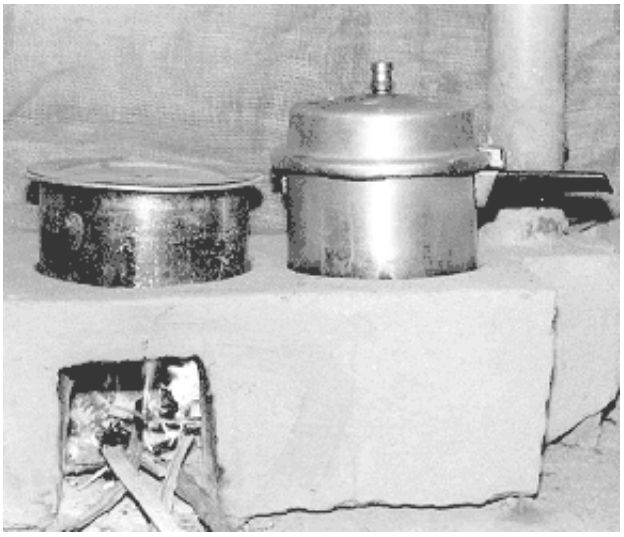
The Akash is a fixed, two-pot mud stove with chimney, suitable for a variety of fuels such as fuelwood, twigs, dung cake and agri-residues. It is a large size stove with 1.6 kW rated power output and thus is suitable for a large family of up to 12 members and can accommodate both spherical and flat bottom vessels 24-30 cm in diameter. Akash stoves are found in households of the northern States such as Haryana, Himachal Pradesh and Rajasthan. So far about 30,000 units have been installed under the NPIC. The production cost estimate is Rs.55-80 (US$ 2.2-3.2).

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


O 9.2
3
6
6
3
Gote
17 X 17
23
19
20
O 5
35
15
27
14
O 5
15
O 5
7
4
ELEVATION
18
22
3
2
19
22
O 5
Hole
5
4
4
1
27
4
RIGHT END VIEW
82
O 5
O 7.5
22
O 27
O 24
O 5
15
O 5
O 4.5
18
O 21
O 24
O 7
18
64
PLAN
NOTE: -
ALL DIMENSIONS IN CM
AKASH (TWO POT)
DEVELOPED BY : E. R. C., PUNJAB UNIV., CHANDIGARH

3.3 ALOK

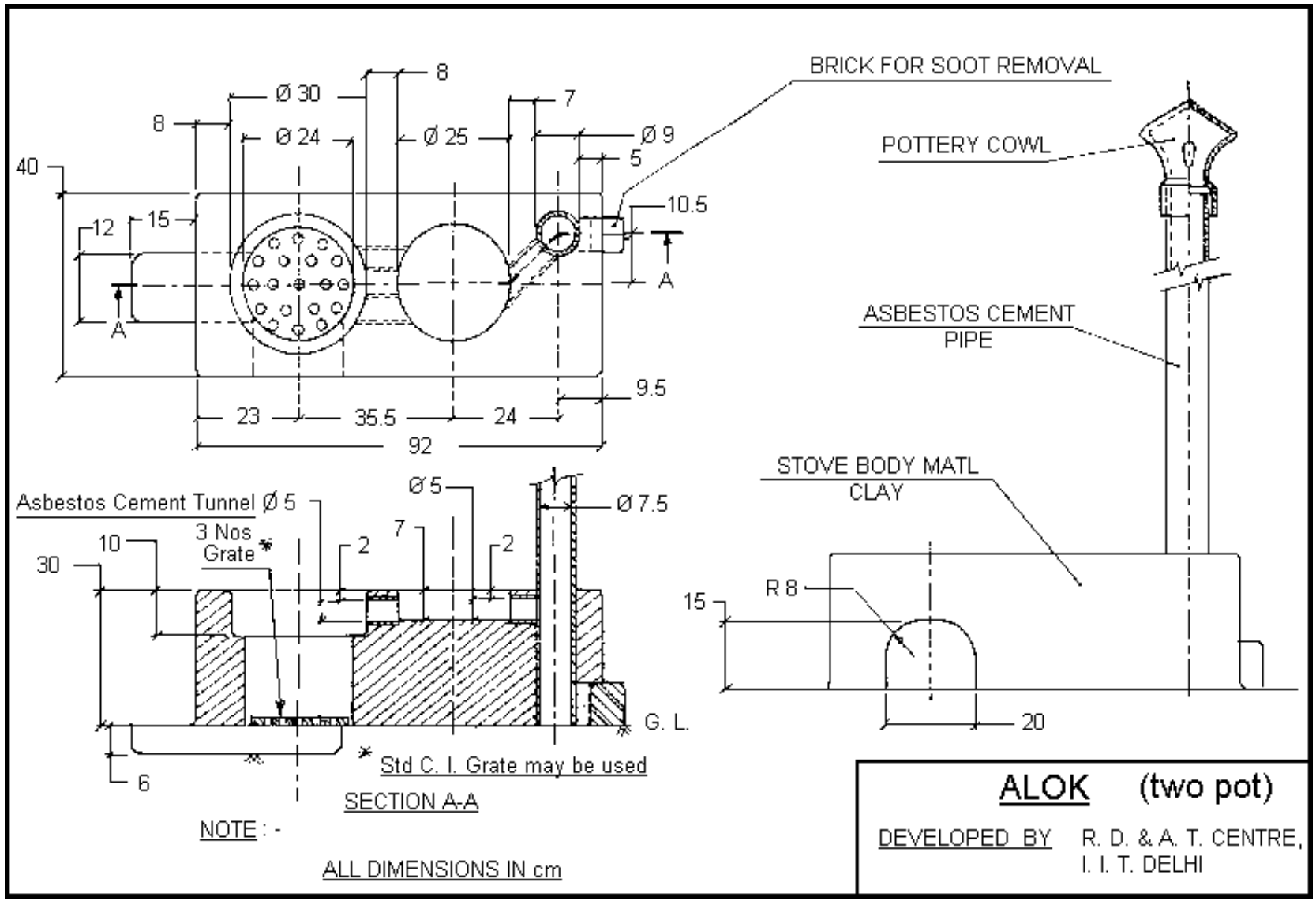


The model was developed in 1989 at the Technical Back-up Unit, Centre for Rural Development & Appropriate Technology (CRD & AT), Indian Institute of Technology, Hauz Khas, New Delhi - 110016.

The Alok is a fixed, two-pot mud stove with chimney with the interconnecting tunnels lined with fired-clay tubes. Fuelwood and twigs are the main fuels. It is suitable for a large family (9 - 12 members), especially in the plains of Uttar Pradesh, Haryana and Punjab. Besides cooking traditional dishes such as rice and vegetables, it is also amenable to the baking of *Chapati* on the fire. It can accommodate flat and spherical bottom pots with diameters of 26-36 cm, though smaller pots of 15-24 cm. in diameter can be accomodated by employing a cast iron ring. Alok can be constructed by a semi-skilled field worker using locally available clay along with prefabricated items: pottery tunnels, grate, asbestos-cement chimney pipe and cowl. So far about 10,000 stoves have been disseminated. The production cost estimate is Rs.75-100 (US$ 3- 4).

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


8
Ø 30
7
8
Ø 24
Ø 25
Ø 9
5
40
10.5
12
15
A
A
9.5
23
35.5
24
92
BRICK FOR SOOT REMOVAL
POTTERY COWL
ASBESTOS CEMENT
PIPE
STOVE BODY MATL
CLAY
Asbestos Cement Tunnel Ø 5
Ø 5
Ø 7.5
3 Nos
Grate *
10
30
2
7
2
R 8
15
20
G. L.
6
* Std C. I. Grate may be used
SECTION A-A
NOTE : -
ALL DIMENSIONS IN cm
ALOK (two pot)
DEVELOPED BY R. D. & A. T. CENTRE,
I. I. T. DELHI

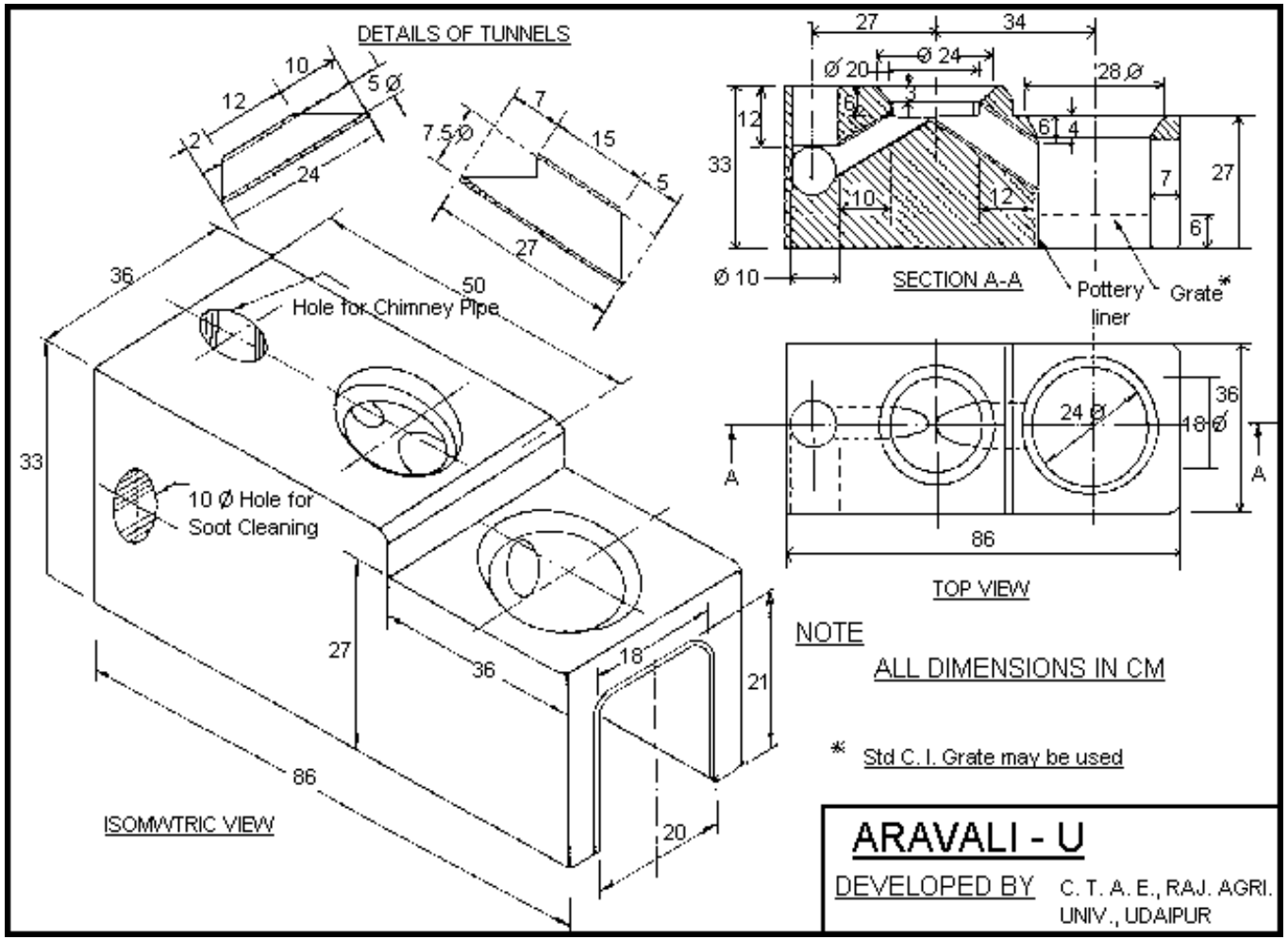
3.4 ARAVALI-U

The model was developed in 1989 at the Technical Back-up Unit, Renewable Energy Centre, College of Technology and Agricultural Engineering, Rajasthan Agricultural University, Udaipur.

The Aravali-U is a fixed, two-pot mud stove with chimney. This "unified design" incorporates all the good features of the two-pot stoves for the requirements of a medium size family (5-10 members). It is very popular in many States, especially Rajasthan, Andhra Pradesh and Uttar Pradesh. A variety of fuels such as fuelwood, twigs, dung cake, straws and other similar agri-residues can be used. The stove can accommodate flat and spherical bottom pots 22-30 cm. in diameter. It was brought under the NPIC for dissemination during 1991. So far about 20,000 units have been disseminated. The production cost estimate is about Rs. 55-80 (US$ 2.2- 3.2).

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


DETAILS OF TUNNELS
10
12
2
24
5 Ø
7
7.5 Ø
15
5
27
36
50
Hole for Chimney Pipe
33
10 Ø Hole for
Soot Cleaning
27
36
18
21
86
20
ISOMMTRIC VIEW
27
34
Ø 20
Ø 24
28 Ø
12
33
6
3
6
4
7
27
10
12
6
Ø 10
SECTION A-A
Pottery
liner
Grate*
36
24 Ø
18 Ø
A
A
86
TOP VIEW
NOTE
ALL DIMENSIONS IN CM
* Std C. I. Grate may be used
ARAVALI - U
DEVELOPED BY C. T. A. E., RAJ. AGRI.
UNIV., UDAIPUR

3.5 ASTRA

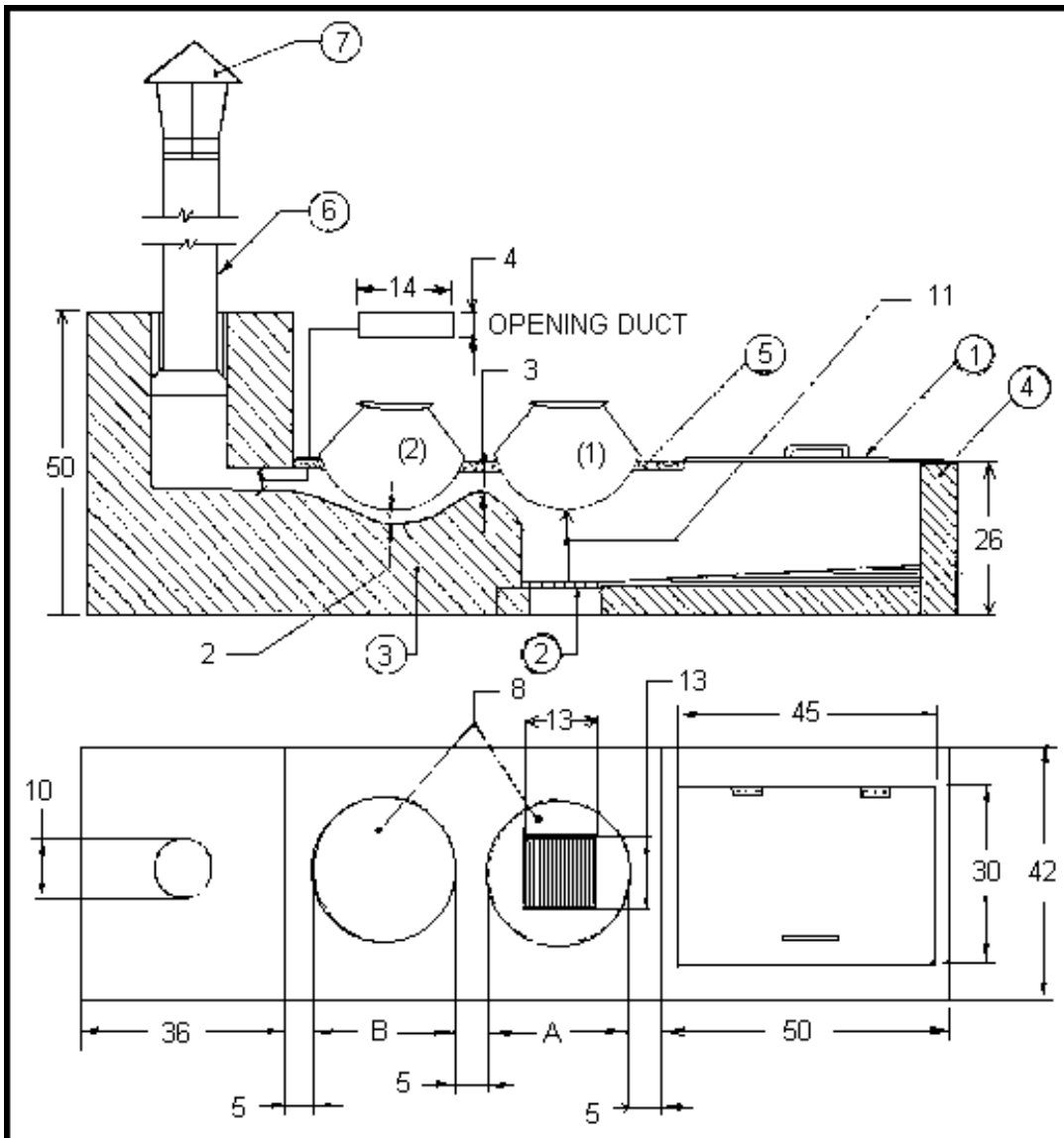
The model was developed in 1985 at the Technical Back-up Unit, Karnataka State Council for Science and Technology (KSCST) located at the Indian Institute of Science, Bangalore - 560012.

The Astra is a specially designed two- or three-pot stove with chimney, for use with spherical bottom vessels. It is widely adopted in southern India where the cooking of traditional dishes, like *Ragi* (a millet dish), requires vigorous stirring and hence a very firm stove. The stove can be custom- constructed for all size of vessels used by households, however pots with diameters 20-30 cm are normally encountered. Construction materials are bricks, mud mortar, cement blocks, metal sheet grate, metal sheet firebox lid, asbestos pipe chimney and cowl. The stove is very popular in the State of Karnataka to which nearly half a million stoves have been disseminated so far. It is suitable for use with fuelwood, twigs and agri-residues and combinations of these. The production cost estimate is Rs. 55-102 (US$ 2.2- 4.1).

Special features: custom-made (taking into account the profile of the utensils) for optimising thermal performance. Can meet the cooking requirements of southern Indian dishes using wood as fuel.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.



DIMENSION	VALUE
A	PAN SEAT DIA (1)
B	PAN SEAT DIA (2)

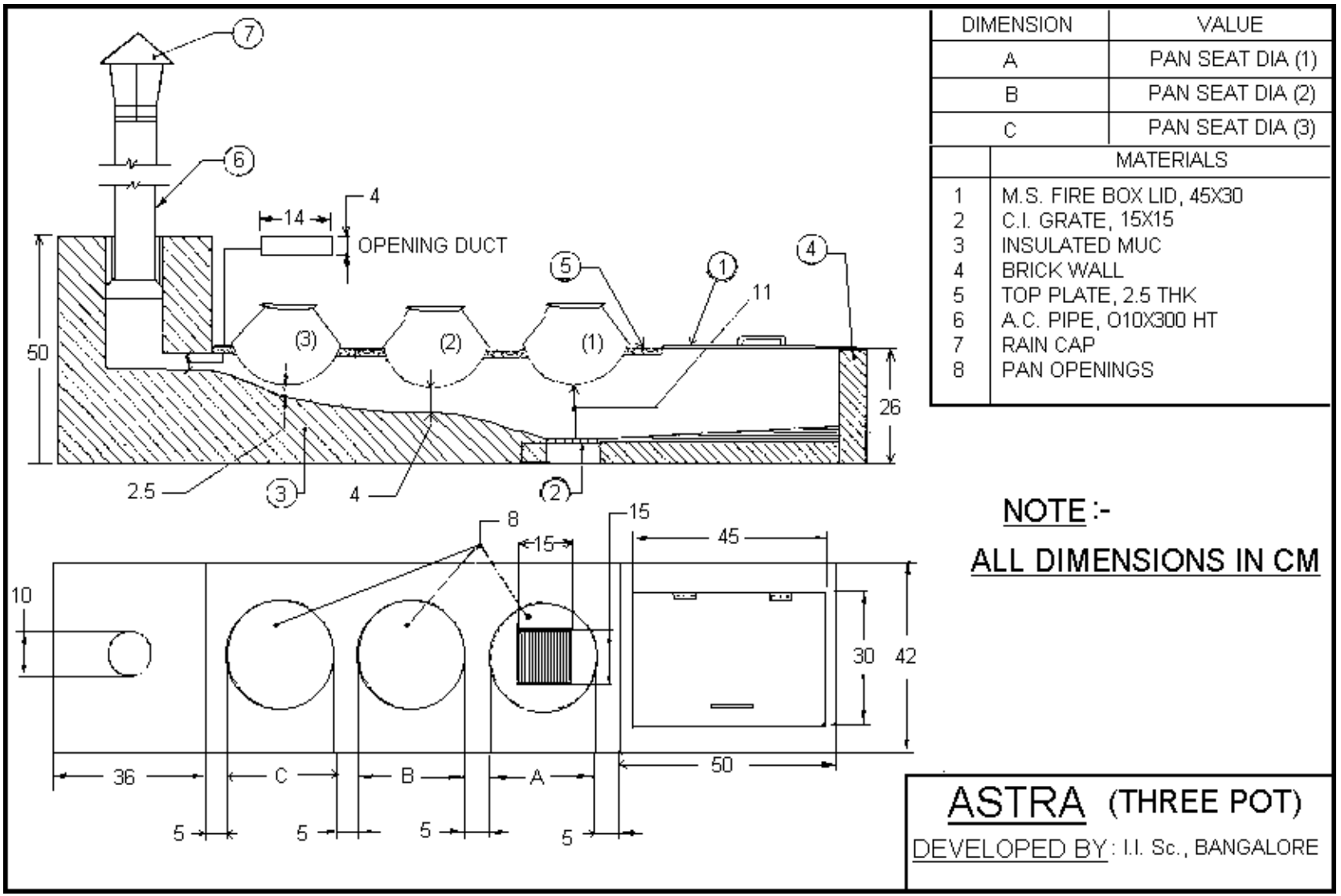
	MATERIALS
1	M.S. FIRE BOX LID, 45X30
2	C.I. GRATE, 13X13
3	INSULATED MUC
4	BRICK WALL
5	TOP PLATE, 2.5 THK
6	A.C. PIPE, O10X300 HT
7	RAIN CAP
8	PAN OPENINGS

NOTE :-

ALL DIMENSIONS IN CM

ASTRA (TWO POT)

DEVELOPED BY : I.I. Sc., BANGALORE



DIMENSION	VALUE
A	PAN SEAT DIA (1)
B	PAN SEAT DIA (2)
C	PAN SEAT DIA (3)

	MATERIALS
1	M.S. FIRE BOX LID, 45X30
2	C.I. GRATE, 15X15
3	INSULATED MUC
4	BRICK WALL
5	TOP PLATE, 2.5 THK
6	A.C. PIPE, O10X300 HT
7	RAIN CAP
8	PAN OPENINGS

NOTE :-

ALL DIMENSIONS IN CM

ASTRA (THREE POT)

DEVELOPED BY : I.I. Sc., BANGALORE

3.6 BHAGYALAXMI

The model was developed in 1991 at the Technical Back-up Unit, Center for Application of Science and Technology for Rural Development (CASTFORD), Indian Institute of Education, 128/2, Karve Road, Kothrud, Pune - 411029.

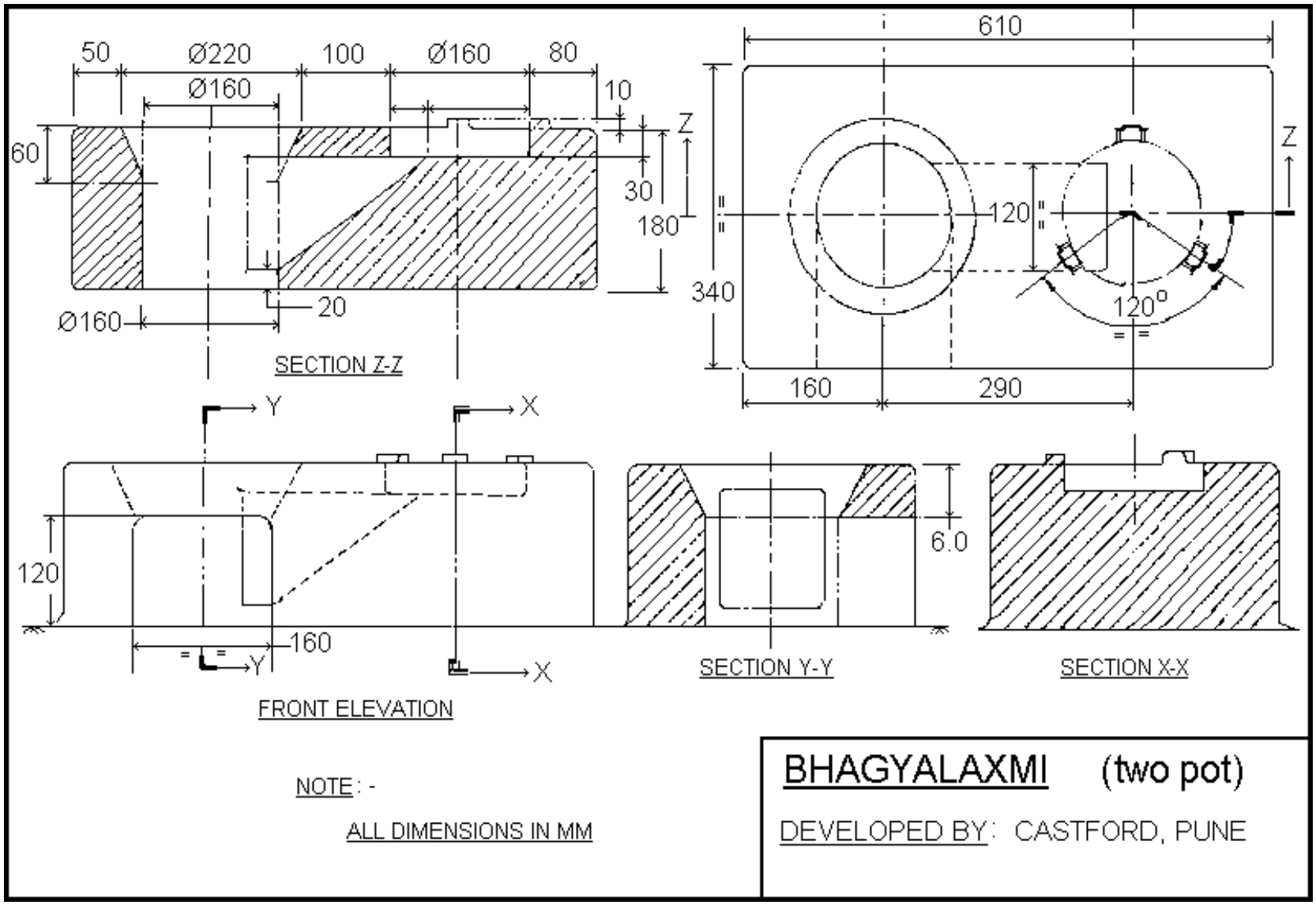
The Bhagyalaxmi is a two-pot, non-chimney mud stove, suitable for a medium size family (5-8 members). The stove can be constructed by a semi-skilled field worker using locally available mud/clay material and a set of iron moulds which effectively reduce construction time and maintain critical dimensions. The stove can accomodate pots 18-25 cm. in diameter. Traditional meals can be conveniently cooked using fuelwood, twigs and agri-residues.

The model has been recently brought under the NPIC and is becoming popular in Maharashtra, Goa and Karnataka States. So far about 5,000 stoves have been disseminated throughout the country. The production cost estimate is Rs. 40 (US$ 1.6).

Special features: a chimneyless low cost design that can be produced centrally and distributed to various beneficiaries, especially amongst the economically weaker section of the society.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


50
Ø220
100
Ø160
80
Ø160
10
60
Z
30
180
20
Ø160
SECTION Z-Z
610
Z
120
340
120°
160
290
Y
X
120
160
Y
X
FRONT ELEVATION
6.0
SECTION Y-Y
SECTION X-X
NOTE : -
ALL DIMENSIONS IN MM
BHAGYALAXMI (two pot)
DEVELOPED BY : CASTFORD, PUNE

3.7 DENGLI

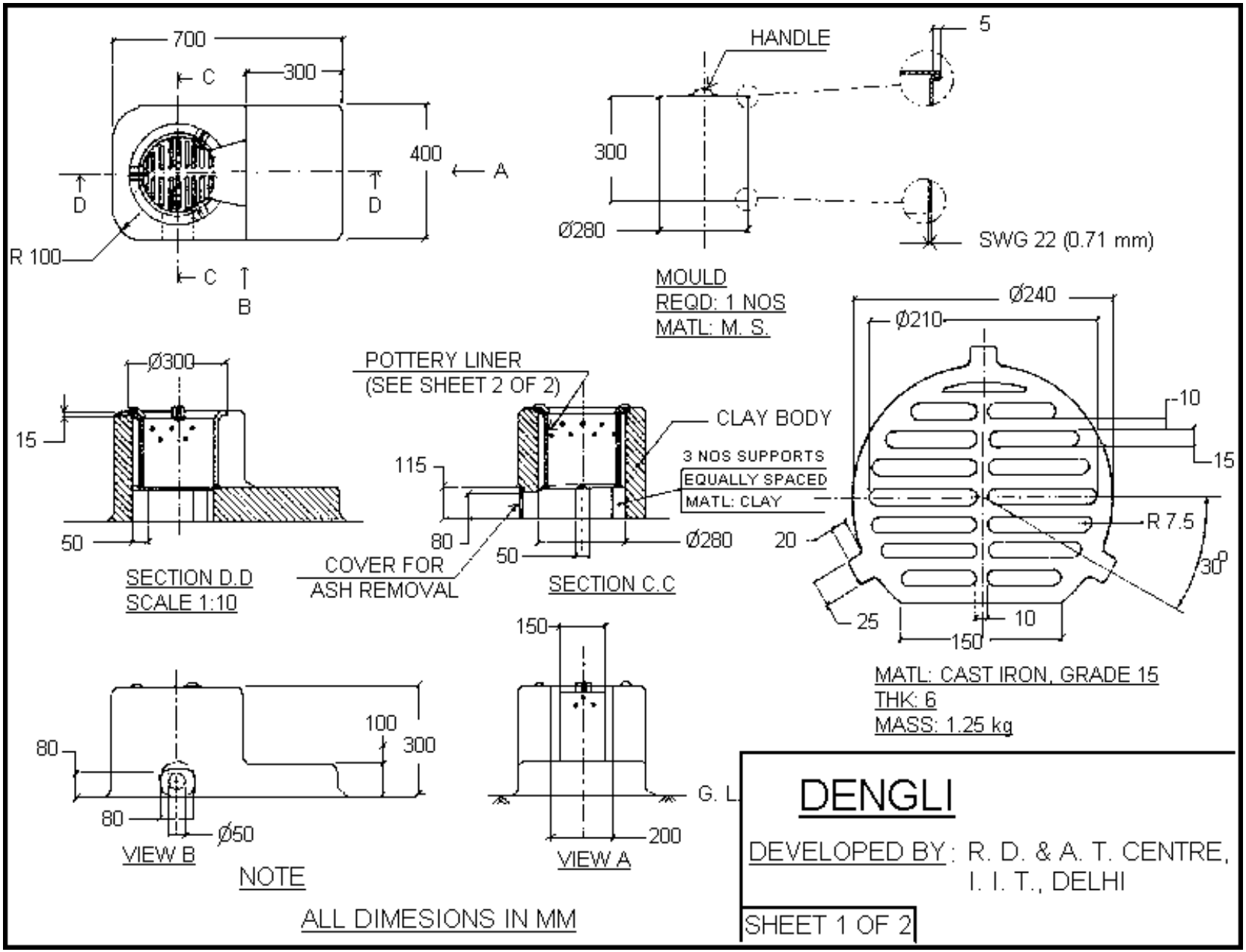
The model was developed in 1991 at the Technical Back-up Unit, Centre for Rural Development & Appropriate Technology, Indian Institute of Technology, Hauz Khas, New Delhi - 110016.

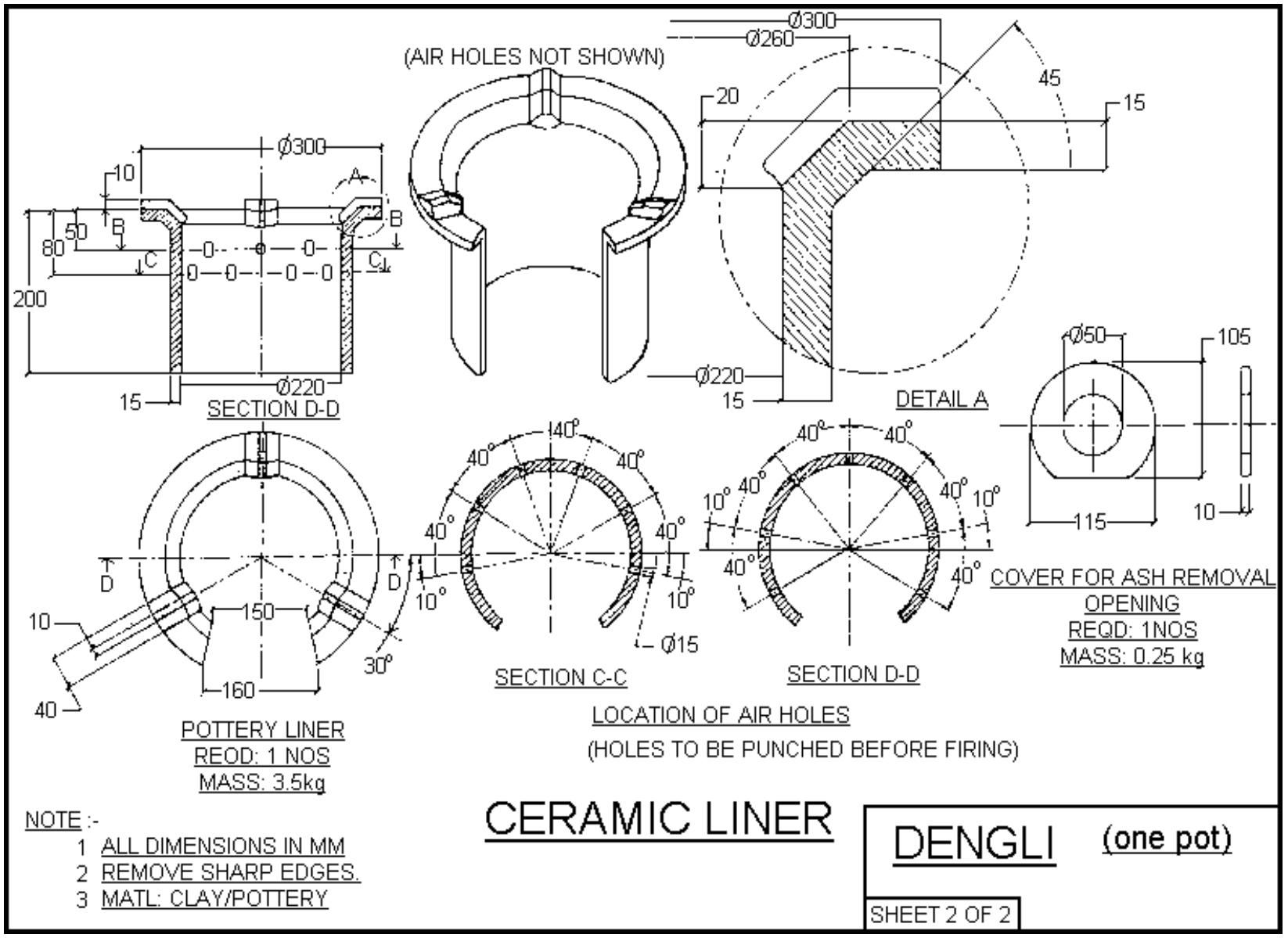
The Dengli is an improved version of a single-pot mud stove without chimney, widely used in Dhinkali village in the Udaipur District of Rajasthan. It also resembles the traditional U-type mud stove which is widely used in the northern region but with added provisions for secondary air supply and grate. The combustion chamber of the Dengli is made of a perforated pottery liner. It can accommodate both spherical and flat bottom utensils 23-30 cm. in diameter and a variety of fuels like fuelwood, twigs, dung cakes, straws and other agri-residues or combinations of these. The model is receptive to cooking traditional meals in the State of Rajasthan, Haryana, Delhi, Uttar Pradesh and Madhya Pradesh, where *chapati* (local bread) is also prepared. The model was recently adopted under the NPIC and about 5,000 units have been disseminated. The production cost estimate is Rs. 27 (US$ 1.1).

Special features: the stove can be constructed by housewives using a pottery liner. Due to low cost and simplified construction, it is gaining fast acceptance among the weaker sections of society. The space below the grate can be used also for slow baking of sweet potato, brinjal etc.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


700
300
C
400
A
D
D
R 100
C
B
HANDLE
5
300
Ø280
SWG 22 (0.71 mm)
MOULD
REQD: 1 NOS
MATL: M. S.
Ø240
Ø210
10
15
R 7.5
20
30°
25
10
150
MATL: CAST IRON, GRADE 15
THK: 6
MASS: 1.25 kg
Ø300
15
50
SECTION D.D
SCALE 1:10
POTTERY LINER
(SEE SHEET 2 OF 2)
CLAY BODY
3 NOS SUPPORTS
EQUALLY SPACED
MATL: CLAY
115
80
50
Ø280
COVER FOR
ASH REMOVAL
SECTION C.C
150
G. L
200
VIEW A
80
100
300
80
Ø50
VIEW B
NOTE
ALL DIMESIONS IN MM
DENGLI
DEVELOPED BY: R. D. & A. T. CENTRE,
I. I. T., DELHI
SHEET 1 OF 2


(AIR HOLES NOT SHOWN)
Ø300
Ø260
45
20
15
Ø300
10
A
B
50
80
C
200
Ø220
15
SECTION D-D
Ø220
15
DETAIL A
Ø50
105
115
10
COVER FOR ASH REMOVAL OPENING
REQD: 1NOS
MASS: 0.25 kg
40°
10°
D
10
150
160
30°
40
Ø15
SECTION C-C
SECTION D-D
POTTERY LINER
REOD: 1 NOS
MASS: 3.5kg
LOCATION OF AIR HOLES
(HOLES TO BE PUNCHED BEFORE FIRING)
NOTE :-
1 ALL DIMENSIONS IN MM
2 REMOVE SHARP EDGES.
3 MATL: CLAY/POTTERY
CERAMIC LINER
DENGLI
(one pot)
SHEET 2 OF 2

3.8 DOACHHI

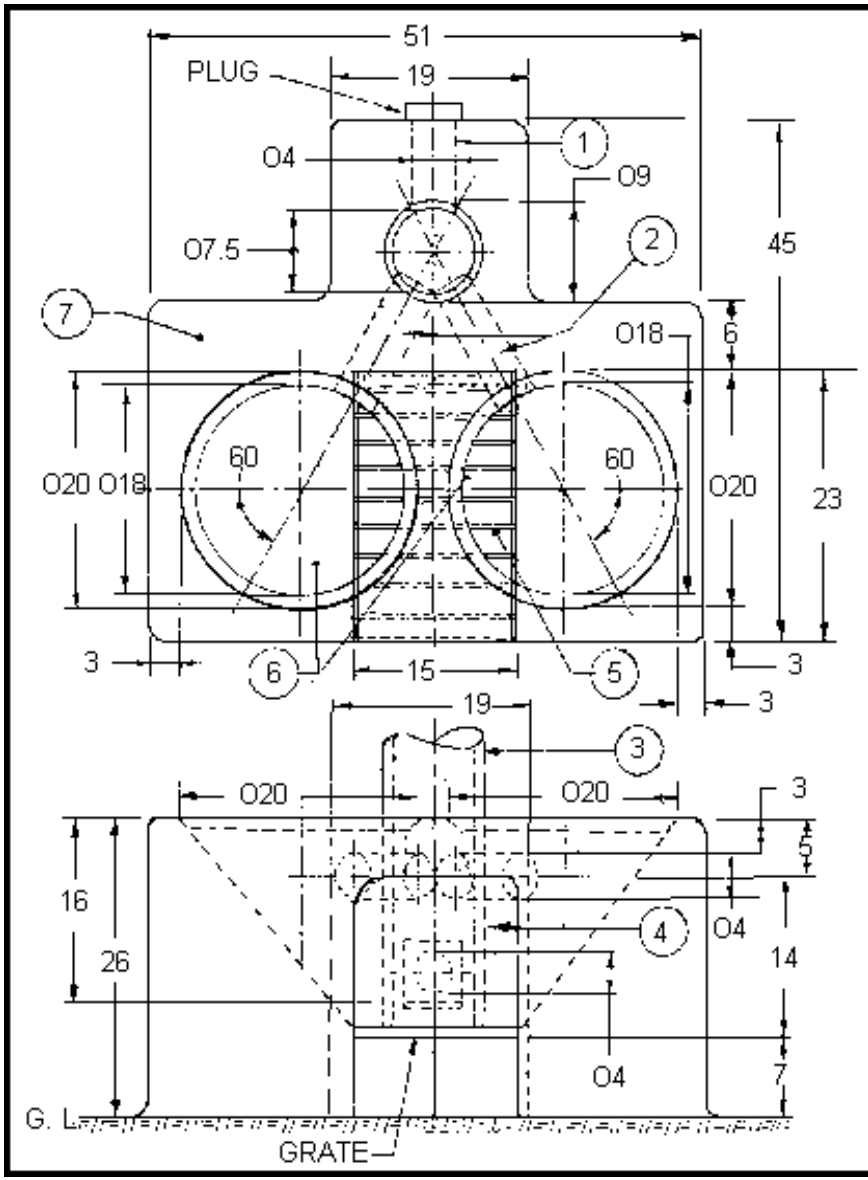
The model was developed in 1989 at the Technical Back-up Unit, Department of Mechanical Engineering, Bihar College of Engineering, Patna-300005.

In eastern parts of India, a traditional, two-pot stove having a single firebox at the centre is widely used for cooking, especially for boiling and steaming. Accordingly, the development of the Doachhi stove was made to suit such a local tradition in the States of Bihar and Uttar Pradesh. The stove has two pot holes that can accommodate both spherical and flat bottom utensils with diameter 19-24 cm. The pottery liner and cast iron grate can also be provided which makes the construction of the stove very simple. However, the stoves can be built by trained Self Employed Workers (SEWs) using locally available materials. The model is popular in Bihar, Uttar Pradesh, West Bengal and other north-eastern States where a variety of fuels as fuelwood, twigs, straws, cowdung, other agri-residues are commonly encountered. Nearly half a million units of Doachhi have been disseminated so far. The production cost estimate is Rs. 70-87 (US$ 2.8-3.5).

Special features: the firebox is located in between the two-pot holes to provide equal heat transfer to both pots.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.



S.NO.	DESCRIPTION	MATERIAL
7	MAIN BODY	MUD/POTTERY
6	POT SEAT	MUD/POTTERY
5	GRATE*	M, S. ROD (10 NOS)
4	FUEL GATE	MUD/POTTERY
3	CHIMNEY	A. C. PIPE
2	TUNNEL	MUD/POTTERY
1	ASH HOLE/PLUG	MUD/POTTERY

* C. I. GRATE MAY BE USED

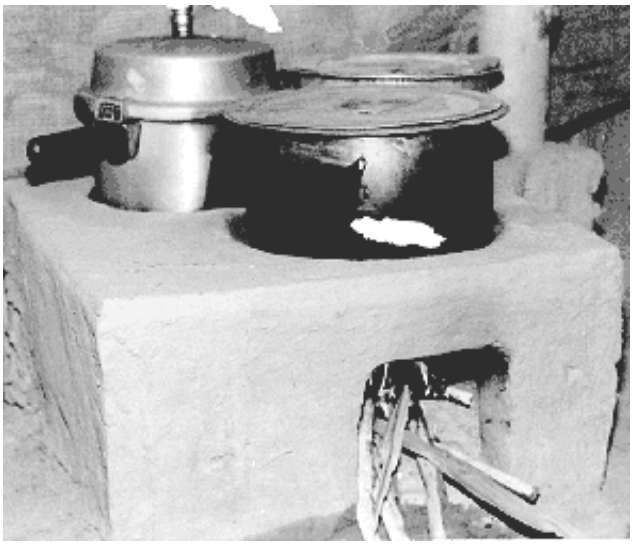
NOTE :-

ALL DIMENSIONS IN CM

DOACHHI (two pot)

DEVELOPED BY: BIHAR COLLEGE OF ENGG., PATNA

3.9 GAURAV



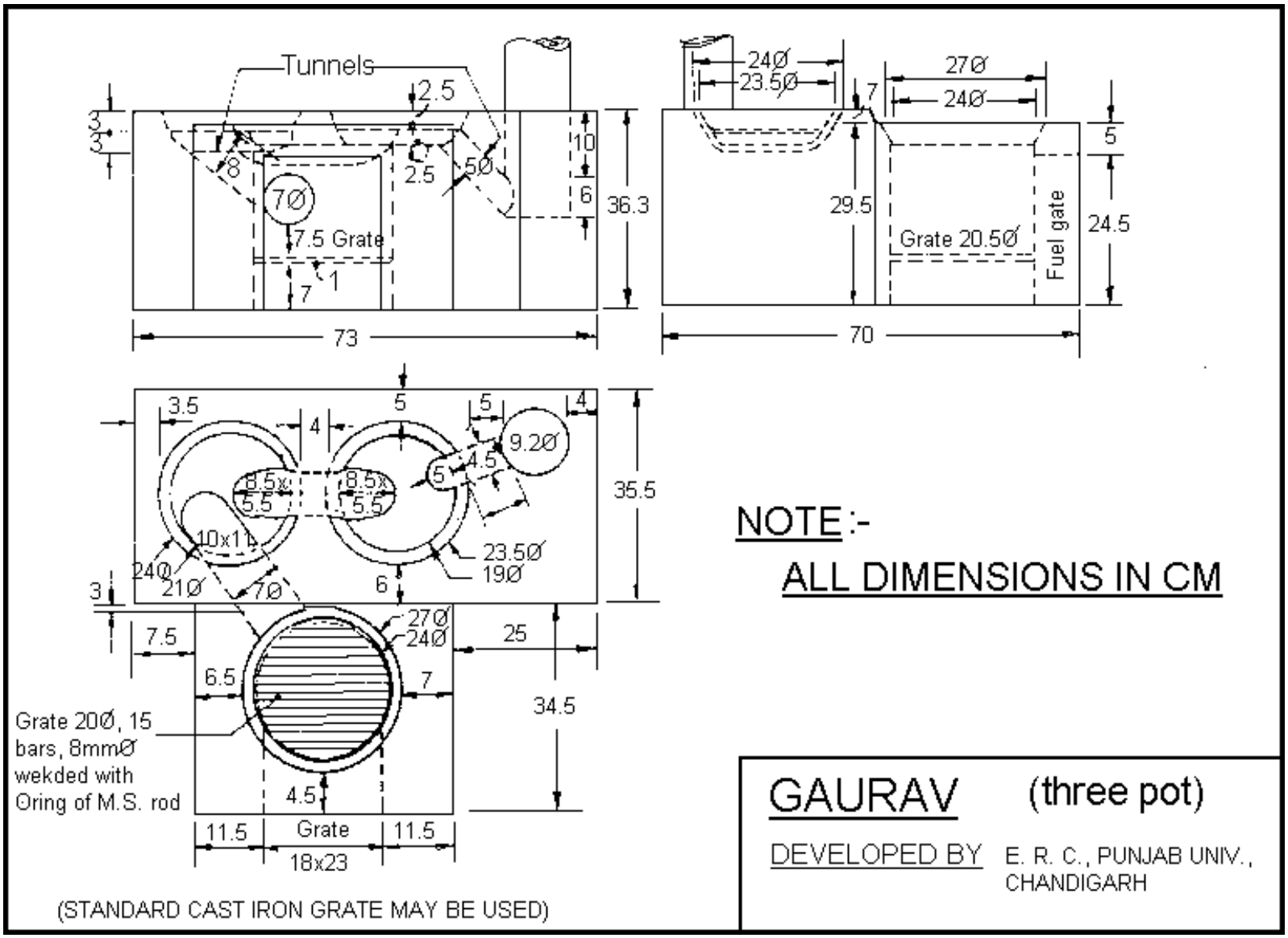
The model was developed in 1989 at the Technical Back-up Unit, Energy Research Centre, Punjab University, Chandigarh - 160014.

The Gaurav is a large, pottery-lined mud stove for use with three pots, capable of being fired by wood, agri-residues and dung cake. The design is furnished with a metal- rod grate for better combustion of fuel. The 3 pot-holes are arranged in a triangular shape and can accomodate flat bottom pots 23-30 cm. in diameter.

It is popular for large family cooking in the plainy areas such as in Punjab, Chandigarh and Haryana and is also very suitable for medium altitude/hilly areas where water heating is required year round such as in Himachal Pradesh, So far, about 10,000 units have been disseminated. The production cost estimate of the Gurav is Rs. 75-110 (US$ 3-4.4).

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


Tunnels
2.5
3
3
8
7Ø
7.5 Grate
1
7
2.5
5Ø
10
6
36.3
73
24Ø
23.5Ø
27Ø
24Ø
7
29.5
Grate 20.5Ø
Fuel gate
5
24.5
70
3.5
4
5
5
4
9.2Ø
4.5
5
8.5x
5.5
8.5x
5.5
35.5
10x11
24Ø
21Ø
7Ø
6
23.5Ø
19Ø
3
7.5
27Ø
24Ø
25
6.5
7
34.5
Grate 20Ø, 15
bars, 8mmØ
wekded with
Oring of M.S. rod
4.5
11.5
Grate
18x23
11.5
(STANDARD CAST IRON GRATE MAY BE USED)
NOTE:-
ALL DIMENSIONS IN CM
GAURAV (three pot)
DEVELOPED BY E. R. C., PUNJAB UNIV., CHANDIGARH

3.10 GRIHLAXMI

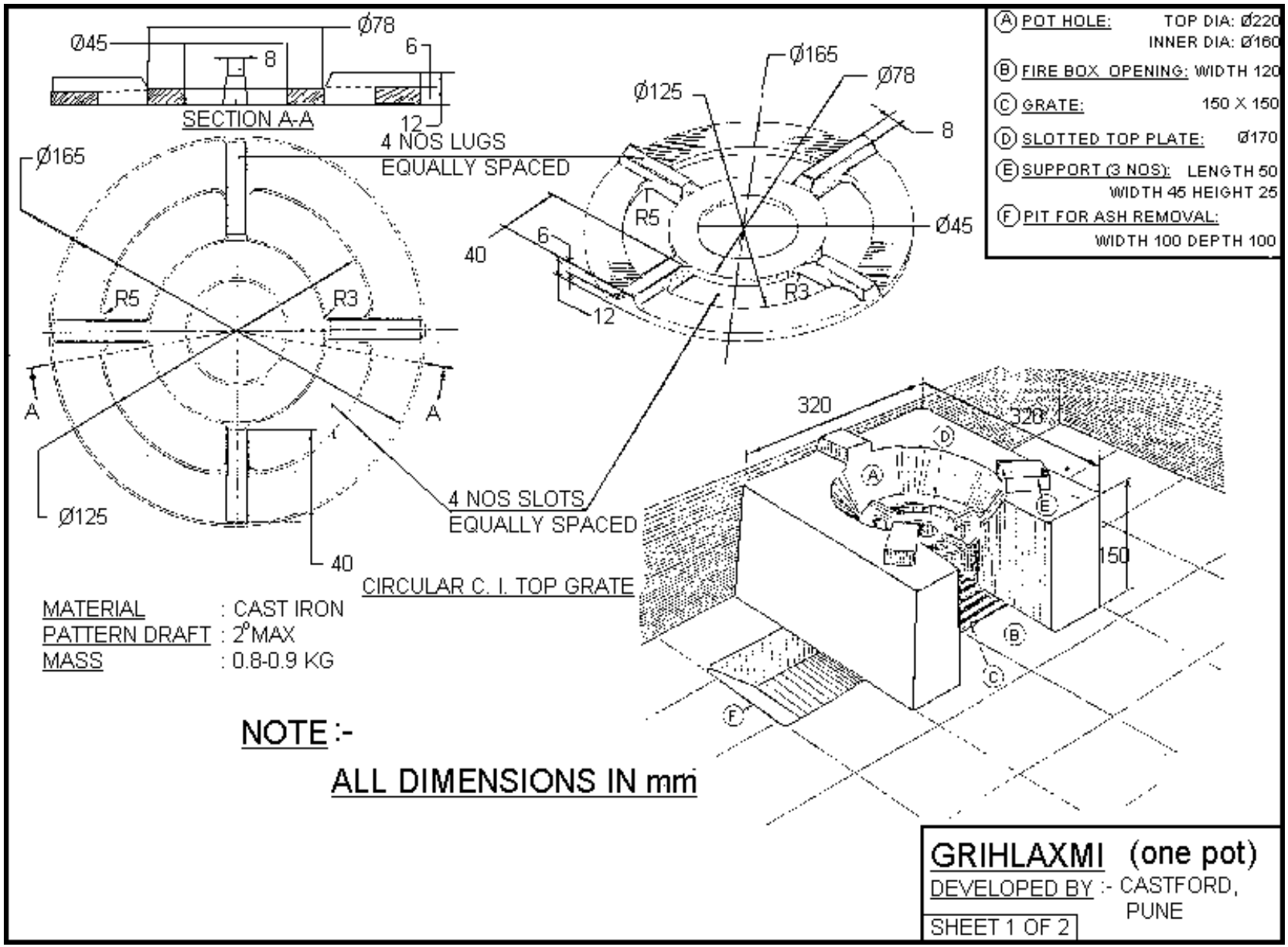
The model was developed in 1990 at the Technical Back-up Unit, CASTFORD, Indian Institute of Education, 128/2, Karve Road, Kothrud, Pune -411029.

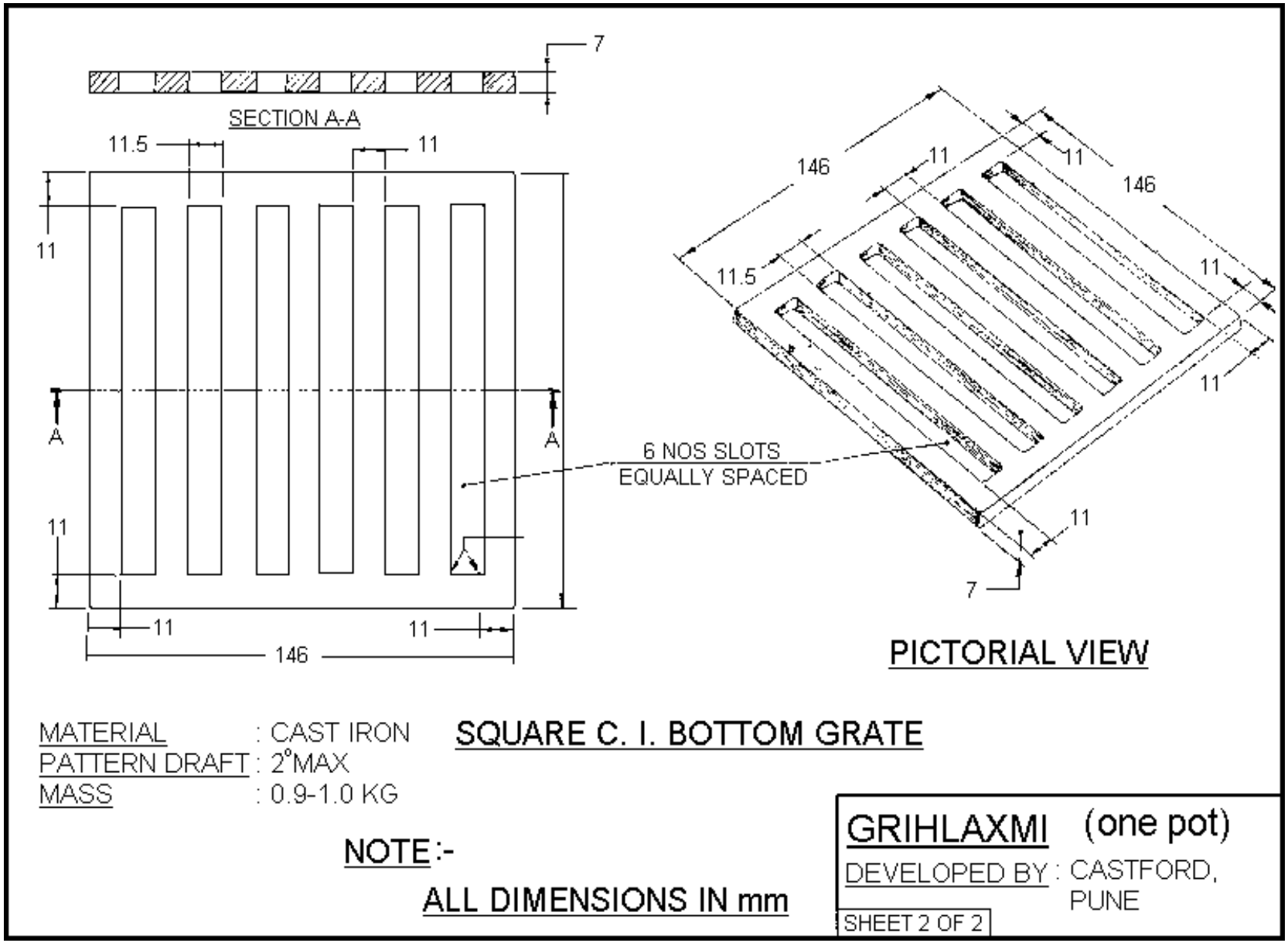
The Grihlaxmi is a single-pot mud stove without chimney, suitable for small family cooking (3-5 members) in the States of Maharashtra, Goa and Karnataka. The stove is capable of cooking traditional foods such as rice, pulses, vegetables etc and the baking of traditional pancakes (*marathi/ bhakari*) using fuelwood, twigs and agri-residues in stick form (e.g. cotton stalk, pigeon pea stalk, sugar cane butt). The stove has two standardized parts, namely, the metal-rod grate and the slotted cast- iron top-plate, for converging the flame as well as improving the combustion of volatile matters. The stove can be conveniently constructed by a semi-skilled worker using local clay material and iron moulds. The design can accommodate pots 18-22 cm in diameter or larger. So far, 25,000 stoves have been disseminated throughout the country. The production cost estimate is Rs. 30-42 (US$ 1.2-1.7).

Special features: a non-chimney low cost design that can be produced centrally and distributed to various beneficiaries. Due to its low cost, the model is popular amongst the weaker section of the society.

For general specifications and test performance: please refer to table 1.1.

Technical drawings: see below.


Ø45
Ø78
8
6
12
SECTION A-A
4 NOS LUGS
EQUALLY SPACED
Ø165
Ø125
R5
R3
A
A
40
4 NOS SLOTS
EQUALLY SPACED
CIRCULAR C. I. TOP GRATE
Ø165
Ø78
8
Ø125
R5
Ø45
40
6
12
R3
320
320
150
A POT HOLE: TOP DIA: Ø220
INNER DIA: Ø160
B FIRE BOX OPENING: WIDTH 120
C GRATE: 150 X 150
D SLOTTED TOP PLATE: Ø170
E SUPPORT (3 NOS): LENGTH 50
WIDTH 45 HEIGHT 25
F PIT FOR ASH REMOVAL:
WIDTH 100 DEPTH 100
MATERIAL : CAST IRON
PATTERN DRAFT : 2°MAX
MASS : 0.8-0.9 KG
NOTE :-
ALL DIMENSIONS IN mm
GRIHLAXMI (one pot)
DEVELOPED BY :- CASTFORD, PUNE
SHEET 1 OF 2



PICTORIAL VIEW

MATERIAL : CAST IRON
PATTERN DRAFT : 2°MAX
MASS : 0.9-1.0 KG

SQUARE C. I. BOTTOM GRATE

NOTE:-

ALL DIMENSIONS IN mm

GRIHLAXMI (one pot)

DEVELOPED BY : CASTFORD, PUNE

SHEET 2 OF 2

3.11 HARSHA

The model was developed in 1990 at the Technical Back-up Unit, Regional Research Laboratory, Bhubaneswar, Orissa.

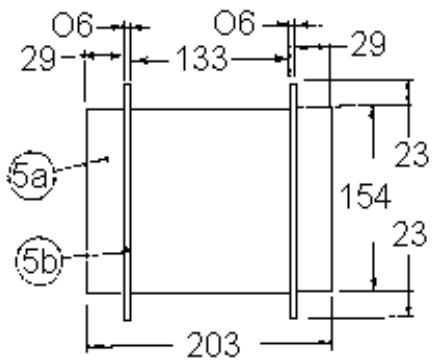
The Harsha is a portable, metallic, single-pot stove without chimney, designed as an alternative to the Priagni stove (presented in section 21) that was specifically suitable for fuelwood only. Accordingly, the TBU at RRL developed this design for multi-fuel operation which is normally encountered in rural India. Besides fuelwood, the Harsha can be used with dung cakes and a variety of agri-residues or with various fuel combinations. It can be used with vessels of diameter 18-26 cm.

The model, with a corrugated grate design with scraper (for periodical ash removal), can be manufactured by small shops having facilities for welding, cutting, grinding and punching sheet metal up to a thickness of 3mm. This stove is gaining popularity and a large number of manufacturers have started making it. The model was brought under the NPIC only two years ago. However, nearly 50,000 stoves have been disseminated in many States, especially Orissa, Himachal Pradesh, Punjab, Uttar Pradesh and Maharashtra. The production cost estimate is Rs. 144 (US$ 5.7).

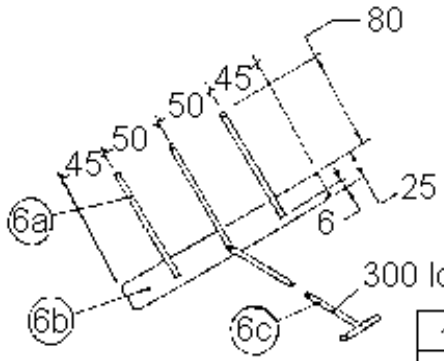
Special features: portable, multi- fuel design.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

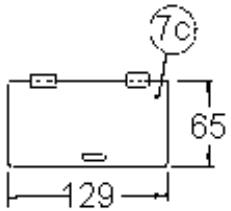
Technical drawings: see below.

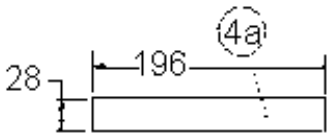


BOTTOM PLATE

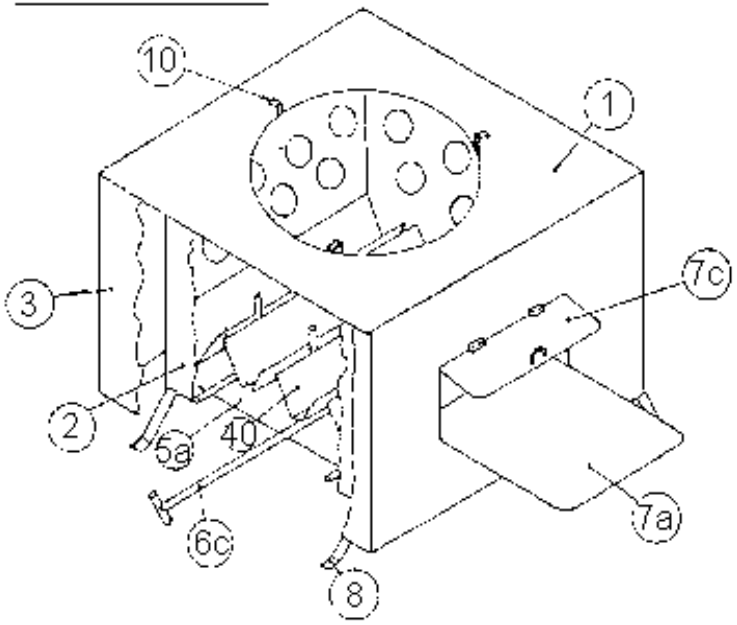


ASH SCRAPER ASSY





GRATE PLATE



PART NO	DESCRIPTION	REQD	mm THICKNESS	KG WEIGHT	REMARKS
10	VESSEL SUPPORT	3	3X19 FLAT	0.060	
9	HANDLE	2	3X19 FLAT	0.188	
8	LEG	4	3X19 FLAT	0.161	
7c	HINGED PLATE	1	1	0.066	SCRAP OF PART 3
7b	PLATE	1	1	0.059	
7a	WOOD SUPPORT PLATE	1	1.6	0.21	SCRAP OF PART 1
6c	ROD	1	Ø6	0.066	
6b	PLATE	1	2	0.075	
6a	ASH SCREPER FINGER	3	Ø6	0.064	
5b	ROD	2	Ø6	0.089	
5a	BOTTOM PLATE	1	1	0.245	
4b	ROD	4	Ø6	0.175	
4a	GRATE PLATE	8	2	0.692	
4	GRATE	1	2	0.867	
3	JACKET	1	1	1.480	
2	COMBUSTION CHAMBER	1	1.6	1.826	
1	TOP PLATE	1	1.6	0.862	

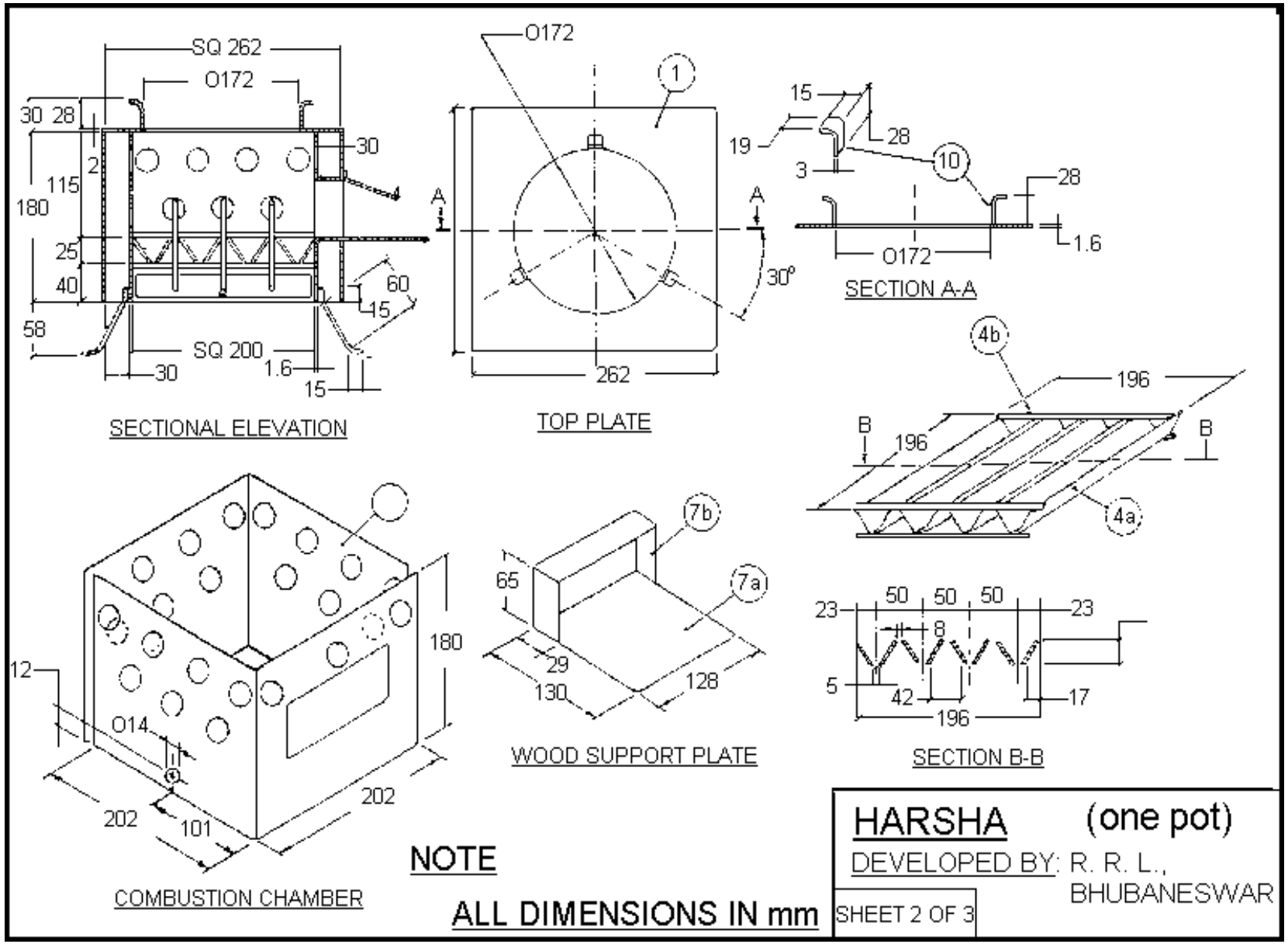
NOTE :-

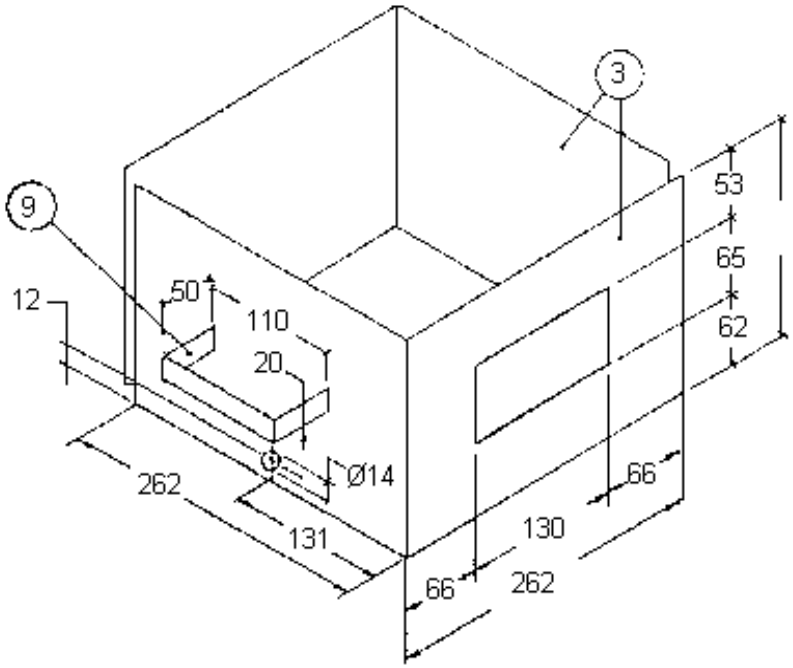
ALL DIMENSIONS IN mm

HARSHA (one pot)

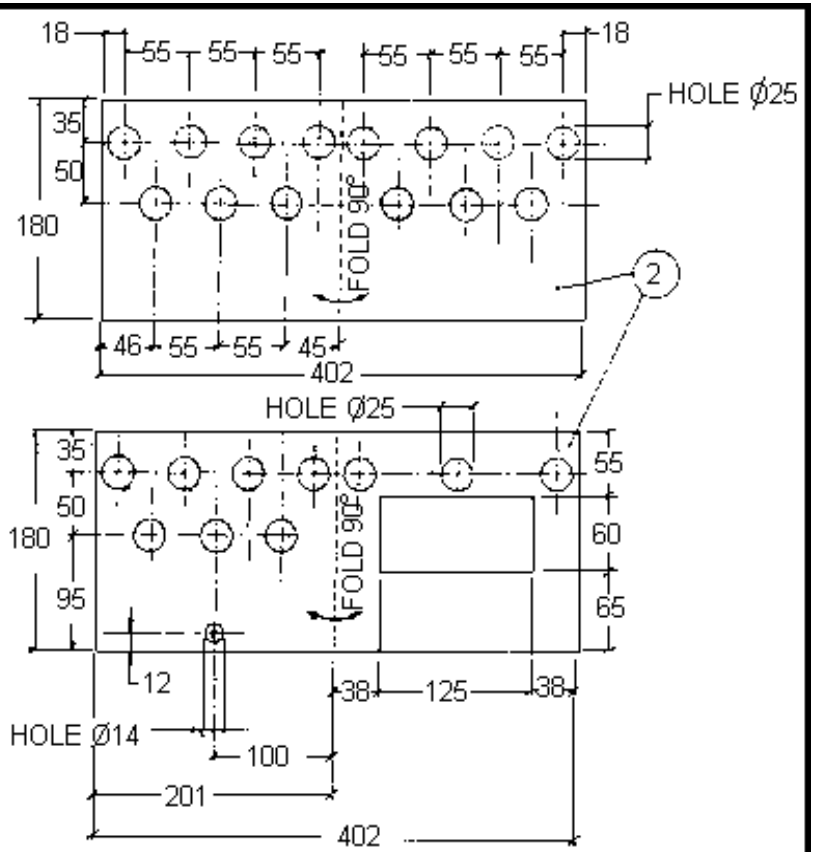
DEVELOPED BY: R. R. L., BHUBANESWAR

SHEET 1 OF 3


SQ 262
O172
30 28
2
115
180
25
40
58
30
SQ 200
30
1.6
15
60
15
SECTIONAL ELEVATION
O172
1
A
A
262
30°
TOP PLATE
15
19
28
3
10
28
1.6
O172
SECTION A-A
4b
196
B
196
B
4a
12
O14
180
202
101
202
COMBUSTION CHAMBER
7b
7a
65
29
130
128
WOOD SUPPORT PLATE
23
50
50
50
23
8
5
42
17
196
SECTION B-B
NOTE
ALL DIMENSIONS IN mm
HARSHA (one pot)
DEVELOPED BY: R. R. L., BHUBANESWAR
SHEET 2 OF 3



JACKET



COMBUSION CHMBER

NOTE

1. ALL DIMENSIONS IN mm
2. MASS OF FINISHED STOVE: 5.6 kg
3. TOTAL MASS OF M.S. REQD FOR FABRICATION: 6.04 + 3% SCAP = 6.22 kg
4. MATL: MILD STEEL (M.S.)
5. ASH SCRAPER CAN BE PROVIDED ON EITHER SIDE OF CHULA
6. WELDING: MIN FILLET: 3.5 mm; LENGHT: 6 mm
   DISTANCEBETWEEN WELDING SPOTS: 40 mm
7. PATENTED DESIGN

HARSHA (one pot)

DEVELOPED BY: R. R. L., BHUBANESWAR

SHEET 3 OF 3

3.12 JANTA

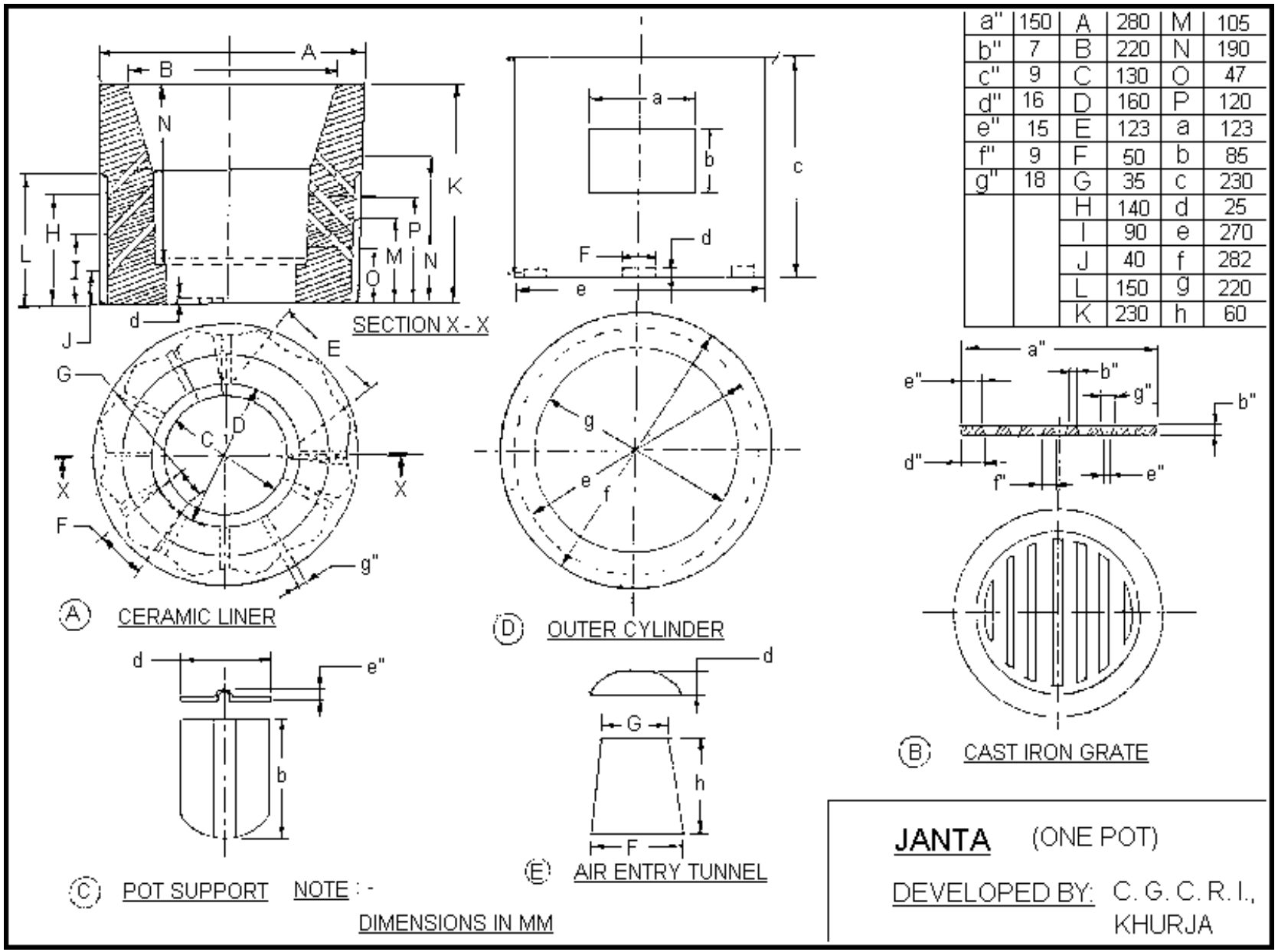
The model was developed in 1991 at the Technical Back-up Unit, Central Glass & Ceramic Research Institute, Khurja, Uttar Pradesh.

The Janta is a single-pot portable, metal-clad, ceramic lined, stove without chimney, with very high thermal efficiency (highest reported in India). This feature is attributable to a special ceramic liner design and the provision of steep secondary air holes around the ceramic wall to enhance complete combustion. The metal-clad is provided for stove strength during use and tranport and also to help regulate the secondary air. The stove can be produced at village level by potters and small sheet metal shops. The cost is relatively low as compared with other metallic portable stoves. Though the stove was primarily designed for fuelwood, it can also accomodate other fuels in stick form.

Due to its very recent development, only about 1,000 units have been introduced. The feed- back has been very encouraging and the model has since been brought under the NPIC for dissemination. It is suitable for a medium-size family and can accommodate pots 22-28 cm in diameter. The production cost estimate is Rs. 100 (US$ 4).

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.



a"	150	A	280	M	105
b"	7	B	220	N	190
c"	9	C	130	O	47
d"	16	D	160	P	120
e"	15	E	123	a	123
f"	9	F	50	b	85
g"	18	G	35	c	230
		H	140	d	25
		I	90	e	270
		J	40	f	282
		L	150	g	220
		K	230	h	60

3.13 KESARI-200

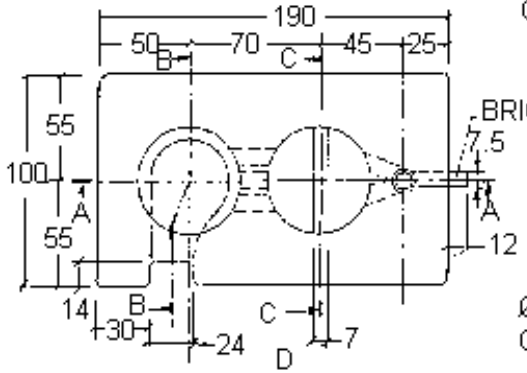
The model was developed in 1988 at Technical Back-up Unit, Centre for Rural Development and Appropriate Technology, IIT New Delhi - 110016.

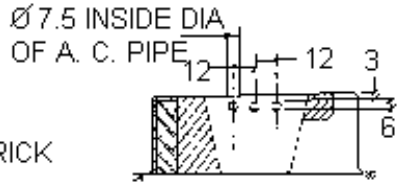
The Kesari is a two-pot mud stove with chimney, suitable for large community cooking (up to 200 persons at a time) using fuelwood as a main fuel. It has no door damper but has a controlled design of the connecting tunnel and a baffle at the center of the second pot hole to extract maximum heat from flue gases to the pot. It can accommodate flat bottom utensils 60-70 cm. in diameter. However, the model can be made in other sizes or power output to meet specific cooking requirements.

The stove is normally constructed with brick by a common brick laying technique using mud mortar along with standard items such as asbestos chimney pipe, flue tunnels, grate and chimney cap. It has found acceptance in community kitchens, hostels, police and para-military units etc. So far 5,000 stoves have been disseminated throughout the country. The production cost estimate is Rs. 100 (US$ 4) plus the cost of bricks.

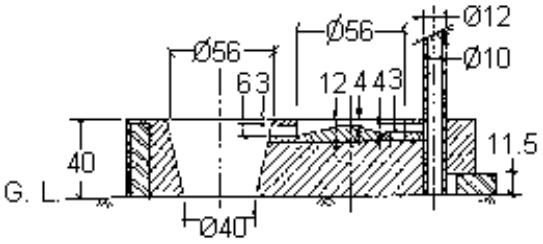
For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.



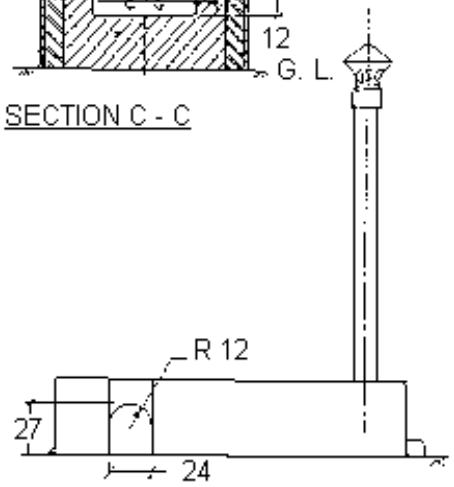


SECTION B - B



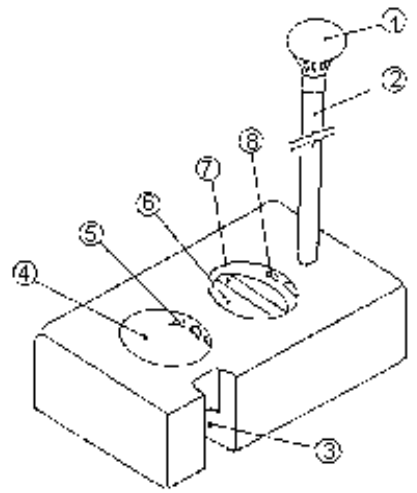
SECTION A - A

SECTION C - C



VIEW D

1. CONE CAP COWL
2. ASBESTOS CEMENT CHIMNEY PIPE
3. FIRE BOX
4. FIRST POT HOLE
5. FIRST TUNNEL
6. SECOND POT HOLE
7. BAFFLE
8. SECOND TUNNEL



NOTE : -

ALL DIMENSIONS IN cm

BRICK WORK

CLAY MIXTURE

KESARI - 200 (two pot)

DEVELOPED BY R. D. & A. T. CENTER, I. I. T., DELHI

SHEET 1 OF 2

3.14 LAXMI

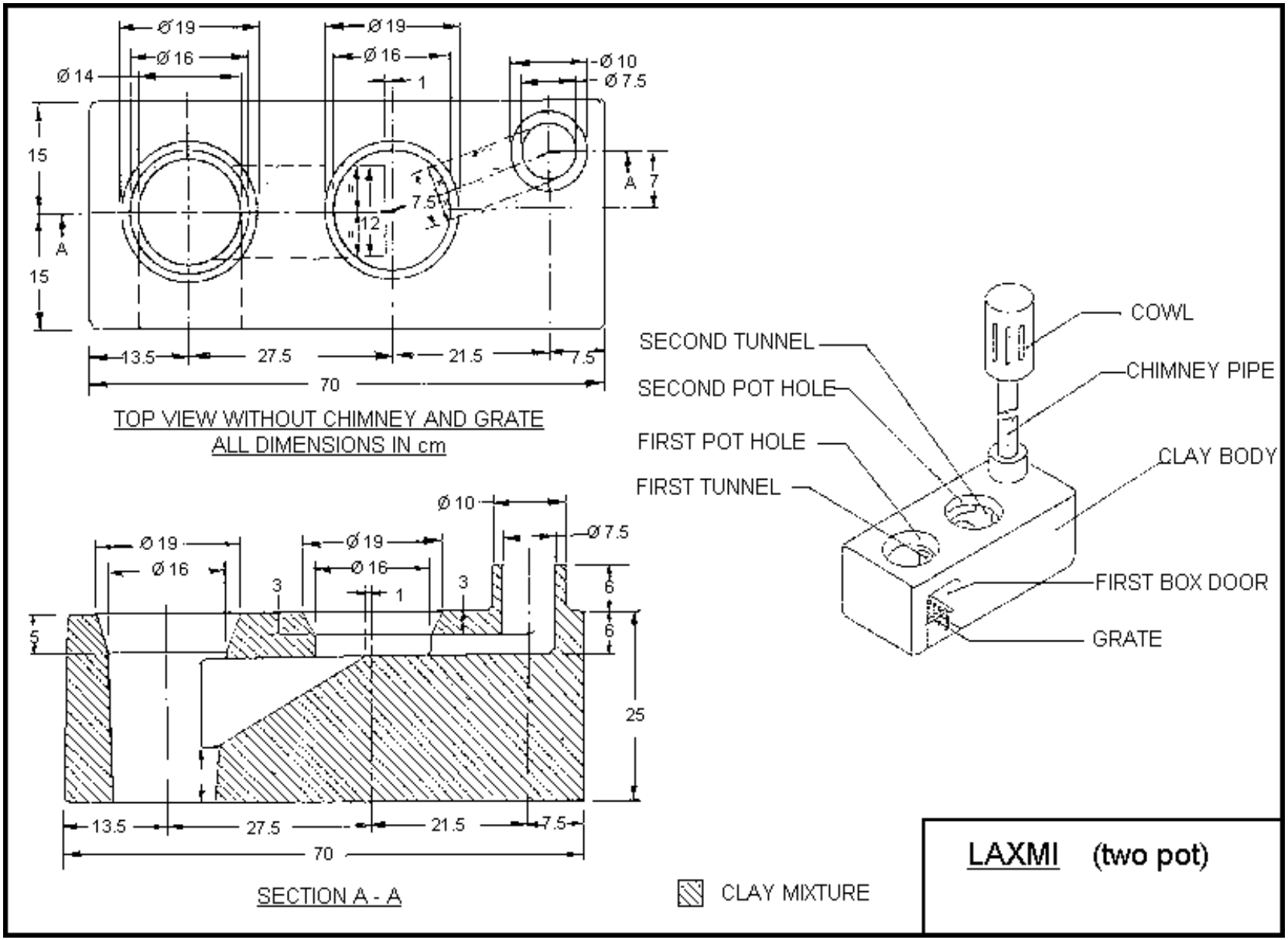
The model was developed in 1986 at the Technical Back-up Unit, Centre for Application of Science and Technology for Rural Development (CASTFORD), Indian Institute of Education, 128/2, J.P. Naik Path, Kothrud, Pune - 411029.

The Laxmi, a two-pot mud stove with chimney, was specifically designed for Western India, particularly for the States of Maharashtra, Goa and Gujarat where baking of *marathi* and *bhakari* (traditional pancake) is common, besides boiling and steaming. The stove can be used with fuelwood, twigs, agri-residues and dung cakes. The design can accommodate pots 18-26 cm. in diameter.

The stove can be constructed with clay and some ready-made parts such as a pottery liner combustion chamber, connecting tunnels, chimney pipe, cowl and metal grate. So far, nearly one million stoves have been disseminated in Maharashtra, Goa, Karnataka and Gujarat. The production cost estimate is Rs. 70-87 (US$ 2.8-3.5).

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


Ø 19
Ø 16
Ø 14
Ø 19
Ø 16
1
Ø 10
Ø 7.5
15
A
7
7.5
12
A
15
13.5
27.5
21.5
7.5
70
TOP VIEW WITHOUT CHIMNEY AND GRATE
ALL DIMENSIONS IN cm
Ø 10
Ø 19
Ø 16
Ø 19
Ø 16
Ø 7.5
3
1
3
6
6
5
25
13.5
27.5
21.5
7.5
70
SECTION A - A
COWL
SECOND TUNNEL
CHIMNEY PIPE
SECOND POT HOLE
FIRST POT HOLE
CLAY BODY
FIRST TUNNEL
FIRST BOX DOOR
GRATE
CLAY MIXTURE
LAXMI (two pot)

3.15 MAMTA

The model was developed in 1989 at the Technical Back-up Unit, Department of Home Science, M.S. University, Baroda - 390002, Gujrat.

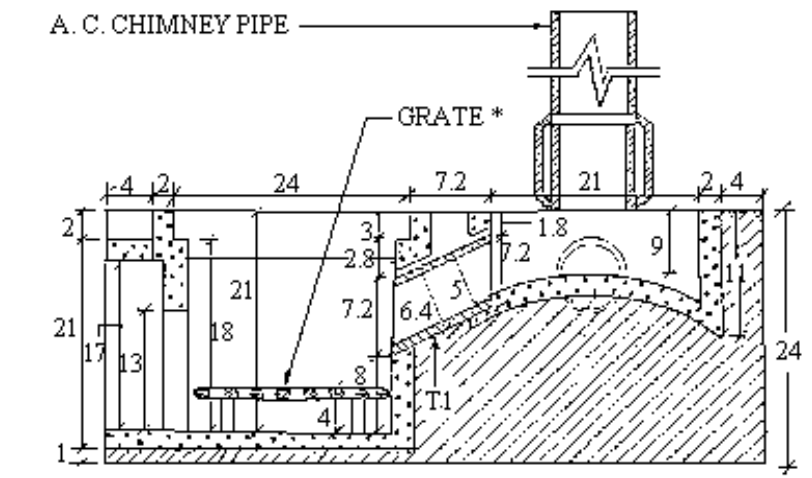
The Mamta is a two-pot mud stove with chimney that can be used for baking *rotla* (traditional bread), in addition to normal cooking in the western States. The design can accommodate spherical and flat bottom vessels 22-28 cm. in diameter. However, a reducer ring can be used for facilitating cooking with smaller vessels. The stove can be used with fuelwood, twigs, dung cakes, agri-residues or combinations of fuels.

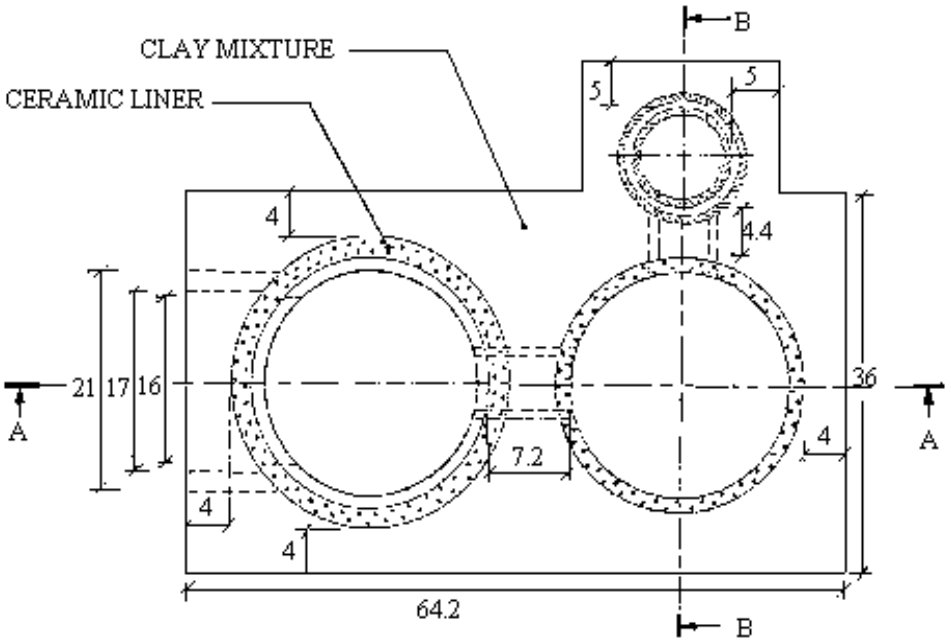
The model can be constructed by trained SEWs. Pottery liners can also be installed for combustion chamber and tunnels along with metal grate and asbestos chimney pipe and cowl. It is popular in Gujarat and Karnataka and so far over 100,000 stoves have been disseminated. The production cost estimate is Rs. 55-72 (US$ 2.2-2.9).

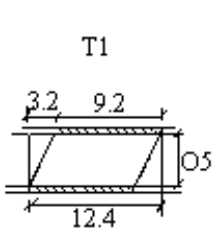
Special features: suitable for baking of *rotla* (23-28 cm. in size) using stepped construction of the combustion chamber.

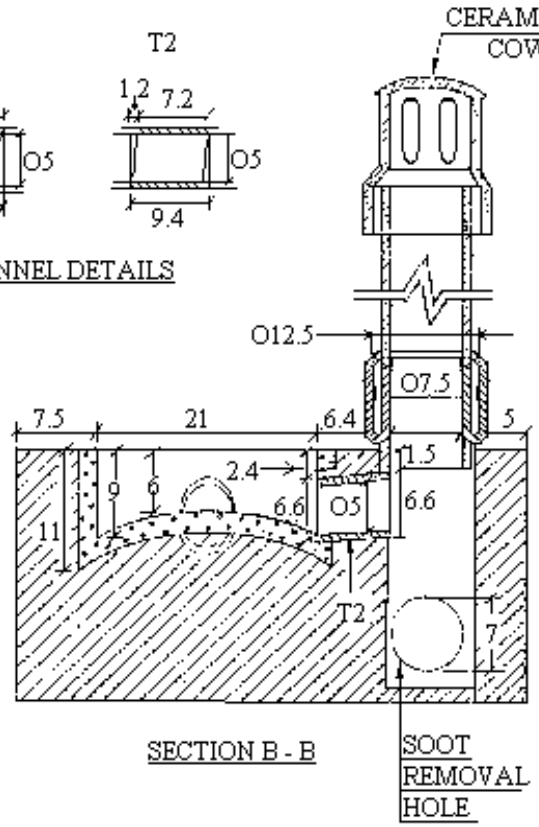
For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.









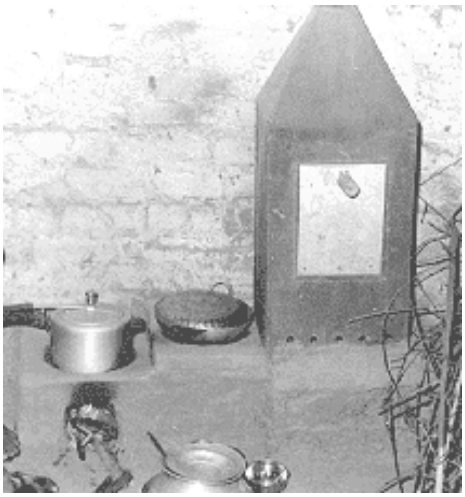
NOTE : -

ALL DIMENSIONS IN cm

MAMTA (two pot)

DEVELOPED BY : - H. M. D., M. S. UNIV. BARODA

3.16 MEGHALAYA



This stove model was developed in 1987 by the Nodal Agency of Meghalaya in cooperation with the Technical Back-up Unit, Centre for Rural Development and Technology, Indian Institute of Technology, Hauz Khas, New Delhi -110016.

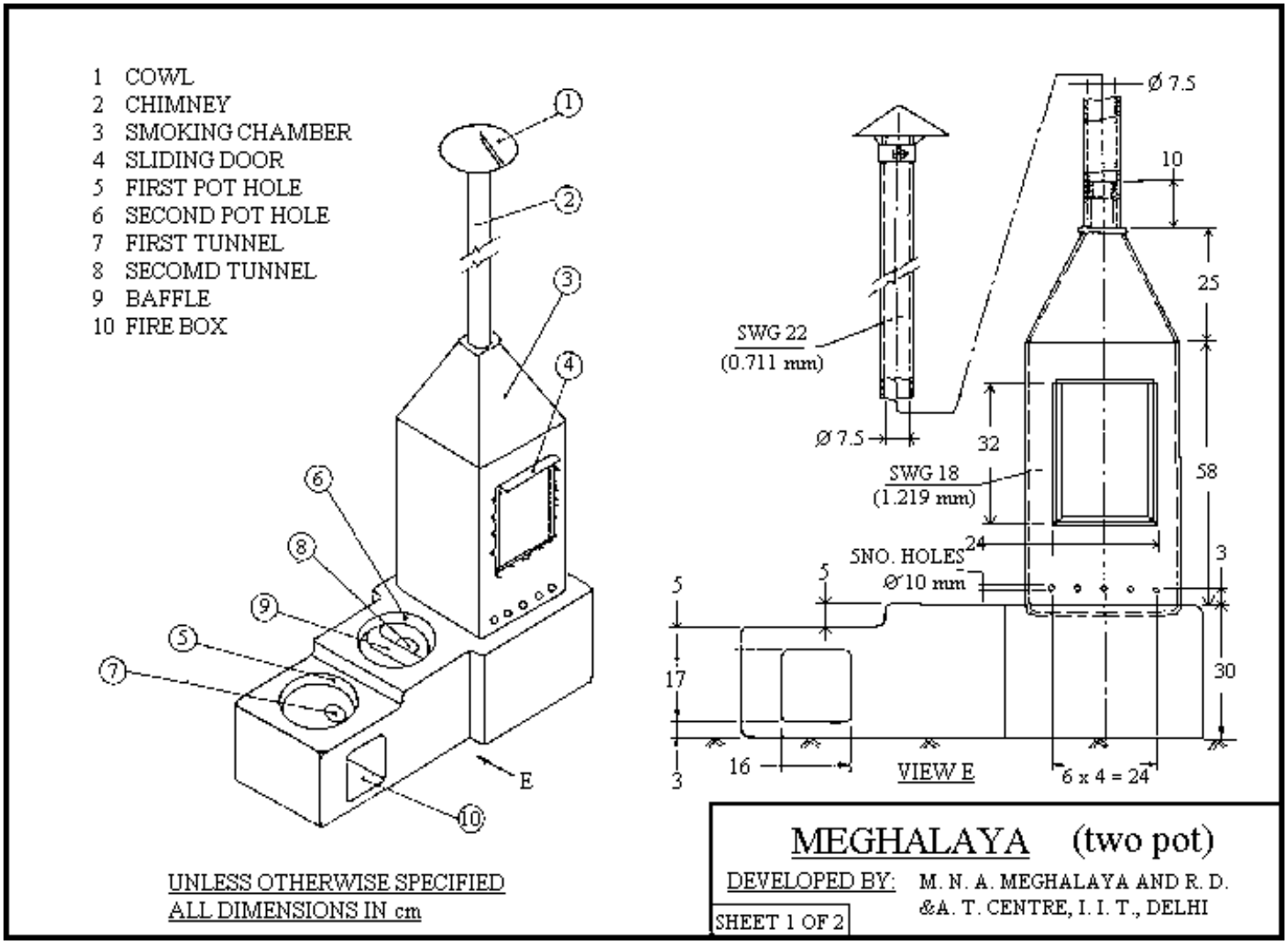
The Meghalaya is a two-pot mud stove with chimney, designed particularly for the north-eastern parts of India where smoking of fish and meat is a traditional practice. Ordinary improved stoves with chimney did not finding acceptance as they did not specifically cater to this practice. A smoking chamber was therefore designed and connected to the tunnel (after the second pot-hole) prior to exiting to the chimney. Inside the chamber several hooks for hanging fish/meat during smoking are provided. The stove is normally used with fuelwood which is easily available in the north-eastern parts of the country. However, agri-residues, preferably in stick form, can also be used.

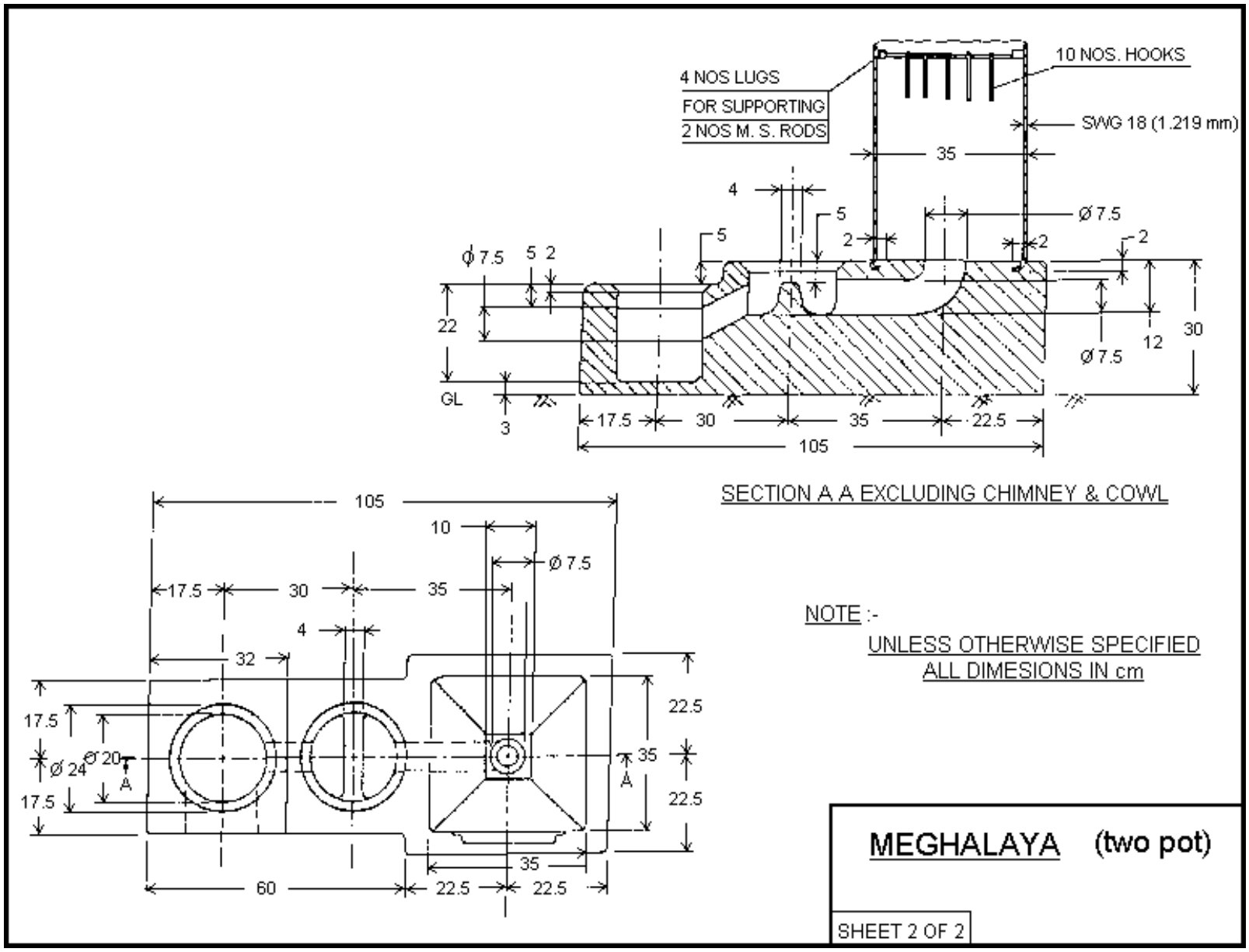
The stove can be constructed by the SEWs or semi-skilled workers using locally available clay material or the combustion chamber can be formed with the pottery liner. The smoking chamber and chimney parts are made of sheet metal and need to be manufactured in a workshop. The stove can accommodate spherical and flat bottom vessels 22-28 cm. in diameter. Nearly 10,000 stoves have been disseminated in the north-eastern States. The production cost estimate is Rs. 93-110 (US$ 3.7-4.4).

Special features: the design incorporates a smoking chamber used for traditional smoking of fish and meat to prolong shelf life.

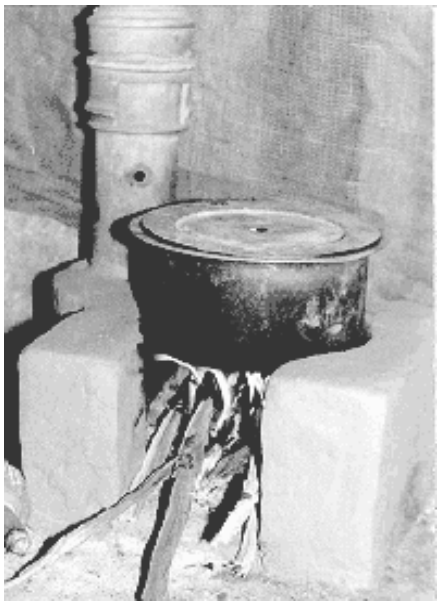
For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


1 COWL
2 CHIMNEY
3 SMOKING CHAMBER
4 SLIDING DOOR
5 FIRST POT HOLE
6 SECOND POT HOLE
7 FIRST TUNNEL
8 SECOMD TUNNEL
9 BAFFLE
10 FIRE BOX
E
Ø 7.5
10
25
SWG 22
(0.711 mm)
Ø 7.5
32
SWG 18
(1.219 mm)
58
24
5NO. HOLES
Ø10 mm
3
5
5
17
30
3
16
VIEW E
6 x 4 = 24
UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS IN cm
MEGHALAYA (two pot)
DEVELOPED BY: M. N. A. MEGHALAYA AND R. D. &A. T. CENTRE, I. I. T., DELHI
SHEET 1 OF 2


4 NOS LUGS
FOR SUPPORTING
2 NOS M. S. RODS
10 NOS. HOOKS
SWG 18 (1.219 mm)
35
4
5
Ø 7.5
2
2
2
5
ϕ 7.5
5 2
22
GL
3
17.5
30
35
22.5
105
12
30
Ø 7.5
105
10
Ø 7.5
17.5
30
35
4
32
17.5
Ø 24
Ø 20
A
17.5
22.5
35
22.5
A
35
60
22.5
22.5
SECTION A A EXCLUDING CHIMNEY & COWL
NOTE :-
UNLESS OTHERWISE SPECIFIED
ALL DIMESIONS IN cm
MEGHALAYA (two pot)
SHEET 2 OF 2

3.17 MOHINI-U



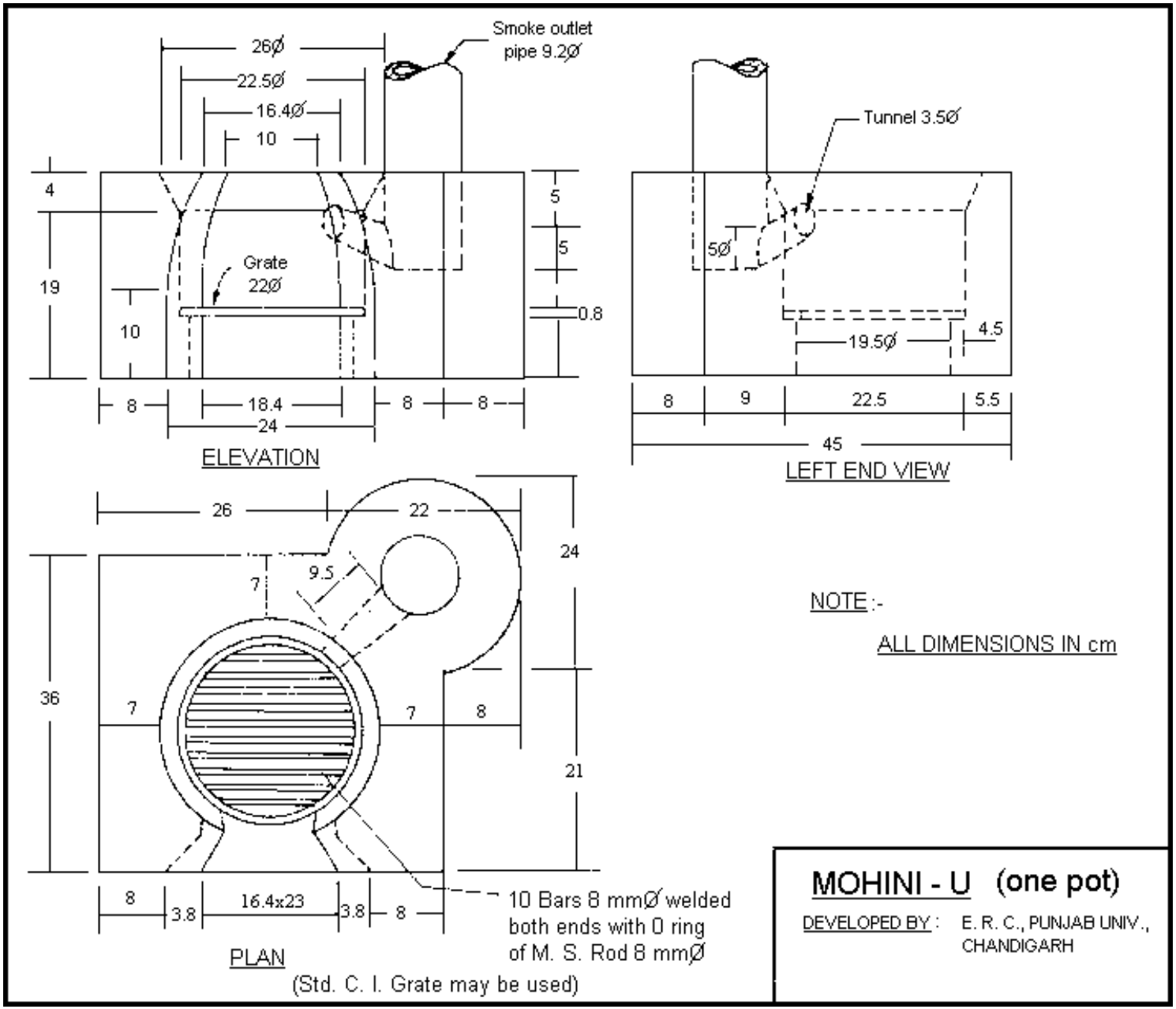
The model was developed in 1990 at the Technical Back-up Unit, Energy Research Centre, Punjab University, Chandigarh - 160014.

The Mohini-U is a single-pot, pottery lined mud stove with chimney, incorporating all critical features of single-pot models being used in northern India and capable of burning fuelwood, dung cakes and agri-residues. The stove which has a power output of about 1 kW, is suitable for medium size (5-8 members) family cooking and baking of *roti* (large size local bread) which is a common food in northern India. The stove can accomodate spherical and flat bottom vessels 22-25 cm. in diameter.

The stove can be constructed by trained SEWs using locally available clay material employing metallic moulds. The model has found wide acceptance in Haryana, Punjab and Rajasthan. So far, about 20,000 units have been disseminated in these States. The production cost estimate is Rs. 70-82 (US$ 2.8-3.3).

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


Smoke outlet pipe 9.2Ø
26Ø
22.5Ø
16.4Ø
10
4
19
10
Grate 22Ø
5
5
0.8
8
18.4
8
8
24
ELEVATION
Tunnel 3.5Ø
5Ø
19.5Ø
4.5
8
9
22.5
5.5
45
LEFT END VIEW
26
22
24
9.5
7
36
7
7
8
21
8
3.8
16.4x23
3.8
8
PLAN
10 Bars 8 mmØ welded both ends with O ring of M. S. Rod 8 mmØ
(Std. C. I. Grate may be used)
NOTE :-
ALL DIMENSIONS IN cm
MOHINI - U (one pot)
DEVELOPED BY : E. R. C., PUNJAB UNIV., CHANDIGARH

3.18 NAV JYOTI

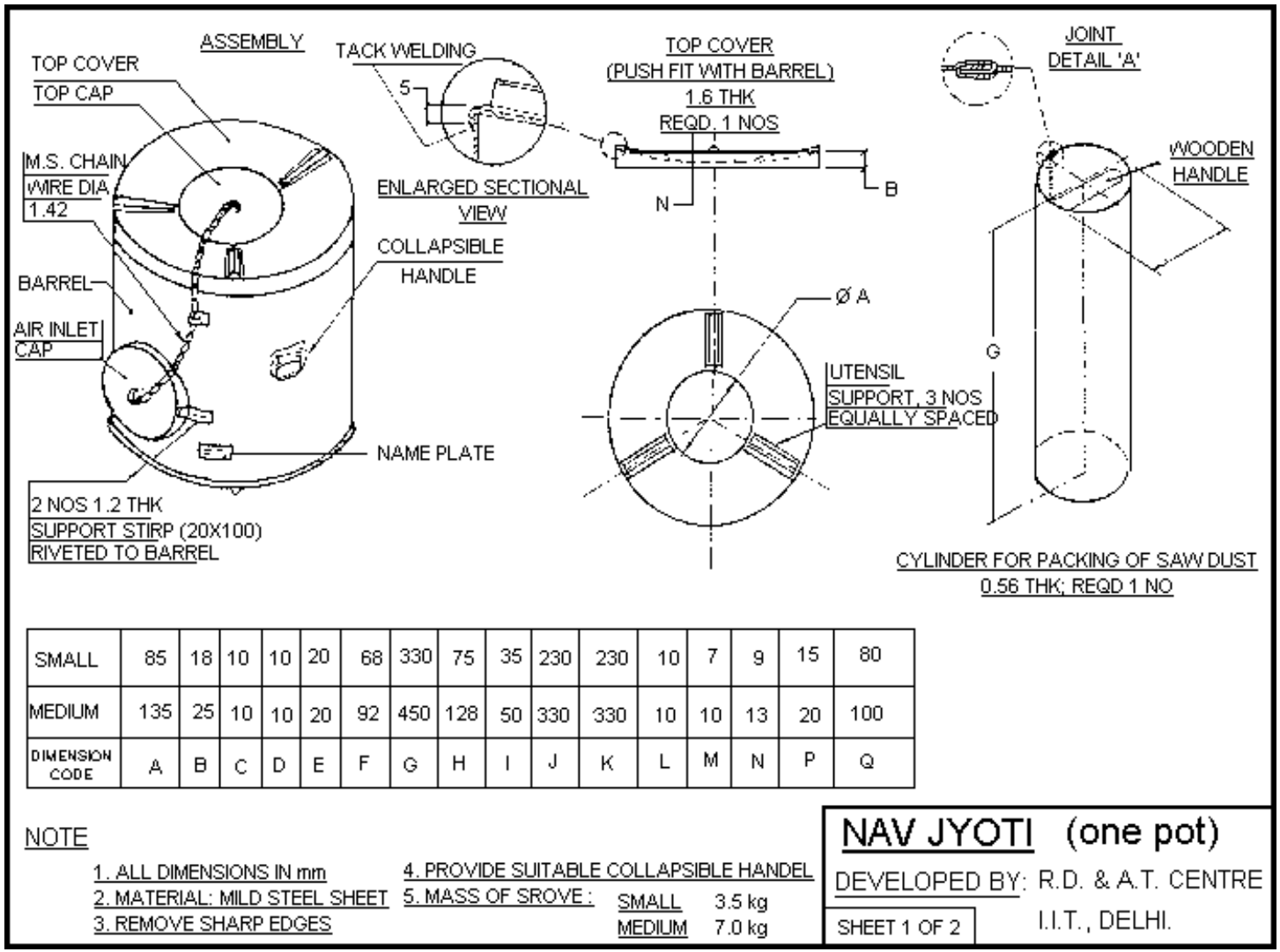
The model was developed in 1991 at the Technical Back-up Unit, Centre for Rural Development and Appropriate Technology, IIT, Hauz Khas, New Delhi - 110016. The illustration above shows a medium size version of the model.

Nav Jyoti is a single-pot, portable metal stove without chimney, primarily designed for low density biomass fuels such as sawdust, leaves, straws, paddy husk, twigs, cow dung etc. It is also possible to prepare standard size briquettes from these low density materials by mixing them with wet dung or clay and sun-drying them whereafter briquettes can be stored for subsequent use in this stove. The stove is suitable for the cooking requirements of a small family (3-5 members). This design is an improvement over the traditional model called, *angeethi*, adopted by rural people for use with loose fuels. Once the stove is fully packed (with fuel like sawdust), it is capable of cooking a meal for the whole family using flat-bottom pots with diameter 20-25 cm. A larger stove is also available for bigger families. The model was brought under the NPIC in 1991 and is becoming popular among poor people living near the forest areas of Maharashtra, Gujarat and Himachal Pradesh. Nearly 10,000 units have been distributed. The production cost estimates are Rs. 75 (US$ 3) and Rs. 158 (US$ 6.3) for small and medium size stoves, respectively.

Special features: the design is suitable for burning sawdust, leaves, rice husk and other low density biomass fuels, especially by the poorer section of the society.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.



SMALL	85	18	10	10	20	68	330	75	35	230	230	10	7	9	15	80
MEDIUM	135	25	10	10	20	92	450	128	50	330	330	10	10	13	20	100
DIMENSION CODE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	Q

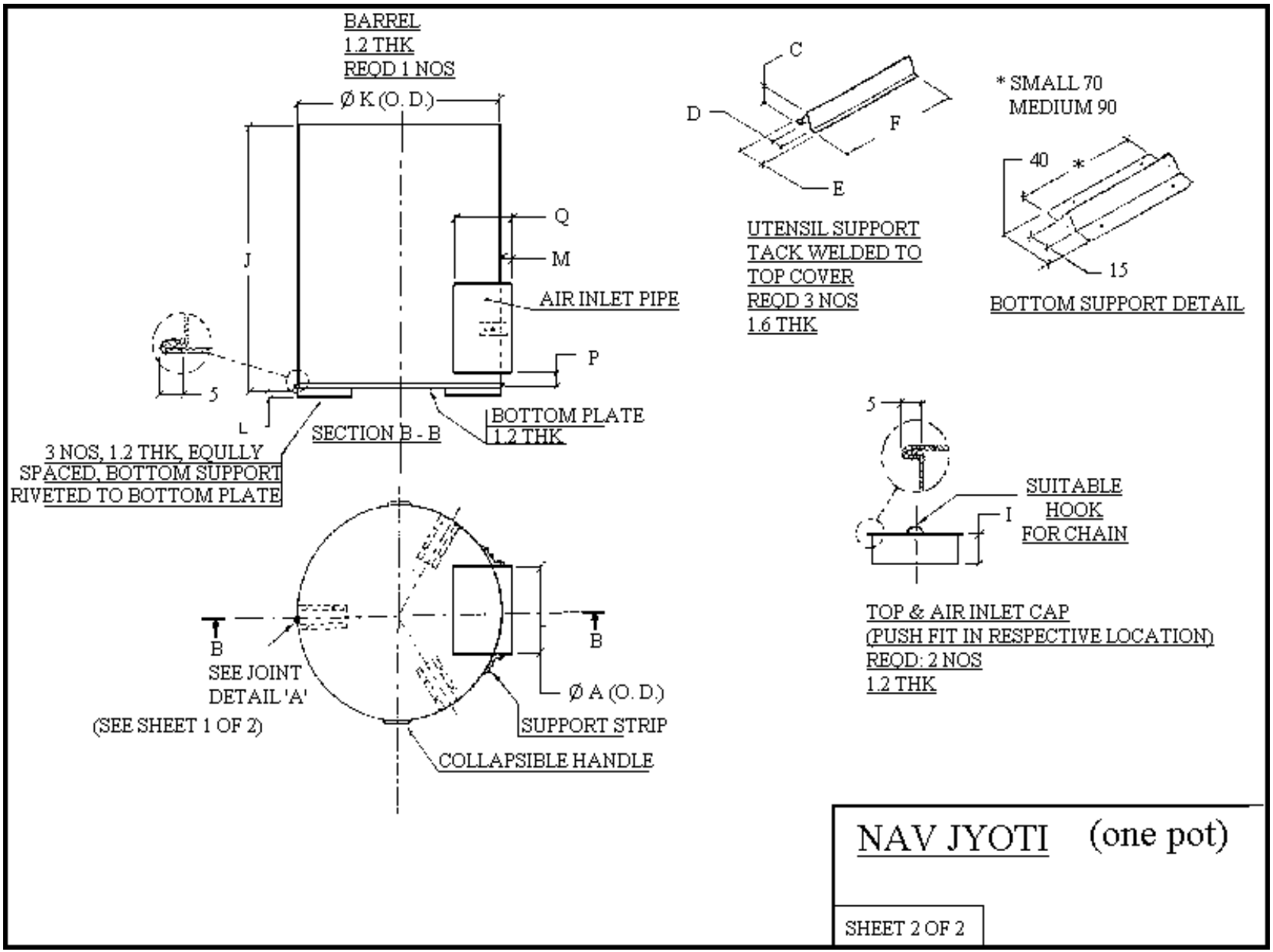
NOTE

1. ALL DIMENSIONS IN mm
2. MATERIAL: MILD STEEL SHEET
3. REMOVE SHARP EDGES
4. PROVIDE SUITABLE COLLAPSIBLE HANDEL
5. MASS OF SROVE : SMALL 3.5 kg
   MEDIUM 7.0 kg

NAV JYOTI (one pot)

DEVELOPED BY: R.D. & A.T. CENTRE
I.I.T., DELHI.

SHEET 1 OF 2


BARREL
1.2 THK
REQD 1 NOS
Ø K (O. D.)
J
Q
M
AIR INLET PIPE
P
5
L
SECTION B - B
BOTTOM PLATE
1.2 THK
3 NOS, 1.2 THK, EQULLY
SPACED, BOTTOM SUPPORT
RIVETED TO BOTTOM PLATE
B
SEE JOINT
DETAIL 'A'
(SEE SHEET 1 OF 2)
B
Ø A (O. D.)
SUPPORT STRIP
COLLAPSIBLE HANDLE
C
D
F
E
UTENSIL SUPPORT
TACK WELDED TO
TOP COVER
REQD 3 NOS
1.6 THK
* SMALL 70
MEDIUM 90
40
*
15
BOTTOM SUPPORT DETAIL
5
SUITABLE
HOOK
FOR CHAIN
I
TOP & AIR INLET CAP
(PUSH FIT IN RESPECTIVE LOCATION)
REQD: 2 NOS
1.2 THK
NAV JYOTI (one pot)
SHEET 2 OF 2

3.19 PARISHAD-21

The model was developed in 1986 by Kerala Sasthra Sahitya Parishad, Trivandrum in cooperation with the Technical Back-up Unit, Department of Mechanical Engineering, College of Engineering, Trivandrum, Kerala.

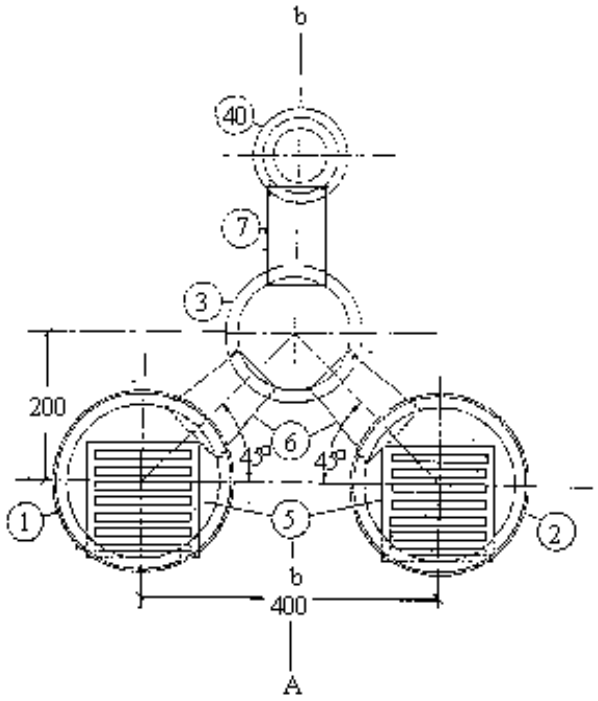
The Parishad is a three-pot, mud-brick stove with chimney for a medium size family (5-8 members). It can accommodate vessels 16-25 cm. in diameter. The model was developed over a period of time maintaining the traditional cooking requirements of the rural households of south India, especially Kerala and nearby areas. While coconut fronds and fuelwood are the main fuels, other agri-residues can also be used. The stove has two pottery lined combustion chambers, pottery tunnels, metal grates, asbestos chimney pipe and cowl.

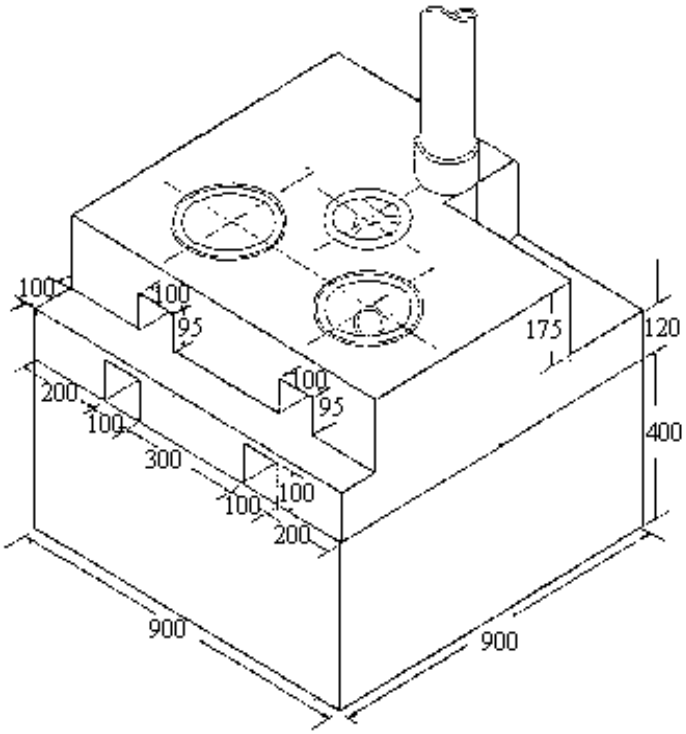
The stove is built on a brick high platform suitable for cooking in a standing position. A normal brick laying technique using mud mortar along with other standard items mentioned above is employed. So far, nearly 200,000 units of Parishad-200 have been disseminated in Kerala State. The production cost estimate is Rs. 95 (US$3.8).

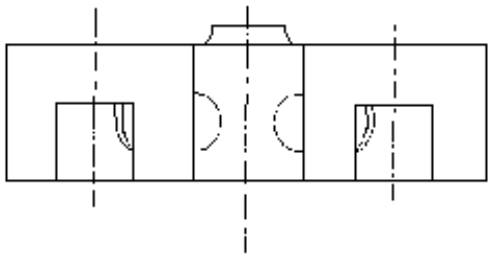
Special features: two front fire-boxes designed to meet the requirements of fast cooking using high power in the initial stage followed by low cooking power for simmering. The stove is designed for cooking in the standing position with sufficient area on top for keeping cooked food materials.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

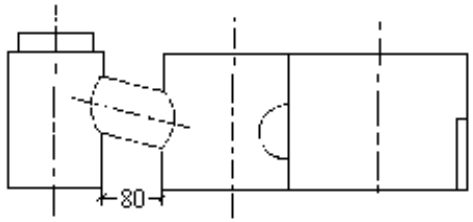
Technical drawings: see below.







VIEW A

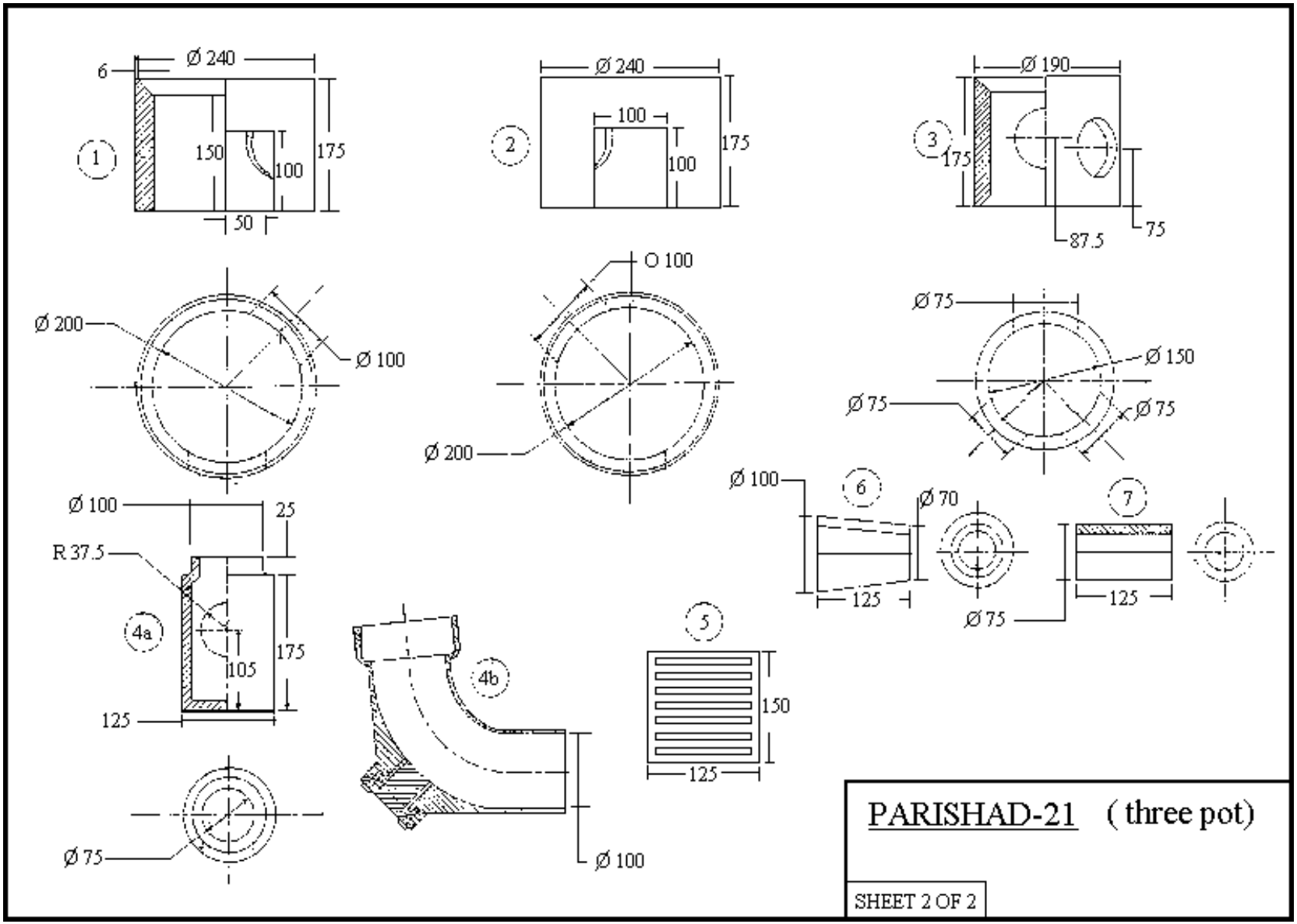


SECTION b - b

PARISHAD-21(three pot)

DEVELOPED BY: COLLEGE OF ENGG., TRIVANDRUM.

SHEET 1OF 2


6
Ø 240
1
150
100
175
50
Ø 240
100
2
100
175
Ø 190
3
175
87.5
75
Ø 200
Ø 100
O 100
Ø 200
Ø 75
Ø 150
Ø 75
Ø 75
Ø 100
6
Ø 70
125
Ø 75
7
125
Ø 100
25
R 37.5
4a
105
175
125
4b
5
150
125
Ø 75
Ø 100
PARISHAD-21 (three pot)
SHEET 2 OF 2

3.20 Pawan-II

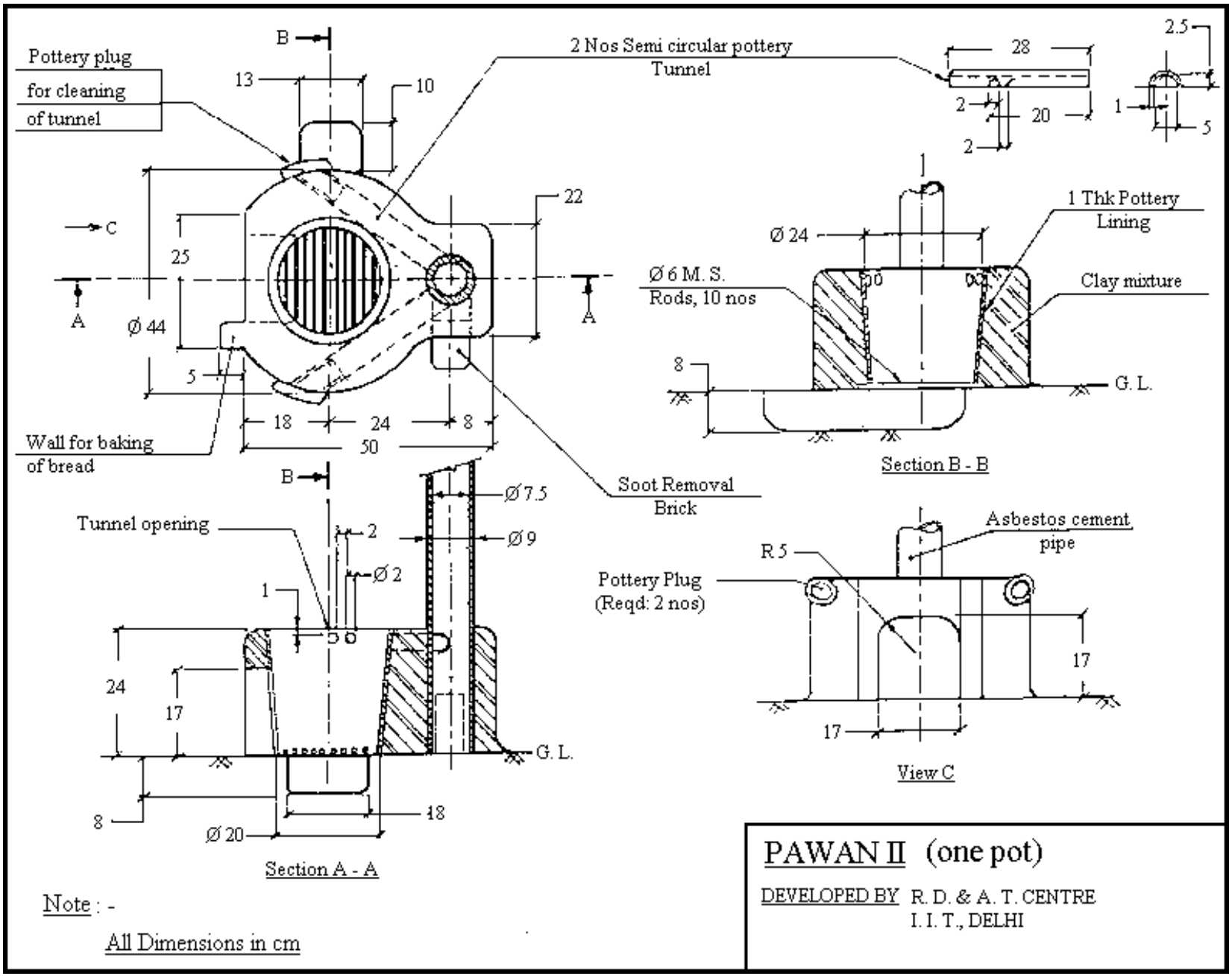
The model was developed in 1988 at the Technical Back-up Unit, Centre for Rural Development and Appropriate Technology, Indian Institute of Technology, Hauz Khas, New Delhi - 110016.

The Pawan is a single-pot, pottery lined mud stove with chimney, suitable for small family cooking (3-5 members) in the plains of northern India. It can be used with a variety of fuels like fuelwood, twigs, dung cakes, straws and other agri-residues. The stove has a bucket-like pottery lined combustion chamber, sufficiently large to accommodate the for an open-fire baking of *chapati* (local bread). It can also accommodate spherical and flat bottom pots 25-30 cm. in diameter. The smaller pots can also be used with the help of reducer rings.

The stove can be constructed by trained SEW using locally available materials with or without a pottery liner along with the asbestos chimney pipe, cowl and metal grate. Nearly 30,000 units have been disseminated in Uttar Pradesh, Delhi, Haryana and Rajasthan. The production cost estimate is Rs. 70-82 (US$ 2.8-3.3), including the chimney.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


Pottery plug
for cleaning
of tunnel
B
13
10
2 Nos Semi circular pottery
Tunnel
28
2
20
2
2.5
1
5
C
25
22
A
A
Ø 44
5
18
24
8
50
Wall for baking
of bread
Soot Removal
Brick
1
Ø 24
1 Thk Pottery
Lining
Ø 6 M. S.
Rods, 10 nos
Clay mixture
8
G. L.
Section B - B
B
Tunnel opening
2
Ø 7.5
Ø 9
Ø 2
1
24
17
G. L.
8
18
Ø 20
Section A - A
Asbestos cement
pipe
R 5
Pottery Plug
(Reqd: 2 nos)
17
17
View C
PAWAN II (one pot)
DEVELOPED BY R. D. & A. T. CENTRE
I. I. T., DELHI
Note : -
All Dimensions in cm

3.21 PRIAGNI

The model was developed in 1983 at the Central Power Research Institute, Bangalore, Karnataka.

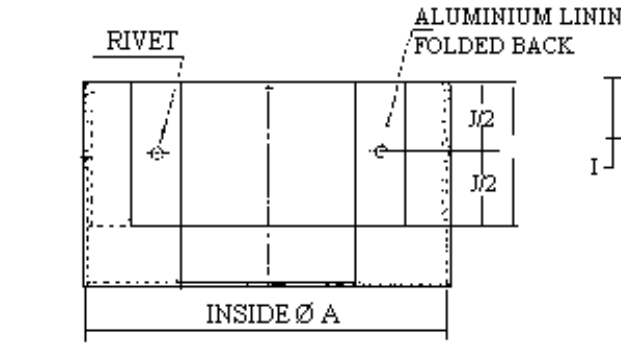
The Priagni is the most popular, portable, metallic, non-chimney woodstove. The stove has been adopted under the NPIC for over 10 years. Four types of material specifications are now standardized to ensured optimum life, efficiency and safety in use. Recently, the portable metal stove was brought under the Indian Standard (IS 13152, 1991).

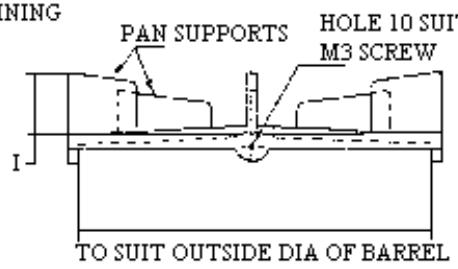
The Priagni stove is available in four sizes, namely, small, medium, large and extra large for catering to the requirements of different families/users. The stove, depending on its size, can accomodate pots 18-30 cm. in diameter. It can be fabricated by small scale industries having facilities for welding, cutting, grinding and punching sheet metal. So far, about 3 million stoves have been disseminated in all parts of the country. The stove is specifically suitable for fuelwood and twigs. The production cost estimate, depending on its size and material specifications, ranges from Rs. 105-188 (US$ 4.2-7.5).

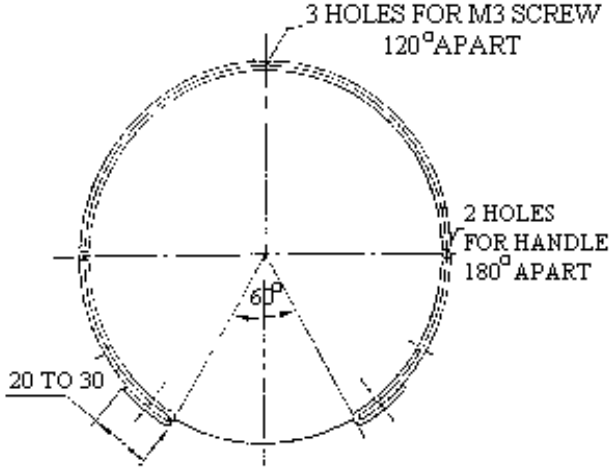
Special features: portable metal stove with combustion chamber provided with aluminium lining to enhance fast and sustainable initial combustion and fuel saving.

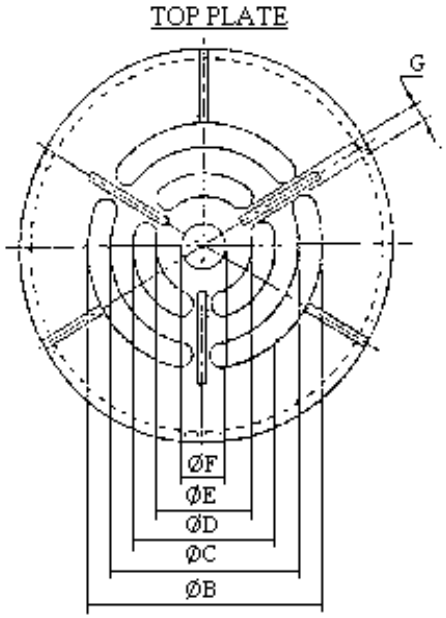
For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.





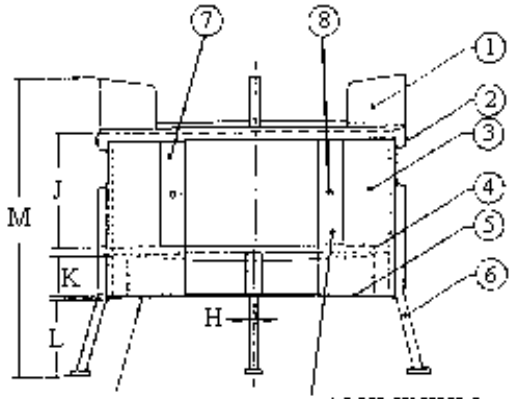




Part no	No	Description
8	2	Rivet
7	1	Aluminium Lining
6	3	Leg
5	1	Bottom Plate
4	1	Grate
3	1	Barrel
2	3	Screw
1	1	Top Plate

NOTE :-

ALL DIMENSIONS IN cm

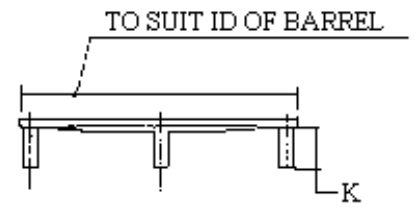


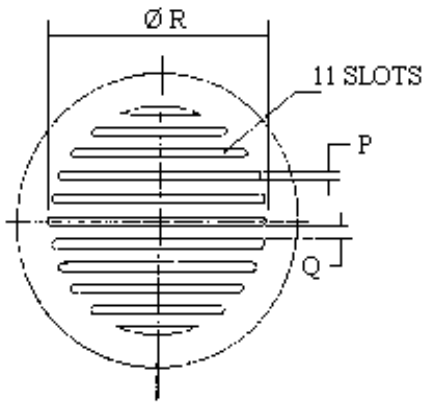
Dimension	A	B	C	D	E	F	G	I	J	K
Medium Size Type 2	240	160	128	96	64	28	12	40	88	33
Type 1	240	160	128	96	64	28	12	40	88	33
Large Size Type 1	300	200	160	120	80	35	16	50	110	40

PRIAGNI (one pot)

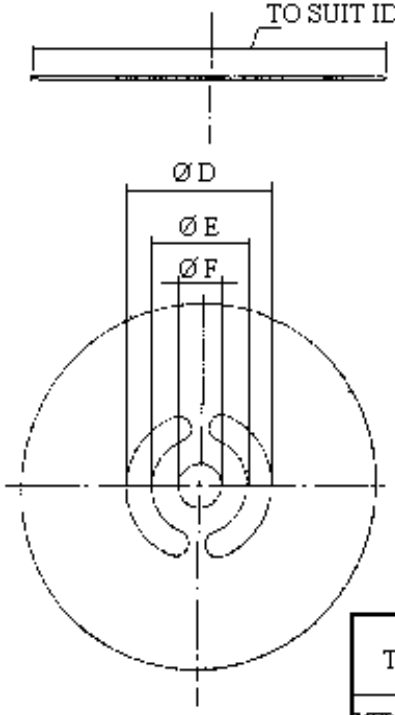
DEVELOPED BY : C. P. R. I., BANGALORE

SHEET 1 OF 2





GRATE



BOTTOM PLATE

UNSPECIFED TOL :-

SHEET METAL PARTS : ±3%

CAST IRON PARTS : ±1

NOTE : -

ALL DIMENSIONS IN mm

TYPE	MATL. SPECIFICATION				
	TOP PLATE	GRATE	BARREL	BOTTOM PLATE	LINING
MEDIUM SIZE TYPE 1	C. I. 6 min	C. I. 6 min	M. S. 1.6 min	M. S. 1.6 min	ALUMINIUM 0.71 min
TYPE 2	C. I. 6 min	C. I. 6 min	C. I. 6 min	C. I. 6 min	ALUMINIUM 0.71 min
LARGE SIZE TYPE 1	C. I. 6 min	C. I. 6 min	M. S. 1.6 min	M. S. 1.6 min	ALUMINIUM 0.71 min

Dimension	*H*	*D*	*E*	*F*	*P*	*Q*	*R*	*K*	*L*	*M*
Medium Size Type 2	8	96	64	28	8.5	9.5	188	33	67	246
Type 1	8	96	64	28	8.5	9.5	188.5	33	67	242
Large Size Type 1	10	120	80	35	11	12	241	40	85	299

PRIAGNI (one pot)

DEVELOPED BY : C. P. R. I., BANGALORE

SHEET 2 OF 2

3.22 PRIYA

The model was developed in 1989 at the Technical Back-up Unit, Department of Home Science, M.S. University, Baroda - 390002, Gujrat.

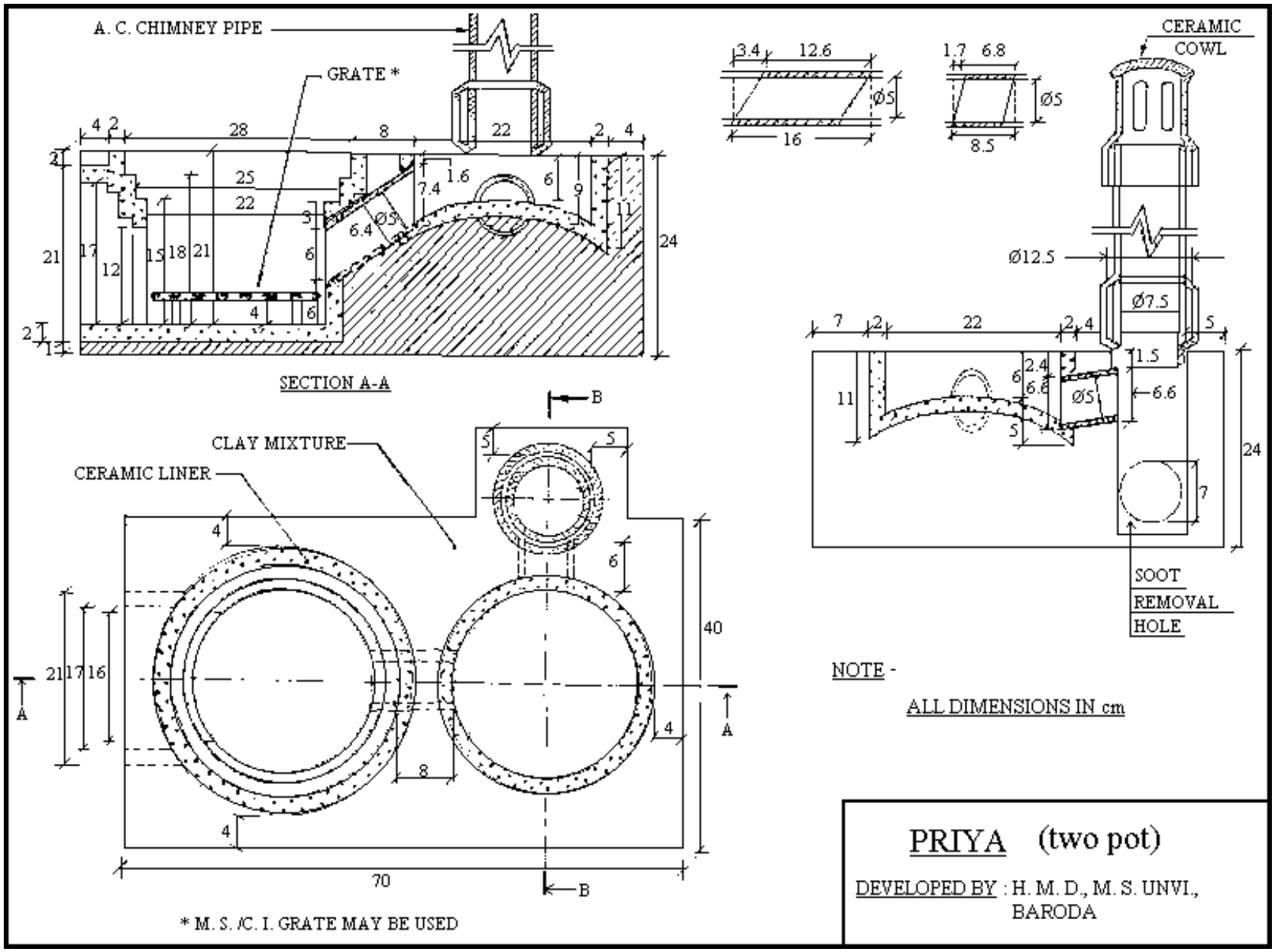
The Priya is a two-pot, pottery-lined mud-stove with chimney. It is very suitable for the cooking of traditional meals and the baking of Gujarati bread or *rotla* which is 20-30 cm. in size. Fuelwood, twigs and agri-residues are the main fuels while small amounts of dung cakes can also be used along with fuelwood.

The first pot-hole has a stepped rim contruction to accommodate vessels of different types and sizes including spherical and/or flat bottom vessels 22-32 cm. in diameter. Pottery liners are used for the construction of the combustion chambers and tunnels while the chimney pipe and cowl are made of asbestos cement and a grate is made of cast iron or a metal sheet. It can be constructed by trained SEWs. So far, nearly 20,000 units have been installed in Gujarat State. The production cost estimate is Rs. 55-80 (US$ 2.2-3.2).

Special features: specially suitable for traditional cooking and baking of local dishes, including *rotla*.

For general specifications and test performance: please refer to table 1.1.

Technical drawings: see below.


A. C. CHIMNEY PIPE
GRATE *
SECTION A-A
CLAY MIXTURE
CERAMIC LINER
* M. S. /C. I. GRATE MAY BE USED
CERAMIC COWL
SOOT REMOVAL HOLE
NOTE -
ALL DIMENSIONS IN cm
PRIYA (two pot)
DEVELOPED BY : H. M. D., M. S. UNVI., BARODA

3.23 SOHINI

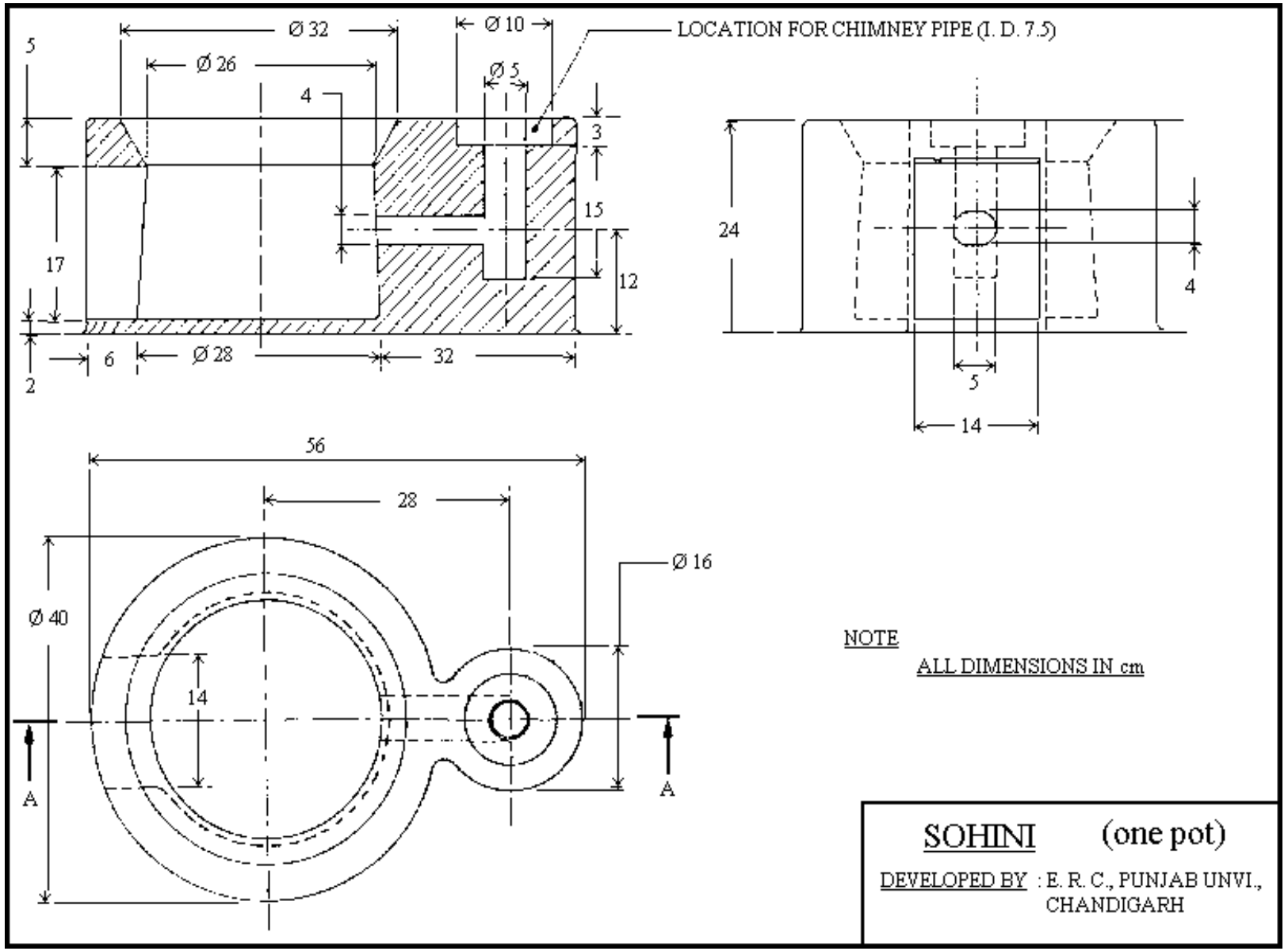
The model was developed in 1987 at the Technical Back-up Unit, Energy Research Centre, Punjab University, Chandigarh - 160014.

The Sohini is a single-pot mud stove with chimney but without grate. It is primarily used for the slow heating of milk and animal feeds etc. It is used also for other traditional cooking in the plains areas of the northern region, including *roti* (large size local bread) and can cater to the requirements of a medium size family (5-8 members). The design can accommodate spherical or flat bottom vessels 26-32 cm. in diameter. The stove tunnel has an elliptical shape in the cross section which provides necessary flow resistance for better fuel efficiency. The stove can be easily constructed by SEWs using locally available clay material and ready-made asbestos cement chimney pipe and cowl. The stove performs well with fuelwood, twigs, dung cakes and agri-residues. So far, nearly 80,000 units have been disseminated in Haryana, Uttar Pradesh, Delhi, Punjab, Rajasthan and Himachal Pradesh. The production cost estimate is Rs. 55-70 (US$ 2.2-2.8).

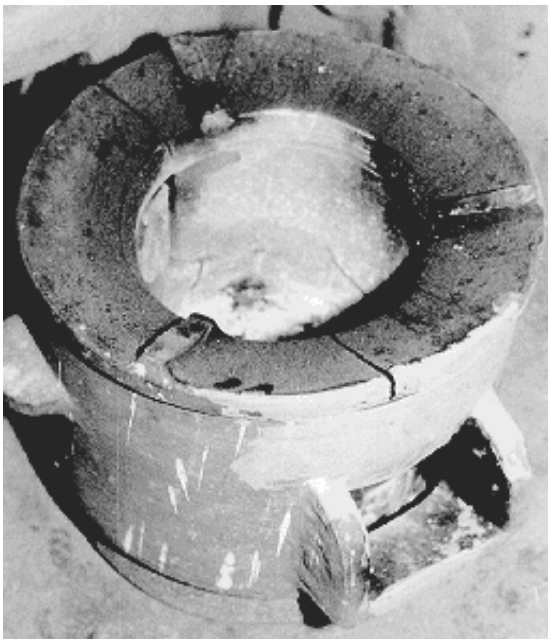
Special features: primarily designed for the slow release of heat over an extended period of time utilizing dung cakes and/or agri-residues to carry out the traditional simmering of milk and animal feeds.

For general specifications and test performance: please refer to table 1.1.

Technical drawings: see below.


Ø 32
Ø 10
LOCATION FOR CHIMNEY PIPE (I. D. 7.5)
Ø 26
Ø 5
5
4
3
15
17
12
6
Ø 28
32
2
24
4
5
14
56
28
Ø 16
Ø 40
14
A
A
NOTE
ALL DIMENSIONS IN cm
SOHINI (one pot)
DEVELOPED BY : E. R. C., PUNJAB UNVI., CHANDIGARH

3.24 SUDHA



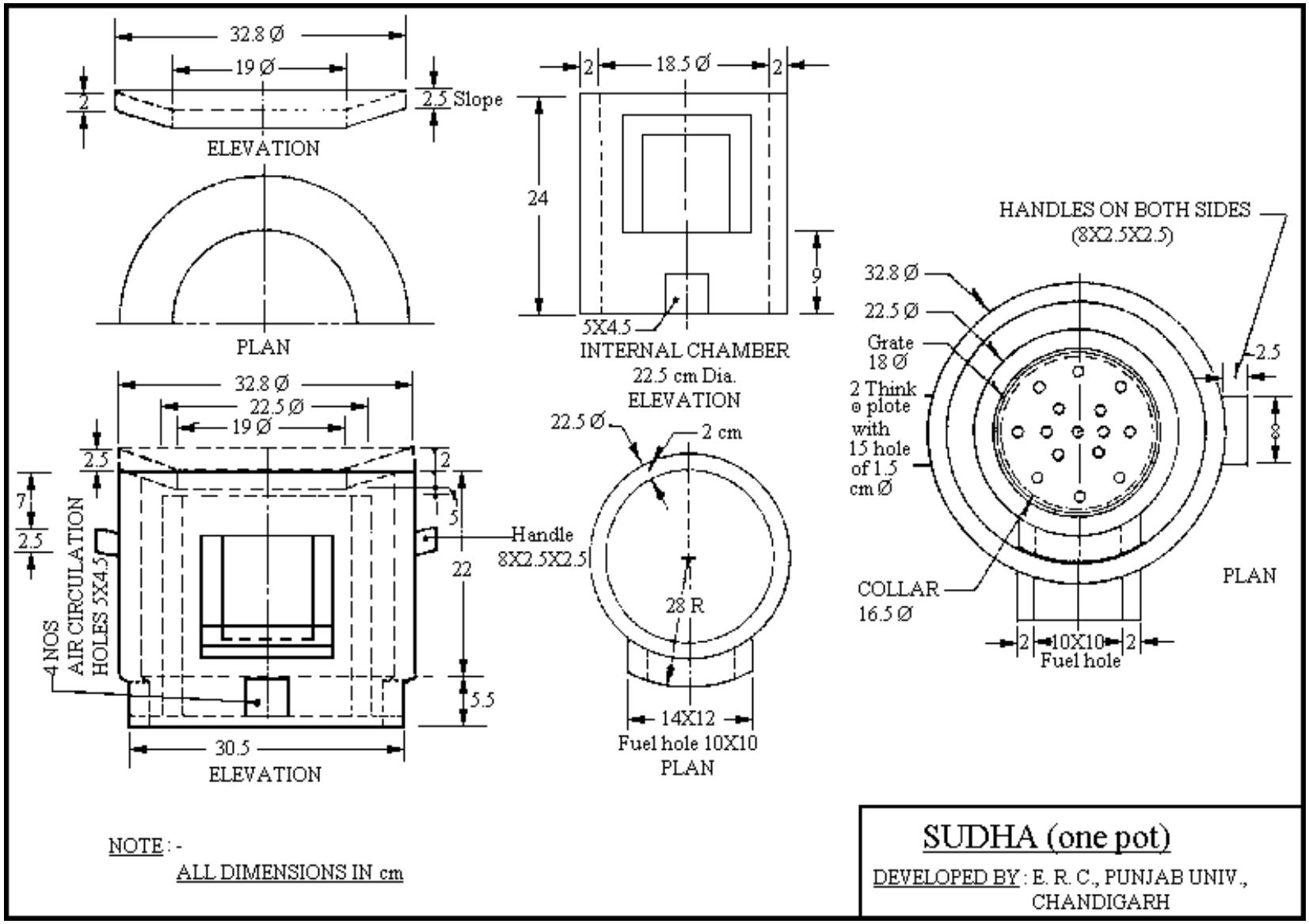
The model was developed in 1992 at the Technical Back-up Unit, Energy Research Centre, Punjab University, Chandigarh - 160014.

The Sudha is a low cost, single-pot pottery stove without chimney. The design is meant for general use, but has taken into account the cooking needs of weaker sections of the society and the requirement of decentralized production by trained potters. The stove can accommodate flat or spherical pots 20-30 cm. in diameter and can be used with fuelwood, twigs, cow dung, agri-residues and briquettes. It is suitable for a medium-to-large family (8-12 members). It can be operated either as a fixed stove or a portable one. Due to the double wall design feature, coupled with the fired-clay grate (for provision of hot secondary air from underneath) complete combustion takes place. The stove therefore can attain very high thermal efficiency, comparatively higher power output, faster cooking and low emissions. Though recently developed, the Sudha stove is considered quite suitable for most parts of the country with similar cooking needs. This new innovation is being proposed for large scale propagation. The production cost estimate is Rs. 30-40 (U$ 1.2-1.6).

Special features: a low cost portable pottery model which can be produced by village potters for sale. Can accommodate various types of fuel available in rural areas.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


32.8 Ø
19 Ø
2
2.5 Slope
ELEVATION
PLAN
2
18.5 Ø
2
24
9
5X4.5
INTERNAL CHAMBER
22.5 cm Dia.
ELEVATION
HANDLES ON BOTH SIDES
(8X2.5X2.5)
32.8 Ø
22.5 Ø
Grate
18 Ø
2 Think
e plote
with
15 hole
of 1.5
cm Ø
2.5
8
COLLAR
16.5 Ø
PLAN
2
10X10
2
Fuel hole
32.8 Ø
22.5 Ø
19 Ø
2.5
2
7
2.5
5
Handle
8X2.5X2.5
22
4 NOS
AIR CIRCULATION
HOLES 5X4.5
5.5
30.5
ELEVATION
22.5 Ø
2 cm
28 R
14X12
Fuel hole 10X10
PLAN
NOTE : -
ALL DIMENSIONS IN cm
SUDHA (one pot)
DEVELOPED BY : E. R. C., PUNJAB UNIV.,
CHANDIGARH

3.25 SUGAM-II

The model was developed in 1988 at the Technical Back-up Unit, Centre for Rural Development & Appropriate Technology, Indian Institute of Technology, Hauz Khas, New Delhi - 110016.

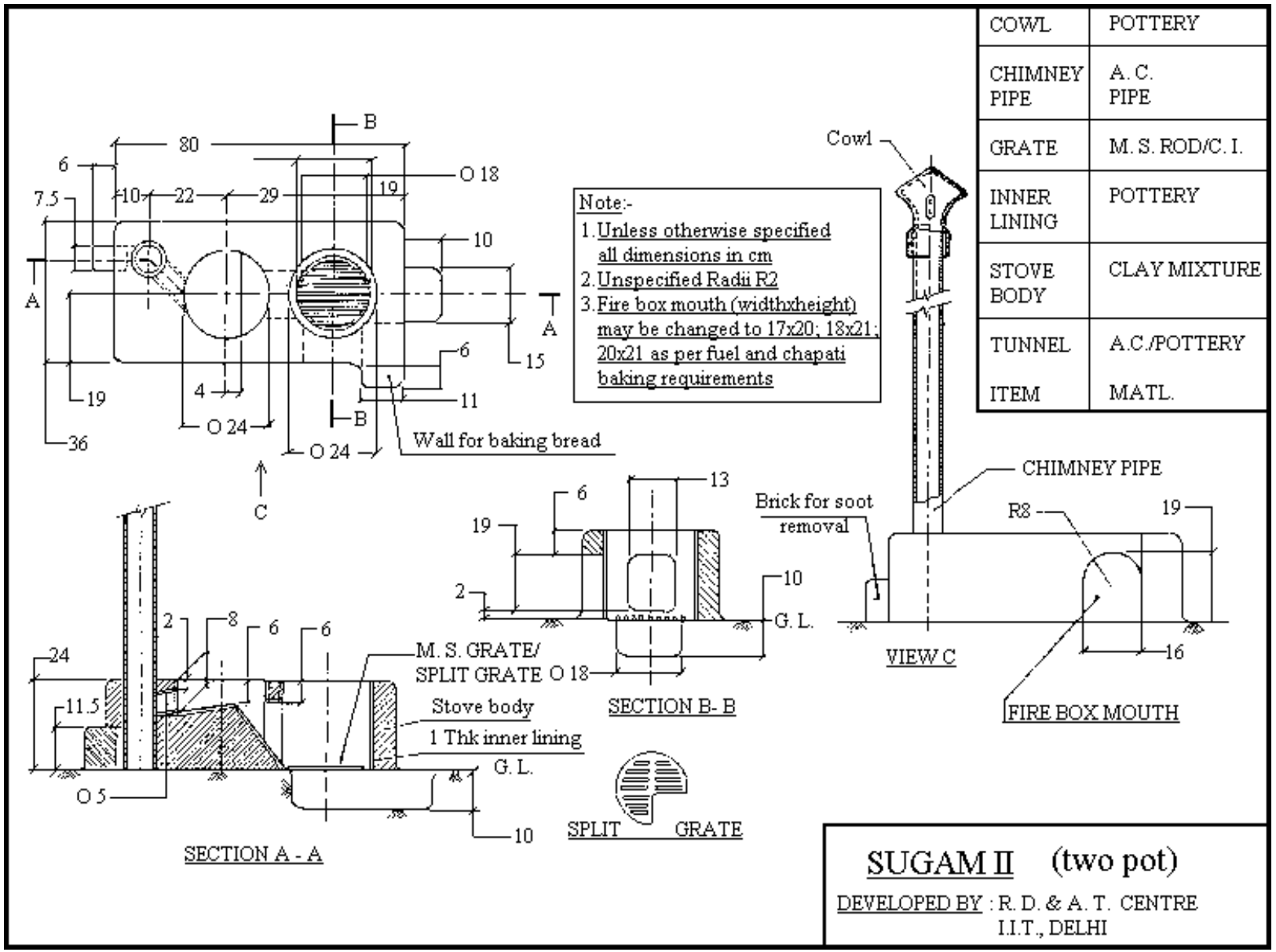
The Sugam-II is a fixed, two-pot mud stove with chimney, suitable for a medium to large family (5-10 members), particularly in the plains of Northern India where baking of *roti* on the fire is a common practice. The stove can accommodate spherical and flat bottom vessels 25-28 cm. in diameter, while smaller pots can also be used with cast-iron reducer rings. The stove can be used with fuelwood, twigs, dung cakes and agri-residues or combinations of these fuels.

The Sugam-II stove can be constructed either by using locally available clay material along with cast-iron grate, asbestos chimney pipe and cowl, or alternatively using pottery liners for the combustion chambers to ensure long term maximum performance. This model is very popular in northern India particularly in Delhi, Uttar Pradesh and Haryana. So far, about 50,000 units have been disseminated. The production cost estimates are Rs. 70 (US$ 2.8) and Rs. 87 (US$ 3.5) for mud and pottery liner constructions, respectively.

Special features: multi-fuel firing with a provision of split-grate for bigger size *chapati* baking.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.



SUGAM II (two pot)

DEVELOPED BY : R. D. & A. T. CENTRE
I.I.T., DELHI

3.26 SUGAM SEVA

The model was developed in 1988 at the Technical Back-up Unit, Centre for Rural Development & Appropriate Technology, Indian Institute of Technology, Hauz Khas, New Delhi - 110016.

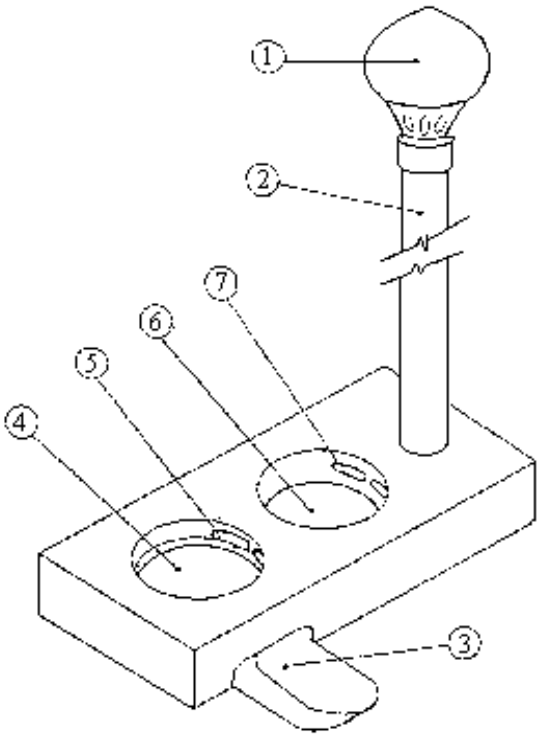
The Sugam Seva is a two-pot mud stove suitable for a medium size family (5-8 members) of eastern India, particularly in West Bengal where rice and fish are the main foods and agri-residues are abundantly available but fuelwood is scarce. The combustion chamber is constructed below ground level to faciltate the feeding of residue fuels such as twigs, leaves, straws, dung cakes or crop residues coated with dung. This stove model has no grate. The stove can accommodate spherical and flat bottom vessels 25-28 cm. in diameter, while pots 15-24 cm diameter. will need cast-iron reducer rings.

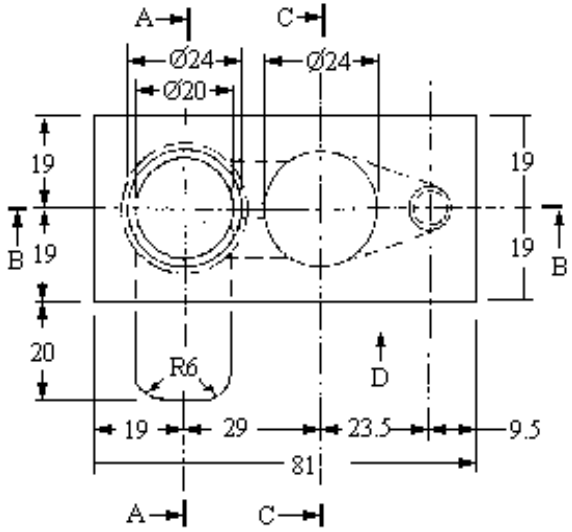
The stove can be constructed by trained field workers using locally available clay material along with standard items such as pottery tunnels, asbestos cement chimney pipe and cowl. So far, 200,000 stoves have been disseminated throughout the eastern region such as in West Bengal, Bihar and Orissa. The production cost estimate is Rs. 55-72 (US$ 2.2-2.9).

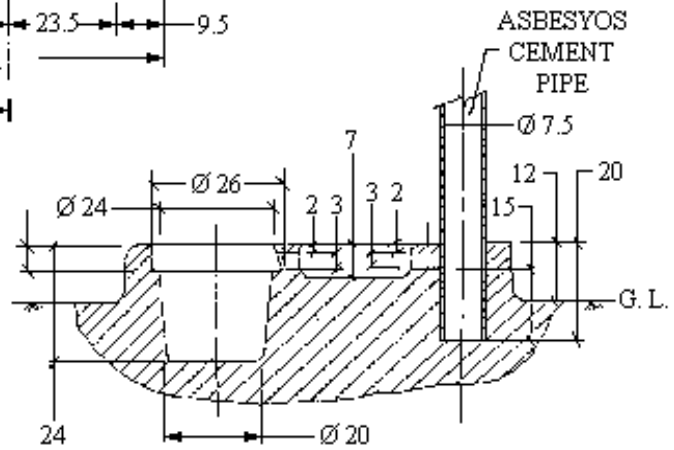
Special feature: a non-grate, dug-in design stove for use with loose residues like straws.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.







SECTION B B
ALL DIMENSIONS IN cm

1. CONE CAP COWL
2. ASBESTOS CEMENT PIPE
3. FIRE BOX
4. FIRST POT HOLE
5. FIRST TUNNEL
6. SECOND POT HOLE
7. SECOND TUNNEL

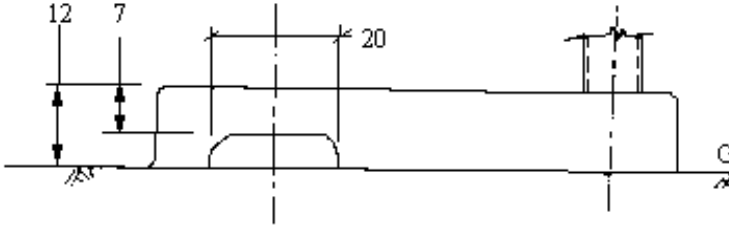
MATL CLAY MINTURE

SUGAM SEVA (two pot)

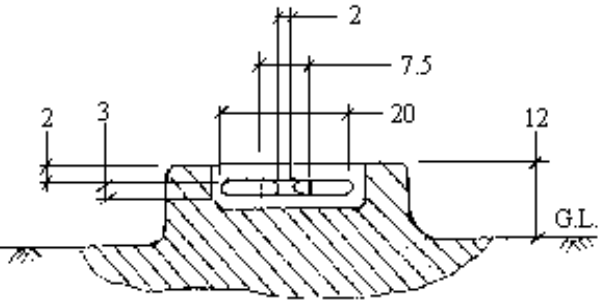
DEVELOPED BY R. D. & A. T. CENTRE,
I. I. T., DELHI

SHEET 1 OF 2

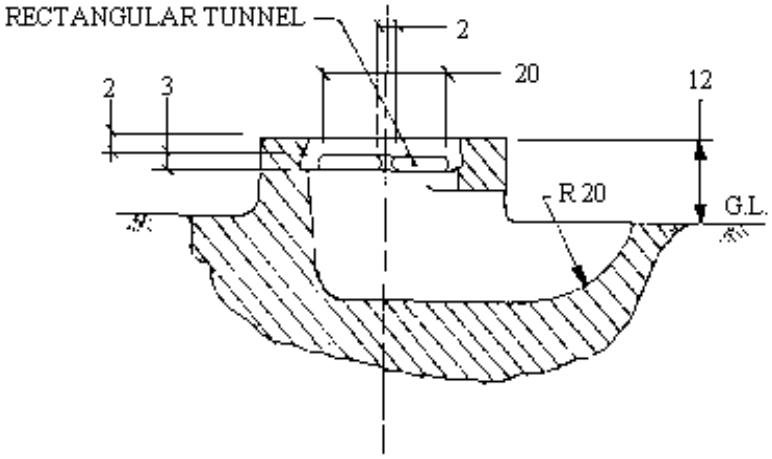
SUGAM-SEVA CHULHA



VIEW D



SECTION C C



SECTION A A

SUGAM SEVA (two pot)

SHEET 2 OF 2

3.27 SUKHAD

The model was developed in 1988 at the Technical Back-up Unit, College of Technology & Agricultural Engineering, Rajasthan Agricultural University, Udaipur-313001.

The Sukhad is a two-pot mud stove with chimney, very popular in many parts of the country. The stove can be used with firewood and agri-residues. It is suitable for a medium size family (5-8 members) using flat or spherical bottom vessels 19-30 cm. in diameter. It also provides strong heat output to the second pot-hole.

The stove is designed such that the second pot-hole is raised by about 6 cm. above the level of the first pot-hole to avoid interference between pot rims when cooking with two large pots. The stove can be constructed by trained SEWs with locally available clay materials and metallic moulds. The chimney pipe and cowl are made of asbestos cement. Optional items like pottery liners and cast-iron grate can also be provided.

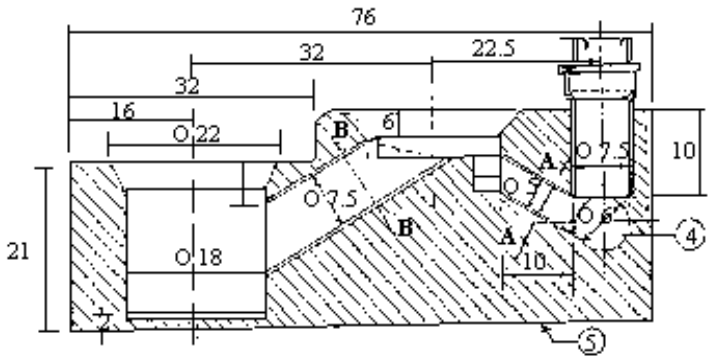
So far, nearly one million stoves have been disseminated in Rajasthan, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Madhya Pradesh and Bihar States. The production cost estimate is Rs. 55 (US$ 2.2) for mud construction and Rs. 72 (US$ 2.9) for construction with the pottery liners.

Special features: fuel-flexibility and can accommodate large size vessels

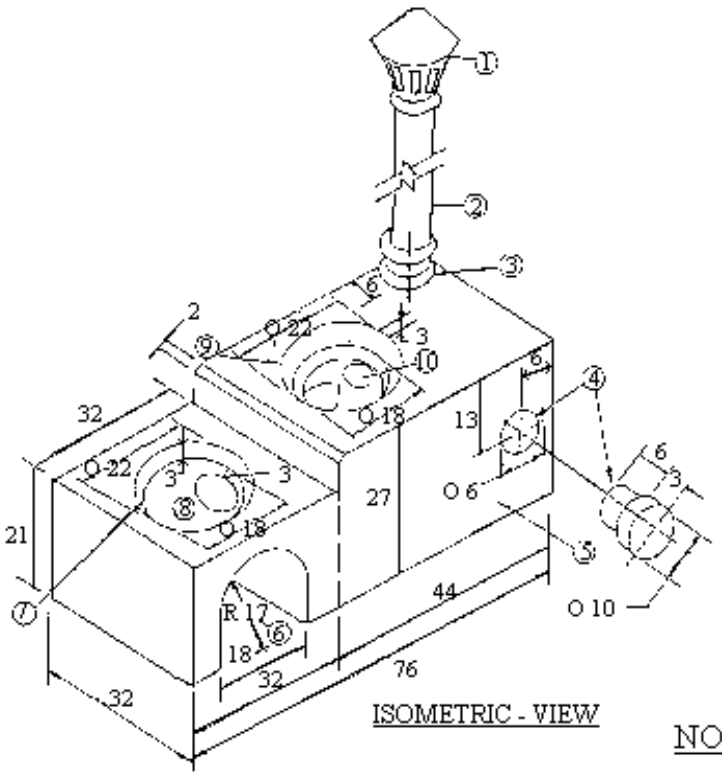
For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.

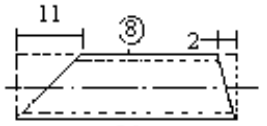
1 - CONICAL COWL - (ASBESTOS CEMENT)
2 - CHIMNEY PIPE Ø - 7.5 - (- DO -)
3 - PIPE PIECE WITH SOCKET - (- DO -)
4 - SOOT CLEANING HOLE AND ITS PLUG. - (CLAY MIX.)
5 - MAIN SODY - (CLAY MIXTURE)
6 - FUEL FEED OPENING
7 - FIRST POT HOLE - (FIRE BOX)
8 - FIRST TUNNEL - (A.C. PIPE PIECE)
9 - SECOND POT HOLE
10 - CHIMNEY TUNNEL - (A.C. PIPE PIECE)

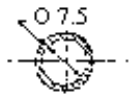


SECTION X - X

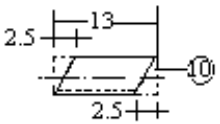


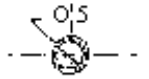
ISOMETRIC - VIEW



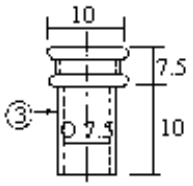


SECTION B - B





SECTION A - A

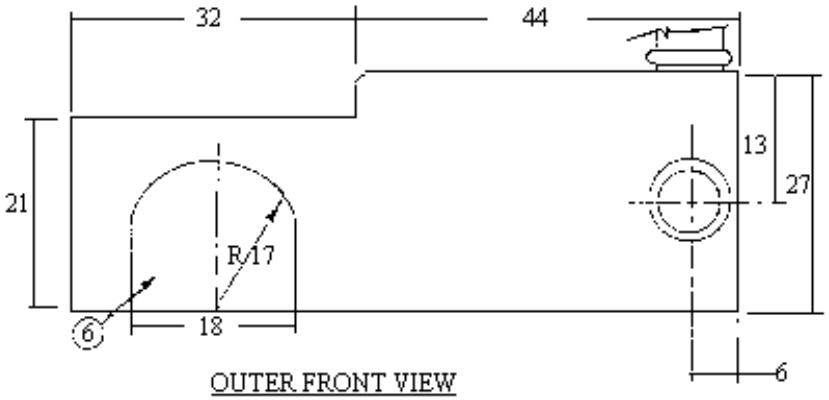


NOTE :-
ALL DIMENSIONS IN cm

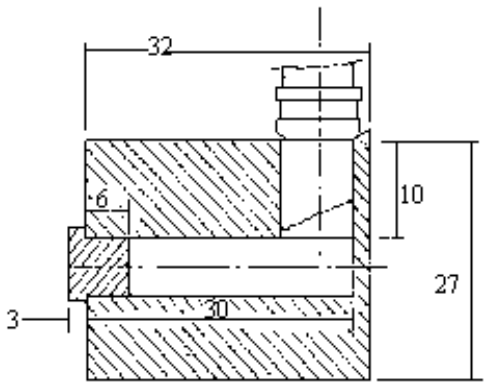
SUKHAD (two pot)

DEVELOPED BY : C.T.A.E., RAJ; AGRI. UNVI., UDAIPUR

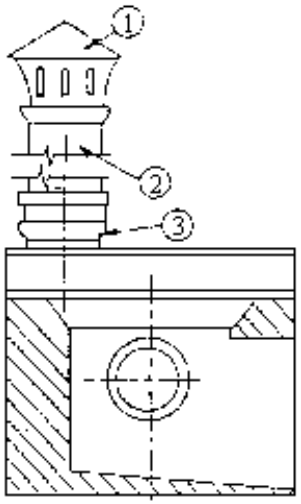
SHEET 1 OF 2



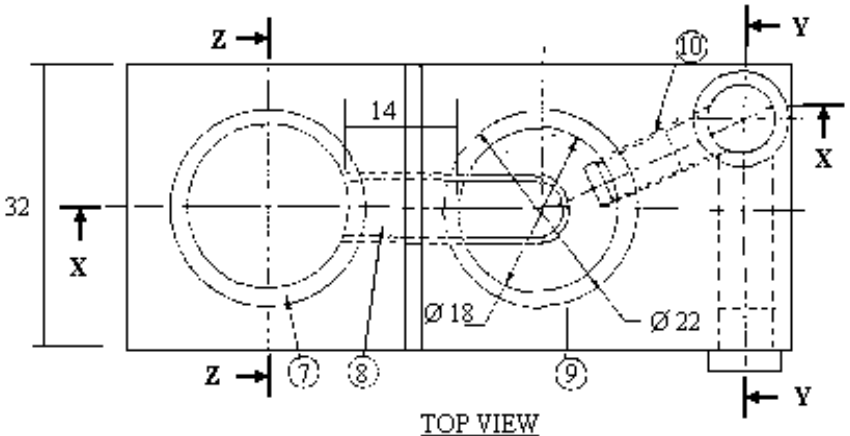
OUTER FRONT VIEW



SECTION Y - Y



SECTION Z - Z



TOP VIEW

NOTE :-

ALL DIMENSIONS IN cm

SUKHAD (two pot)

SHEET 2 OF 2

3.28 SURBHI-T

The model was developed in 1987 at the Technical Back-up Unit, Energy Research Centre, Punjab University, Chandigarh - 160014.

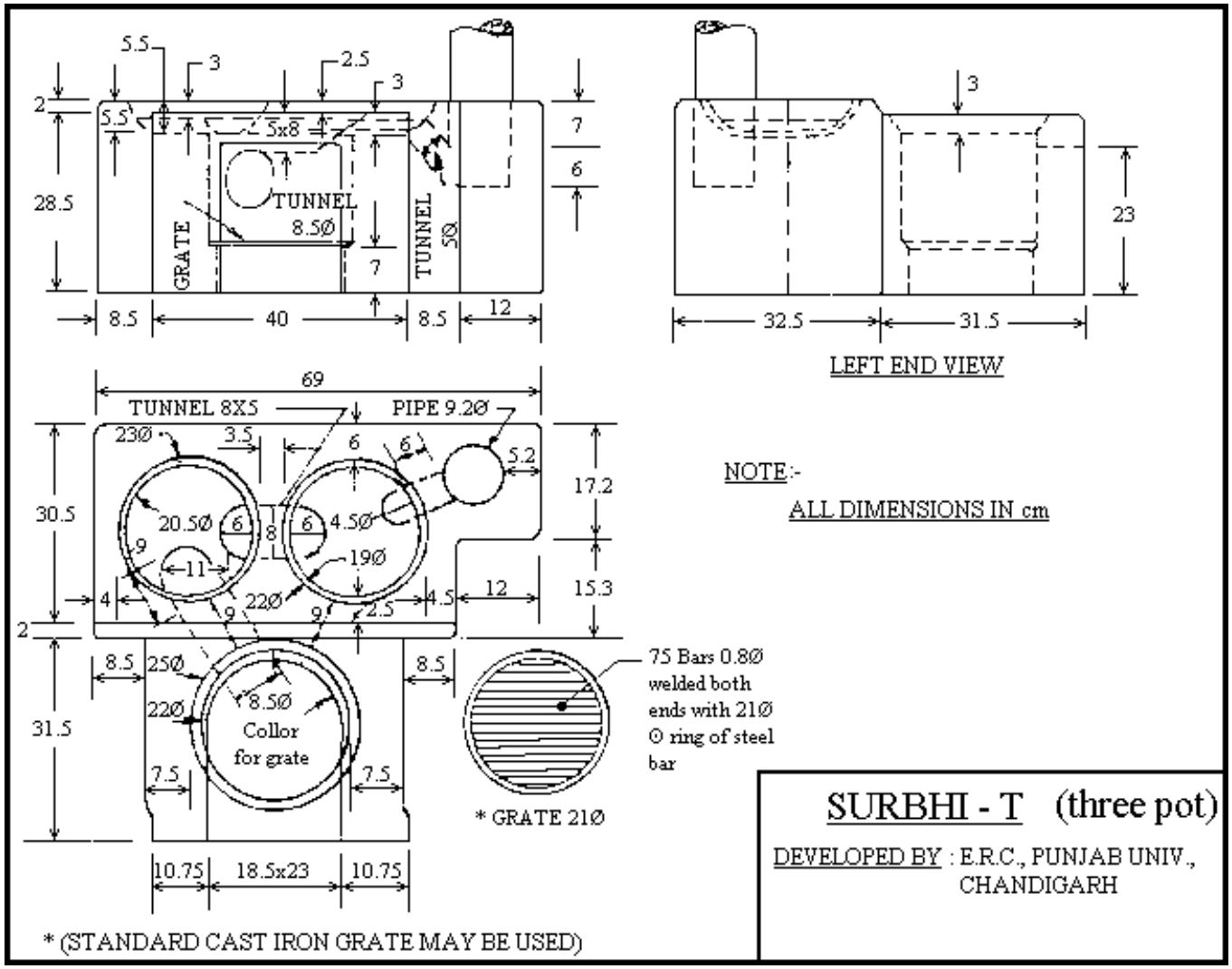
The Surbhi-T is a three-pot mud stove with chimney arranged in a "T" shape. It is suitable for a medium size family, especially in hilly areas where water heating is required for bathing. The stove can be fueled with fuelwood, dung cakes and agri-residues and has found wide acceptance in Himachal Pradesh. It can accommodate flat and spherical bottom vessles 18-28 cm. in diameter.

The stove can be constructed by trained local workers using moulds along with the ready-made metal grate and asbestos cement chimney pipe and cowl. Due to being suitable only for hilly areas, only about 5,000 units so far have been disseminated in Himachal Pradesh. At present this model is also being propagated in the other hilly States also. The production cost estimate is Rs. 55-80 (US$ 2.2-3.2).

Special feature: a three-pot design to meet both cooking and water heating requirements in hilly areas.

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


5.5
3
2.5
3
2
5.5
5x8
7
6
28.5
TUNNEL
8.5Ø
GRATE
7
TUNNEL
5Ø
8.5
40
8.5
12
3
23
32.5
31.5
LEFT END VIEW
69
TUNNEL 8X5
PIPE 9.2Ø
23Ø
3.5
6
6
5.2
17.2
30.5
20.5Ø
6
8
6
4.5Ø
9
11
19Ø
15.3
4
22Ø
9
9
2.5
4.5
12
2
8.5
25Ø
8.5
22Ø
8.5Ø
Collor
for grate
31.5
7.5
7.5
10.75
18.5x23
10.75
* GRATE 21Ø
75 Bars 0.8Ø
welded both
ends with 21Ø
⊙ ring of steel
bar
NOTE:-
ALL DIMENSIONS IN cm
SURBHI - T (three pot)
DEVELOPED BY : E.R.C., PUNJAB UNIV.,
CHANDIGARH
* (STANDARD CAST IRON GRATE MAY BE USED)

3.29 UDAI

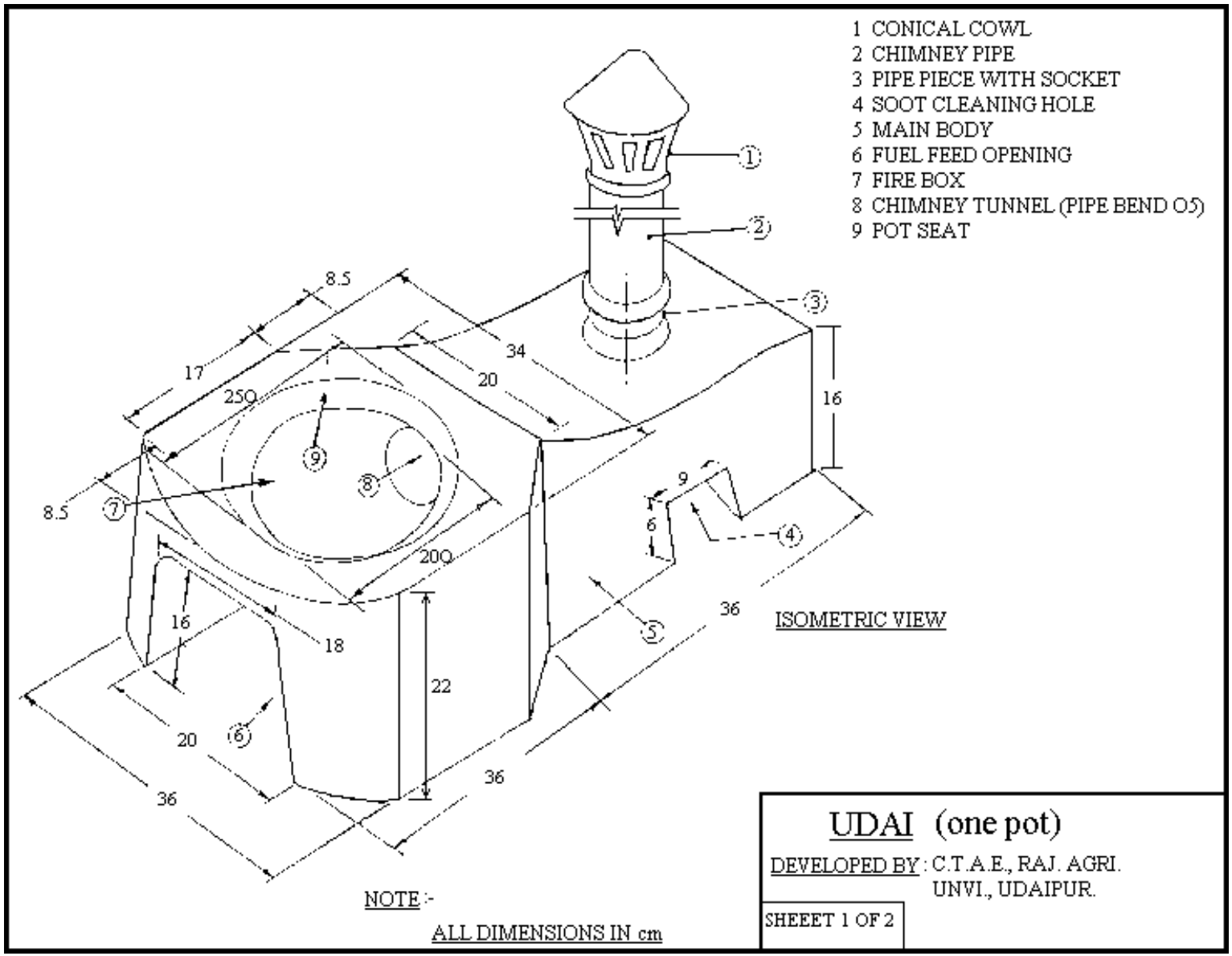
The model was developed in 1989 at the Technical Back-up Unit, College of Technology & Agricultural Engineering, Rajasthan Agricultural University, Udaipur-313001.

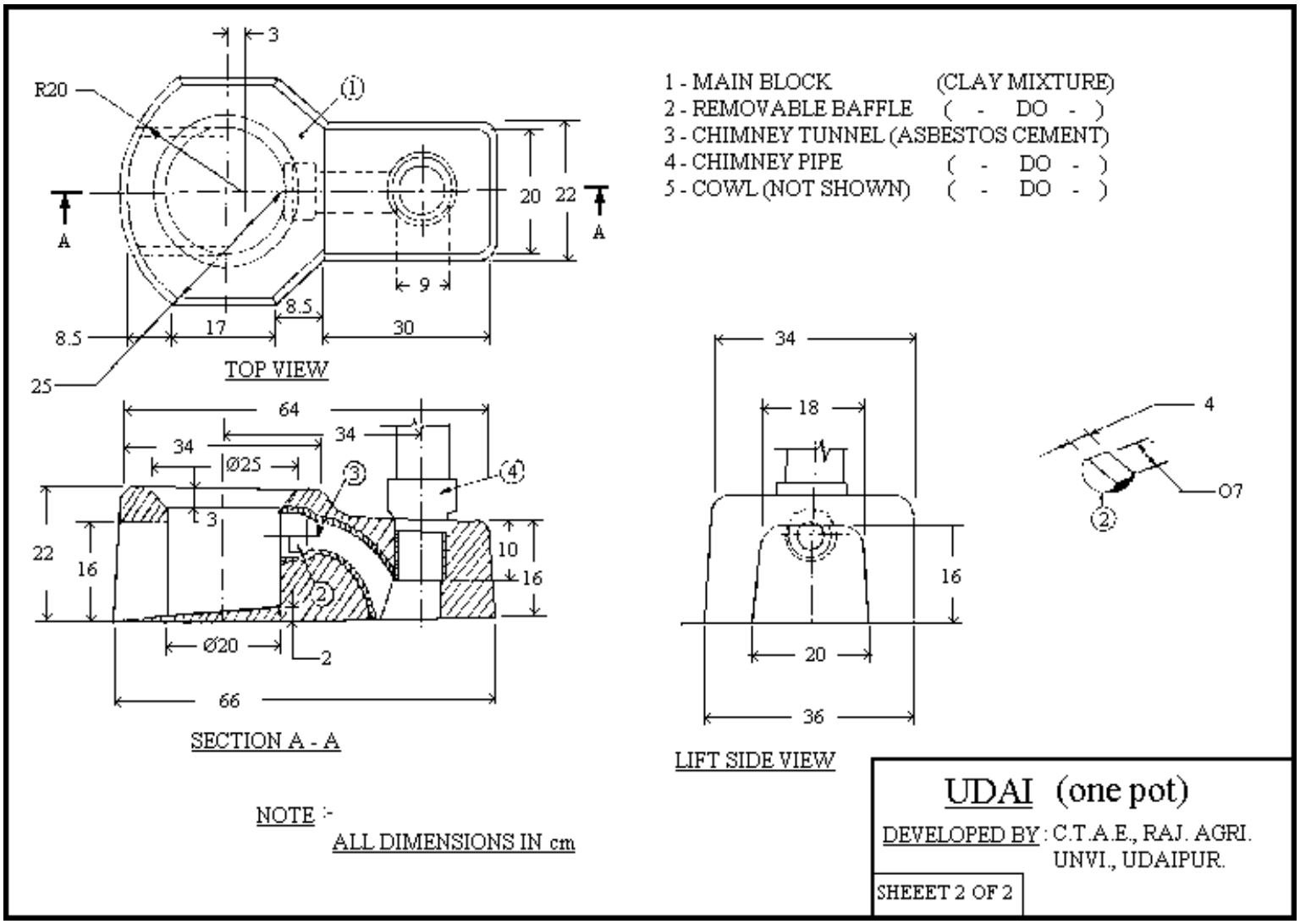
The Udai is a single-pot mud stove with chimney, without grate, suitable for small families (3 - 5 members). The stove is equipped with a specially designed bent flue pipe made from asbestos cement which helps divert the hot flue gases downward to create necessary flow resistance to achieve a better fuel efficiency. A D-form baffle can be placed in the tunnel to control the flow of air intake and the flue gas, especially when burning with residue fuels. It can accommodate spherical and flat bottom vessels 21-30 cm. in diameter. The stove can be well used with fuelwood and agri-residues.The stove is capable of cooking all types of boiled and steamed dishes in western regions, including the traditional baking.

The stove can be constructed by trained SEWs using locally available materials. So far, nearly 65,000 units have been disseminated in Rajasthan, Andhra Pradesh, Uttar Pradesh and Madhya Pradesh. The production cost estimate is Rs. 55-67 (US$ 2.2-2.7).

For general specifications and test performance: please refer to table 1.1 and 1.2 at the end of this chapter.

Technical drawings: see below.


1 CONICAL COWL
2 CHIMNEY PIPE
3 PIPE PIECE WITH SOCKET
4 SOOT CLEANING HOLE
5 MAIN BODY
6 FUEL FEED OPENING
7 FIRE BOX
8 CHIMNEY TUNNEL (PIPE BEND O5)
9 POT SEAT
8.5
17
25Ø
34
20
16
8.5
9
6
20Ø
16
18
22
20
36
36
36
ISOMETRIC VIEW
NOTE :-
ALL DIMENSIONS IN cm
UDAI (one pot)
DEVELOPED BY : C.T.A.E., RAJ. AGRI. UNVI., UDAIPUR.
SHEEET 1 OF 2


1 - MAIN BLOCK (CLAY MIXTURE)
2 - REMOVABLE BAFFLE (- DO -)
3 - CHIMNEY TUNNEL (ASBESTOS CEMENT)
4 - CHIMNEY PIPE (- DO -)
5 - COWL (NOT SHOWN) (- DO -)
TOP VIEW
SECTION A - A
LIFT SIDE VIEW
NOTE :-
ALL DIMENSIONS IN cm
UDAI (one pot)
DEVELOPED BY : C.T.A.E., RAJ. AGRI. UNVI., UDAIPUR.
SHEEET 2 OF 2

3.30 Summaries of General and Technical Features of Selected Improved Chulhas

Table 1.1 General Features of Selected Improved Chulhas

Model name and year developed	Cost estimation (Rs)	Type of fuel used	Normal cooking operation (minutes)	Pot size normally used (diameter cm.)
1.ABHINAV/JETAN 1987	Rs. 55-72	fuelwood, dung & agri-residues	40-60	24-25 cm.
2.AKASH 1989	Rs. 55-80	fuelwood, dung & agri-residues	40-60	24-30 cm.
3.ALOK 1989	Rs. 75-100	fuelwood, dung & agri-residues	60-80	28-35 cm.
4.ARAVALIU 1985	Rs. 55-80	fuelwood, dung & agri-residues	40-60	22-30 cm.
5.ASTRA 1991	Rs. 55-102	fuelwood, dung, agri-residues & combination	35-55	20-30 cm.
6.BHAGYALAXMI 1991	Rs. 40	fuelwood, twigs & agri-residues	40-60	25-30 cm.
7.DENGLI 1989	Rs. 27	fuelwood, dung cake	40-60	23-30 cm.
8.DOACHHI 1989	Rs. 70-87	fuelwood, dung, agri-residues & combination	60-80	19-24 cm.
9.GAURAV 1990	Rs. 75-110	fuelwood, dung & agri-residues	40-50	23-50 cm.
10.GRIHLAXMI 1990	Rs. 30-42	fuelwood, twigs & agri-residues	50-70	18-22 cm.
11.HARSHA 1991	Rs. 144	fuelwood, charcoal, dung, agri-residues & combination	60-80	18-26 cm.
12.JANTA 1991	Rs. 100	fuelwood, charcoal, dung	40-50	22-28 cm.
13.KESARI-200 1988	Rs. 100	fuelwood, twigs & agri-residues	80-120	60-70 cm.
14.LAXMI 1986	Rs. 70-87	fuelwood, dung & agri-residues	40-60	18-26 cm.
15.MAMTA 1989	Rs. 55-72	fuelwood, dung, agri-residues & combination	50-70	21-28 cm.

table 1.1 continued

Model name and year developed	Cost estimation (Rs)	Type of fuel used	Normal cooking operation (minutes)	Pot size normally used (diameter cm.)
16.MEGHALAYA 1987	Rs. 93-110	fuelwood, dung, agri-residues & combination	40-60	22-28 cm.
17.MOHINIU 1989	Rs. 70-82	fuelwood, dung & agri-residues	40-50	23-30 cm.
18.NAVJYOTI 1991	Rs. 75-158	sawdust, rice husk, low density biomass	65-85	20-30 cm.
19.PARISHAD-21 1986	Rs. 95	fuelwood, coconut leaves & stems, dung, agri-residues & combination	35-55	16.25 cm.
20.PAWAN-II 1988	Rs. 70-82	fuelwood, dungcake & agri-residues	40-60	25-30 cm.
21.PRIAGNI 1983	Rs. 105-188	wood - medium size wood, twigs agri-residues	55-75	18-30 cm.
22.PRIYA 1989	Rs. 55-80	fuelwood, dung & agri-residues	50-70	23-32 cm.
23.SOHINI 1983	Rs. 55-70	dung cake, fuelwood & agri-residues	60-80	27-40 cm.
24.SUDHA 1992	Rs. 30-40	fuelwood, dung, agri-residues, charcoal & briq. fuel	30-40	20-30 cm.
25.SUGAM-II 1988	Rs. 70-87	fuelwood, dung, agri-residues & combination	40-60	25-28 cm.
26.SUGAMSEVA 1988	Rs. 55-72	fuelwood, agri-residues & dung cake	45-60	25-30 cm.
27.SUKHAD 1988	Rs. 55-72	fuelwood & agri-residues	40-60	19-30 cm.
28.SURBHIT 1987	Rs. 55-80	fuelwood, dung & agri-residues	40-60	18-28 cm.
29.UDAI 1989	Rs. 55-67	fuelwood, twigs & agri-residues	45-75	21-30 cm.

Note: 1 US$ = 25 Rupees

Table 1.2 Test Performance of Selected Improved Chulhas[1]*

Model	Fuel type total (1)	Pot type/size used (2)	Power output calculated (3)	Burning rate (4)	Thermal effic. (5)	Emission characteristics (6)		Remark (7)
		diam./cm.	KW	Kg/h	HU%	CO/CO^2 ratio	TSP mg/m_3	
1. ABHINAV/JETAN	Wood Dung	FB D24-22	0.98 0.35	1.0 1.0	22.0 11.4	0.053 0.07	1.45 -	
2. AKASH	Wood Dung	FB D28-24	1.15 0.75	1.0 1.0	21.9 24.7	0.04 0.05	1.8 -	
3. ALOK	Wood Dung	FB D30-25	1.77 1.1	1.5 1.5	26.3 24.7	0.04 0.04	1.6 -	
4. ARAVALI-U	Wood Dung+wood (1:1 by wt.) Dung	FB D24-28	1.13 1.3 0.90	1.0 1.5 1.5	25.3 23.2 20.0	0.04 0.07 0.09	1.6 - -	
5. ASTRA	Wood Dung	FB D24	1.34 0.44	1.0 1.0	30.0 14.6	0.04 0.04	1.26	
6. BHAGYALAXMI	Wood Dung	FB D20	1.25 0.82	1.0 1.0	26.0 27.0	0.04 0.04	- -	
7. DENGLI	Wood Dung Dung+wood (1:1 by wt.)	RB D-26	0.98 0.55 0.73	1.0 0.8 1.0	25.0 22.9 19.7	0.02 0.04	1.7 -	

*/ All tests were conducted at the TBU of the Center for Rural Development and Appropriate Technology IIT, Delhi under the same test conditions (Courtesy of Dr. R.C. Maheswari).

table 1.2 continued

Model	Fuel type total (1)	Pot type/size used (2)	Power output calculated (3)	Burning rate (4)	Thermal effic. (5)	Emission characteristics (6)		Remark (7)
		diam./cm.	KW	Kg/h	HU%	CO/CO^2 ratio	TSP mg/m_3	
8. DOACHHI	Wood	FB	0.90	1.00	20.2	0.04	1.80	
	Dung	D20	0.53	1.00	17.4	0.06	-	
	Dung+wood		0.72	1.0	19.2	0.04	-	
9. GAURAV	Wood	FB	1.89	1.50	28.1	0.03	1.2	
	Dung	D25-30	0.72	1.5	15.8	0.08		
10. GRIHLAXMI	Wood	FB	1.10	1.0	28.8	0.04	1.16	
	Dung	D28	0.56	1.0	18.5	0.06		
	Mustard stems		0.8	1.0	16.0	0.07		
11. HARSHA		FB	1.11	1.06	24.8	0.03	1.67	
	Wood	D24	0.56	1.0	18.5	0.05	-	
	Dung		0.8	0.57	21.9	0.04	-	
	Charcoal							
12. JANTA		FB	2.68	1.5	50.2	0.01	1.20	
	Wood	D36	1.1	1.5	24.6	-	-	Fire box not suitable for dung cake.
	Dung							
13. KESARI-200		FB	6.64	4.0	37.1	0.04	TBI	
	Long wood							
14. LAXMI		FB	0.98	1.0	22.0	0.04	1.20	
	Wood	D20	0.44	1.0	14.7	0.08	-	Small firebox not suitable for dung cake
	Dung							

Note: (1) fuelwood used is *Acacia nilotica* with calorific value of 3,800 kcal/kg and dung cake with calorific value of 2,600 kcal/kg.
(2) FB = flat bottom, RB = round/spherical bottom, D20 = diameter of 20 cm, etc.
(3), (4), (5) and (6) please refers to Indian test standard as shown in Annex 2.

table 1.2 continued

Model	Fuel type total (1)	Pot type/size used (2)	Power output calculated (3)	Burning rate (4)	Thermal effic. (5)	Emission characteristics (6)		Remark (7)
		diam./cm.	KW	Kg/h	HU%	CO/CO^2 ratio	TSP mg/m_3	
15. MAMTA	Wood	FB	0.98	1.0	24.0	0.06	1.28	
	Dung	D24	0.48	1.0	16.0	0.08	-	
	Mustard stems		0.53	1.0	14.0	0.09	-	
16. MEGHALAYA	Wood	FB	0.17	1.0	24.0	0.03	1.20	
	Dung	D23	0.7	1.0	22.8	0.05	-	
17. MOHINI-U	Wood	FB D24	1.14	1.0	25.4	0.04	TBI	
18. NAVJYOTI	Sawdust	FB	0.83	0.9	23.3	0.03	1.11	
	Paddy husk	D36	0.79	0.6	23.0	0.04	1.11	
	Subabul leaves		0.98	0.5	22.6	0.07	3.8	
19. PARISHAD-21		FB	1.68	1.5	30.0	0.03	1.91	
	Wood	D24	1.22	2.0	26.3	0.04	-	
	Dung							
		RB	1.07	1.0	22.0	0.04	0.83	
20. PAWAN-II	Wood	D26	0.51	1.0	17.0	-	-	
	Dung		0.74	1.0	19.8	-	-	
	Wood+Dung (1:1 by wt.)							
21. PRIAGNI		FB	1.16	1.01	26.0	0.04	1.25	
	Wood							
22. PRIYA		FB	0.98	1.0	20.0	0.04	1.22	
	Wood	D26-24	0.42	1.0	13.7	0.08	-	
	Dung		0.30	1.0	8.0	1.1	2.1	
	Mustard stems							

table 1.2 continued

Model (1)	Fuel type total (1)	Pot type/size used (2)	Power output calculated (3)	Burning rate (4)	Thermal effic. (5)	Emission characteristics (6)		Remark (7)
		diam./cm.	KW	Kg/h	HU%	CO/CO^2 ratio	TSP mg/m_3	
23. SOHINI	Dung	RB D36	0.80	1.5	24.3	0.04	1.72	
24. SUDHA	Wood	RB D20-30	1.92	0.97	42.8	0.01	0.05	
25. SUGAM-II	Wood	RB	1.18	1.0	28.2	0.04	0.91	
	Dung	D26	0.91	1.25	24.2	0.05	-	
	Mustard stems +Dung (1:1 by wt.)		0.60	1.0	18.2	0.05	-	
	Wood+Dung (1:1 by wt.)		0.94	1.0	25.0	-	-	
26. SUGAM SEVA	Wood	RB	1.12	1.0	25.1	0.04	1.2	
	Dung	D26	0.7	1.0	23.0	0.06	-	
	Dung+Wood		0.9	1.0	24.5	-	-	
27. SUKHAD	Wood	RB	1.0	1.0	25.0	0.04	1.10	
	Dung	D23	0.74	1.0	20.6	0.05	-	
	Dung+Wood		0.92	1.0	19.8	0.05	-	
28. SURBHI-T	Wood	FB	1.16	1.0	30.4	0.04	1.2	
	Dung	D23-23-20	0.6	1.0	20.0	-	-	
29. UDAI	Wood	FB	0.9	1.0	20.0	0.06	2.0	
	Dung	D24	0.5	1.0	16.4	0.07	-	

4 NETWORKS OF THE NATIONAL PROGRAMME ON IMPROVED CHULHA

4.1 Ministry of Non-Conventional Energy Sources (MNES)
C.G.O. Complex Lodhi Road, New Delhi 110 003

a) Programme Officers:

- Joint Secretary MNES	Shri D.K. Mittal,
- Principal Scientific Officer	Shri B.M.L. Garg,
- Senior Scientific Officer-I	Shri Inder Kumar,
- Senior Scientific Officer-II	Shri S.K. Jagwani,
- Section Officer	Shri M. Mukhopadhyay.

b) Regional Offices and Monitoring Cells:

- Hyderabad Regional Office 1-11-222/6/D, Gouri Sadan, Begumpet, HYDERABAD-500016, A.P.	Principal Scientific Officer, Shri D. Veerabraham.
- Bhopal Regional Office 29, Zone-II,4 Maharana Pratap Nagar, BHOPAL-462011, M.P.	Principal Scientific Officer, Shri Padam Singh.
- Chandigarh Regional Office SCO No.364, Sector -44-D, CHANDIGARH-160 036.	Principal Scientific Officer, Shri S.S. Bawa.
- Lucknow Regional Office A-1/18, Sector H, Aliganj, LUCKNOW, U.P.	Principal Scientific Officer, Dr. A.K. Singhal.
- Ahmedabad Regional Office 2nd Floor, Bhaikaka Complex, Drive in Road, Thaltej, AHMEDABAD-380 054, GUJARAT.	Principal Scientific Officer, Dr. Anil Dhussa.
- Guwahati Regional Office Pub Sarania, Ist Bye lane West, Near Railway Lane Gate, Chandmari, GUWAHATI-3, ASSAM.	Principal Scientific Officer, Shri S. Aggarwal.
- Madras Regional Office 2nd floor, Kuralagam Bldg, MADRAS-600108, TAMIL NADU.	Senior Scientific Officer -I, Shri Radha Krishnan.

4.2 Designated NPIC Technical Back-up Units

- Energy Research Center Punjab University CHANDIGARH-160014.	Prof. S.K. Sharma, Honorary Director.
- College of Technology & Agricultural Engineering Rajasthan Agricultural University, UDAIPUR.	Prof. A.N. Mathur Principal Sci. Officer.
- Dept. of Mechanical Engineering Bihar College of Engineering, PATNA-800005.	Prof. S.P. Sinha.
- Center for Rural Dev. and Appropriate Technology, IIT., Hauz Khas, NEW DELHI.	Prof. R.C. Maheshwari, Head.
- Dept. of Bio-Energy, Col. of Agricultural Engineering, Tamil Nadu Agricultural University, COIMBATORE.	Prof. N.C. Vijayraghvan Head.
- Thapar Polytechnic, PATIALA.	Shri D.K. Sharma, Principal.
- Center for Application of Science and Technology for Rural Dev. (CASTFORD), Indian Institute of Education, 128/2, Karve Road, KOTHRUD, PUNE.	Dr. A.D. Karve, Director.
- Home Management Department, Faculty of Home Science, M.S. University, BARODA.	Dr.(Mrs.) Rachel George.
- Department of Chemical Engr. Regional Engineering College, SRINAGAR, J&K.	Prof. G.A. Wani.
- Dept. of Mechanical Engineering, College of Engineering, TRIVANDRUM, KERALA.	Prof. R.V.G. Menon.
- Karnataka State Council for Sci. and Technology, Indian Inst. of Science, BANGALORE.	Shri S. Rajagopalan, Executive Secretary.

- Regional Inst. of Rural Dev. BICHPURI, AGRAP.	Shri D.D. Gupta, Principal.
- Dr. Yashwant Singh Parmar Univ. NOUNI, SOLAN, H.P.	Dr. B.P. Singh.
- Design & Project Engr. Group, Regional Research Laboratory, BHUBANESWAR-751013.	Dr. S. Khuntia, Scientist.
- Department of Chemistry, University of Kalyani, KALYANI, WEST BENGAL.	Dr. C.P. Dutta.
- Central Glass and Ceramic Research Inst., KHURJA, U.P.	Dr. K.N. Maiti, Scientist.
- Department of Mechanical Engr. Regional Engineering College, WARRANGAL, ANDHRA PRADESH.	Prof. T.A. Sitharama Rao.
- Central Fuel Research Inst. P.O. Forest Research Institute DHANBAD-828108.	Shri P.K. Bandyopadhyaya, Chief Project Coordinator.
- Assam Science, Technological and Environmental Council, Panchawati, Silpukhuri, GUWAHATI.	Shri P.C. Sarma, Head Energy.
- Center of Energy Studies & Res., School of Energy Studies, Devi Ahilya Vishwavidyalaya, Khandwa Road Campus, INDORE-452001.	Prof. R.L. Sawhney, Head.

4.3 List of State Nodal Agencies

1. Secretary,
Government of Assam,
Rural Development Department,
Dispur, GUWAHATI-6.

2. Principal Secretary,
Energy Forests Environment, Science
Government of Andhra Pradesh,
Secretariat,
HYDERABAD.

3. Secretary,
Government of Bihar,
Energy Department,
Sinchai Bhawan, PATNA.

4. Addl. Chief Secretary,
Panchayat & Rural Housing
Department, Govt. of Gujarat
Gandhinagar, GUJARAT.

5. Commissioner & Secretary
Department of Social Welfare,
Government of Haryana,
New Secretariat, CHANDIGARH.

6. Commissioner-cum-Secretary,
Rural Development Department,
Government of Himachal Pradesh,
SHIMLA.

7. Secretary,
Department of Science, Ecology
& Environment,
Govt. of Jammu & Kashmir,
SRINAGAR/JAMMU.

8. Secretary,
Rural Development & Panchayati
Raj Department,
M.S. Building, 3rd floor,
3rd Stage,
BANGALORE.

9. Chairman,
Science, Technology &
Evironment Committee and Ex-Officio
Secretary to the Govt.
Science, Technology & Secretariat,
TRIVANDRUM.

10. Secretary (Energy),
Government of Madhya Pradesh,
BHOPAL.

11. Secretary,
Govt. of Maharashtra,
Rural Development Department,
Mantralaya, BOMBAY.

12. Secretary,
Science & Technology,
Government of Manipur, IMPHAL.

13. Secretary,
Shillong
Planning Department
MEGHALAYA.

14. Secretary,
Rural Development Department,
Govt. of Mizoram,
AIZAWL.

15. Secretary,
Government of Nagaland,
Rural Development Department,
KOHIMA.

16. Secretary,
Science, Technology & Environment
Department, Government of Orissa,
Secretariat, BHUBANESWAR.

17. Chief Secretary,
U.T. of Pondicherry,
PONDICHERRY.

18. Secretary, Science & Technology,
Government of Punjab,
CHANDIGARH.

19. Development Commissioner,
Rural Development Department,
Government of Rajasthan,
JAIPUR.

20. Secretary,
Rural Development Dept.(NRSE)
Thashing Secretariat,
GANGTOK (SIKKIM).

21. Commissioner-cum-Secretary,
Govt. of Tamil Nadu,
Department of Rural Development,
Fort. St. George, MADRAS-600 008.

22. Secretary,
Department of Science Technology
& Environment,
Govt. of Tripura, AGARTALA.

23. Secretary,
Govt. of Uttar Pradesh,
Rural Development Department,
Vidhan Bhawan, LUCKNOW.

24. Secretary,
Government of West Bengal,
Relief & Welfare Department,
Writer's Building, CALCUTTA.

25. Chief Secretary,
Andaman & Nicobar Administration,
PORT BLAIR.

26. Chief Engineer,
Rural Works Department,
ITANAGAR (Arunachal Pradesh).

27. Administrator,
Dadra Nagar Haveli,
SILVASSA.

28. Development Commissioner,
Delhi Administration,
5/9, Under Hill Road,
NEW DELHI-110 054.

29. Secretary,
Rural Development Department,
PANJIM (GOA).

30. Administrator,
U.T. of Lakshadweep,
KAVARATTI-682 888.

31. Administrator,
U.T. of Daman & Diu.
DAMAN.

32. Chairman,
Gujarat Energy Dev. Agency,
B.N. Chambers, R.C.Dutt Road,
BARODA.

4.4 List of Local Implementing Agencies

1. Director,
Rural Development Department,
Sethi Trust Building, G.S.Road,
Bhangagarh, GUWAHATI, ASSAM.

2. Managing Director,
Non-Conventional Development
Corporation of Andhra Pradesh,
5-8-207/2, Pisgah Complex,
HYDERABAD.

3. Director,
Bihar Renewable Energy
Development Agency,
18, Aniket Housing Society,
KIDWAIPUR, PATNA.

4. Development Commissioner,
Development Department,
Govt. of Gujarat,
GANDHINAGAR, GUJRAT.

5. Director,
Gujarat Energy Dev. Agency,
B.N. Chambers, 3rd floor,
R.C. Dutt Road,
VADODARA.

6. Managing Director,
National Tree Grower's Co-operative
Foundation Ltd., ANAND.

7. Additional General Manager(AS&E)
Gujarat Agro Industries Corporation
Juhapura Sarkhej Road, AHMEDABAD.

8. Director,
Women & Child Development,
Govt. of Haryana,
New Secretariat, CHANDIGARH.

9. Director,
Rural Development Department,
Govt. of Himachal Pradesh,
SHIMLA.

10. Managing Director,
H.P. Agro Industries Corp. Ltd.
Saligram Bhawan,
SHIMLA.

11. Chief Executive Officer,
HIMURJA,
Chandi Bhawan,
SHIMLA.

12. Project Director/Chief
Executive,
J&K Energy Development,
Civil Secretariat,
SRINAGAR/JAMMU.

13. Director,
Rural Development & Panchayati
Raj Department,
M.S. Building, 3rd Floor,
3rd Stage, BANGALORE.

14. Director,
Agency for Non-Conventional
Energy & Rural Tech.
TC/24/1965, THYCAUD P.O.
TRIVANDRUM.

15. Managing Director,
M.P. Urja Vikas Nigam,
G.T.B. Complex,
T.T. Nagar, BHOPAL.

16. Joint Secretary,
Govt. of Maharashtra,
Rural Development Dept.
Mantralaya, BOMBAY.

17. Director,
Maharashtra Energy Dev.
Agency (MEDA), 6th Floor, New Kamani
Chambers, Ade Marzban St.,
Ballard Estate, BOMBAY.

18. Director(E&NCE/BGS)
Khadi & Village Industries Commission,
3, Irla Road, Vile Parle,
WEST BOMBAY.

19. Director,
Science, Technology & Environment,
Govt. of Manipur, IMPHAL.

20. Joint Secretary,
Planning Department,
Govt. of Meghalaya, SHILLONG.

21. Director,
Rural Development Deptt.
Govt. of Mizoram, AIZAWL.

22. Project Director,
State Rural Development Agency,
Govt. of Nagaland, KOHIMA.

23. Project Executive Officer,
Govt. of Pondicherry,
Rural Development Department,
VILLIANUR.

24. Chief Executive
Punjab Energy Dev. Agency(PEDA)
SCO No.54-56, Sector 17-A,
CHANDIGARH.

25. Director,
Rural Development Department,
Govt. of Punjab,
Sector 17-C, CHANDIGARH.

26. Director,
Rural Development & Panchayati
Raj Department, Govt. of Rajasthan, JAIPUR.

27. Project Director,
New & Renewable Sources of
Energy, Rural Development
Department, GANGTOK

28. Chief Executive,
Orissa Renewable Energy Dev.
Agency, S-57, Mancheswar Industrial
Estate, BHUBANESWAR.

29. Director,
Rural Development Department,
Govt. of Tamil Nadu,
Kuralagam Building, MADRAS.

30. Chairman & Managing Dir.,
Tamil Nadu Ener. Dev. Agency
Jhaver Plaza IVth Floor, 1-A,
Nungambakkam High Rd. MADRAS.

31. Senior Scientific Officer,
Deptt. of Sc, Tech. & Environment,
Assam Rifles Complex,
Gorkhabasti, Kunjaban, AGARTALA.

32. Commissioner,
Govt. of Uttar Pradesh,
Rural Development Department,
Jawahar Bhawan, LUCKNOW.

33. Director,
Non-Conventional Development
Agency, B-46, Mahanagar Extension,
LUCKNOW.

34. General Manager,
U.P. State Agro Industries Corpn.,
22, Vidhan Sabha Marg,
LUCKNOW.

35. Additional Director,
Social Welfare,
Govt. of West Bengal,
Juvenile Court Building, CALCUTTA.

36. Superintending Engineer,
Electrical Department,
Andaman & Nicobar Admn.,
PORT BLAIR.

37. Project Director(Energy)
Rural Works Department,
Govt. of Arunachal Pradesh,
ITANAGAR.

38. Development & Planning Officer,
Dept. of Rural Development,
Dadra&Nagar Haveli, SILVASSA.

39. Director,
Delhi Energy Development Agency,
11, Lancers Road, Timarpur,
DELHI.

40. Project Director,
Rural Development Agency,
Dr. Kudchadkar's Building,
2nd Floor, Malacca Road, PANJIM
(GOA).

42. Block Development Officer,
R.D.A. Section,
U.T. of Daman & Dui, DAMAN.

41. Asstt Executive Engineer(Ele).
U.T. Of Lakshadweep,
KAVARATTI-673 555.

43. Member-in-charge,
All India Women's Conference,
6 Bhagwan Dass Road, NEW DELHI.

4.5 List of Approved Portable Chulha Manufacturers

Andhra Pradesh

1. M/s. Om Shakthi Industries,
   9-D, IDA, Phase 5,
   PATANACHERU, HYDERABAD.

2. M/s. Energy Devices,
   4-3-74, Hill Street,
   2nd Floor,
   SECUNDERABAD-50008.

3. M/s. Vasavi Industries Gamini
   Compound, Chivatam Road,
   TANUKU-534211 (A.P.).

4. M/s. Suwib Energy Systems,
   C-III/4, Narasapur Cross Road,
   Bala Nagar,
   HYDERABAD-500037.

5. M/s. Gamini Industries,
   Chivatam Road,
   TANUKU-534211 (A.P.).

6. M/s. Associated Engg. Works,
   P.B. No.17,
   TANUKU-534211 (A.P.).

7. M/S Sai Renewable Energy Devices,
   Obuladova Nagar,
   ANANTHPUR (A.P.).

Assam

8. M/s. Innovations Inc. (India),
   Prag Continental,
   Pan Bazar,
   GUWAHATI.

9. M/s. Lohit Fabricators,
   Industrial Area,
   Shed No.7, Bamuni Maidan,
   GUWAHATI-781021.

10. M/s. Assam Agro-Industries Dev.
    Corporation Ltd.,
    Ramakrishna Road,
    Ulubari, GUWAHATI-781007.

11. M/s. Afcon Towers and Structures,
    Panbazar,
    GUWAHATI - 1.

Bihar

12. M/s. Chetan Fabrication,
    Satsang Vihar,
    West Church Road,
    GAYA-823001.

13. M/S Surya Engineers,
    Zeya Manzil,
    Lal Bagh,
    PATNA-800006.

Haryana

14. M/S Vishal Enterprises,
    Plot No,. 397, Modern Industrial
    Estate,
    BAHADURGARH.

Himachal Pradesh

15. M/s. H.P.Agro Industries Corp.Ltd.,
    SHIMLA - 171002.

Jammu & Kashmir

16. M/s. Mehraj Agricultural Implements,
    Bbhaw-e-Din, Nowhatta,
    SRINAGAR - 190002.

Karnataka

17. M/s. Heat Systems,
    61, Second Cross,
    Domlur Layout,
    BANGALORE-560071.

18. M/s. Vijay Engineering Works,
    Rajanukunte Village,
    Bangalore North Taluk,
    BANGALORE Urban District.

19. M/s. Fabrimec Pvt. Ltd.,
No.42, Geetha Mansion,
3rd Floor, K.G. Road,
BANGALORE-560009.

20. M/s. Nucifera Chemtech, B.H.Road,
Madihalli,
TIPTUR-572202.

21. M/S Vijaya Industries,
Katapady-574104, Post UDUPI Taluk,
KARNATAKA.

Kerala

22. M/s. Steel Industries Kerala Ltd,
Foundry Unit, Ottapalam,
KERALA-679103.

Madhya Pradesh

23. M/s. Amika Screen Works,
12, Dev Sahib Ki Gali,
Tilak Road,
UJJAIN-456001.

24. M/s. Manasati Energy Savers,
49, Vidhyanagar,
IIIrd Floor, Behind Sapna
Sangeeta Talkies,
INDORE-452001.

25. M/s. Surya Energy Saver,
Vishal Centre Building,
Hamida Road,Opp. Petrol Pump,
BHOPAL.

26. M/s. Prit Enterprises,
L/G-140-B, Harswardhan Nagar,
BHOPAL-462001.

27. M/s. Sun-N-Cook, M-221, Ash Bag Colony A,
BHOPAL-462016.

Maharashtra

28. M/s. Kalpak Engineers,
Non-Conventional Engineers,
A-2/17, Mandapeshwar Kripa,
S.V.P. Road, Borivili(West)
BOMBAY - 400103.

29. M/s. ARPEE Natural Energy System,
A/2, Manas, Lingayat Colony,
Nasik Road - 422101.

Orissa

30. M/s. Metal Processor,
Uditinagar,
ROUREKELA-769012

31. M/s. Orissa Pump & Engg. Co. Ltd.,
B-9, New Industrial Estate,
JAGATPUR, CUTTAK (ORISSA).

32. M/s. Prachi Works (P) Ltd.,
35, Sector A Zone B,
Mancheswar Industrial Estate,
BHUBANESWAR-10.

Rajasthan

33. M/s Urja Bandhu,
C/o. M/s. Vinod Stores,
JAIPUR.

Delhi

34. M/s. Vishal Enterprises,
A-96/6, Wazirpur Industrial Area,
NEW DELHI-110052.

35. M/s. Bharat Engineering Co.,
Vinsun-12/3626, Bhola Ram Market,
Chowk Mori Gate,
DELHI-110006.

36. M/s. Ganges International,
52, Regal Building,
Connaught Place, NEW DELHI.

37. M/s. Kiran Enterprises,
12/71, Punjabi Bagh,
NEW DLEHI-110026.

38. M/s. Natural Energy Systems,
15/35, West Punjabi Bagh,
NEW DELHI-110026.

39. M/s.Shivam Energy Devices Systems,
B-45, G.T.Karnal Road Industrial Area,
DELHI-110033.

40. M/s. Pals & Company,
161-B, Vikaram Vihar,
Lajpat Nagar-IV,
NEW DELHI-110024.

41. M/s. Nitisha Enterprises,
25, Gole Market,
NEW DELHI-110001.

42. M/s. Sanjeev Solar Enterprises,
DSIDC-Shed No.B-70/8,
Lawrence Road,
NEW DELHI

43. M/s. Ridhima Enterprises,
64/C-12/III, Rohini,
DELHI-110085.

Uttar Pradesh

44. M/s. U.P. State Agro Industrial Corporation,
22, Vidhan Sabha Marg,
Post Box No.261,
LUCKNOW-226001.

45. M/s. U.P. Poorvanchal Vikas Nigam,
Vikas Marg,
FAIZABAD.

46. M/s. Jain Industries,
Sheikhpur, (Near Dhanya Mehri Pul),
Alamnagar Road,
LUCKNOW-226003.

47. M/s.India Renewable Energy Devices,
132, Parao,
SHIKOHABAD-205138.

48. M/s. Fabrako Engineers,
E-6, Industrial Area,
Site-2, Amman Road,
RAE BARELI.

49. M/s. Sirohi Industries,
752/9-B/21, Brahampuri,
MEERUT-250002.

50. M/s. Sushil Traders,
191, Beharipur,
BAREILLY.

51. M/s. Hari Agro Engg., Works,
Pilokheri Road, Lisari Gate,
MEERUT-250002.

52. M/s. Chaudhary Engineering Works,
90/1, Pilokhary Road,
Lisari Gate,
MEERUT-250002.

53. M/s. Kaley Enterprises,
196, Lajpat Nagar,
BARABANKI.

54. M/s. Pradeep Enterprises,
Bazar Bazaza, Pilkhuwa-245304
Distt. GHAZIABAD.

55. M/S Steel Sales Co.,
Lower Bazar,
PAURI GARHWAL.

56. M/S V.N. Engineers,
54, A/1, Mokhampur Industrial Complex,
Phase I, Delhi Road,
MEERUT-250002.

57. M/s. Singhal Polypacks (P) Ltd.,
Shed No. 12, C.I. Estate,
Patel Nagar,
DEHRA DUN.

West Bengal

58. M/s. Swastik (India),
Suit No.61,
209, Acharya Jagdish Bose Road,
CALCUTTA-700007.

59. M/s. Goel International,
140, Chittaranjan Avenue,
CALCUTTA - 700007.

60. M/s. Urja Bandhu,
51, Chanditolla Road,
CALCUTTA - 700053.

61. M/s. Harsh Udog Inc.
144/145 J.N. Mukherjee Road,
(Plot No.36A) Ghusuri,
HAWRAH - 711107.

62. M/s. Mukherjee Industries,
29, Strand Road,
CALCUTTA - 700001.

63. M/s. Mascot Integrated Industries,
9, Dharamtala Road, Salkia,
HOWRAH-6.

Tamil Nadu

64. M/s. Kaushika Enterprises,
3, Sharadambal Street,
Opp. Vidyodaya, Gokulam Colony,
T. Nagar,
MADRAS.

65. M/s. Jeya Bharath Enterprises,
No. 12, Amman Kovil Street,
Vadapalani,
Madras-600026.

66. M/s. Heat Systems,
(C-62)8, Nalla Thampi Street,
Near Pallavaram,
MADRAS-600075.

Punjab

67. M/s. Punjab Agro Industries
Corporation,
Salem Tabri,
LUDHIANA-141005.

68. M/s. Kamal Industries,
52, Niranjan Niwas,
Waraich Colony,
PATIALA - 147001.

Gujarat

69. M/s. Gujarat Agro Industries Copn.
Juhapura, Sarkhej Road,
AHMEDABAD-380055.

Annex 1

Subsidy Pattern for Improved Chulha

The National Programme on Improved Chulhas (NPIC), a centrally sponsored scheme of the Government of India, was initiated as a demonstration project in December 1983. Originally, the entire cost of hardware of the fixed models was borne by the central government. For the portable models, two categories of beneficiary applied: the first included the Scheduled Castes (SC), the Scheduled Tribes (ST), and the Hilly areas for which a subsidy of 75% of the cost was given, and the second include the general user category for which the subsidy was 50% of the cost. In addition, Rs. 5 per chulha was paid by the government as a supervisory fee to the trained workers for installation in the households as well as giving operating and maintenance instruction to the users.

From the year 1987/88, the government decided to recover the supervision fee of Rs. 5 directly from the beneficiaries.

From 1987/88 to 1990/91, with a view to increasing the sense of beneficiary participation, the contribution of the beneficiaries was raised to Rs. 10. This was made up of Rs. 5 for supervision fee and Rs. 5 for the material cost.

From the year 1991/92, the subsidy pattern for improved chulha acquisition/installation remained more or less the same, with one exception: each beneficiary was now asked to contribute Rs. 10 supervision fee while the material cost contribution was Rs. 5 as before. Improved chulha models for community use were also introduced with subsidy rates of Rs. 100 and Rs. 50 for portable and fixed models, respectively.

From 1992/93 onwards the subsidy pattern remained the same as 1991/92, except for the addition of an upper ceiling on the subsidy per chulha: Rs. 50 for fixed models and Rs. 50 and Rs. 75 for portable models for general user category and for SC/ST/Hilly areas, respectively. The subsidy for community models has since been withdrawn.

A summary of the subsidy patterns of the NPIC since its inception is given below:

Subsidy Pattern for Improved Chulhas

Type of Chulha	Dec'1983 - Mar'1986	1986-87	1987-88 to 1991-92	1992-93	Present Unit Cost
A. Family Size:					
1. Fixed Chulha	Full cost of material + supervision fee	Full cost of material	Full cost material minus Rs. 5/- (beneficiary share)	Approved unit cost minus beneficiary's minimum contribution (maximum subsidy limited to Rs. 50/-)	Rs. 25/- to Rs. 103/-
2. Portable Chulha					
i) For SC/ST/Hilly Area	75% of the unit cost	75% of the unit cost	75% of the unit cost	75% of the unit cost limited to Rs. 75/-	Rs. 75/- to Rs. 188/-
ii) For General Category	50% of the unit cost	50% of the unit cost	50% of the unit cost	50% of the unit cost limited to Rs. 50/-	
B. Community Chulha:					
Full cost of hardware material was subsidized for community models of fixed chulhas. However, from 1988-89 a token subsidy of Rs. 50/- for fixed and Rs. 100/- for portable community chulhas was provided under the National Programme on Improved Chulhas. The subsidy on community models has been withdrawn with effect from 1-4-1992.					Rs. 100/- onwards (depending on the construction material).

Annex 2

Indian Standard on Solid Biomass Chulha-Specification CIS 1315 Z (Part 1): 1991[1]

Annex A (Clause 11.1), Test For Thermal Efficiency

A-1 Thermal Efficiency

A-1.0 Thermal efficiency of a chulha 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 Room Conditions

A-2.1.1 The air of the test room shall be free from draughts likely to affect the performance of the chulha. The room temperature shall be 25$\pm$5^{o}C at the beginning.

A-2.1.2 At the start of the test, the chulha and the wood being used shall be at room temperature.

A-3 Equipment

A-3.1 Instruments and Other Accessories:

a) Bomb calorimeter.
b) Mercury in glass thermometers 0-100^{o}C) {see IS 2480 (Part I) with solid stem/other temperature measuring device with the accuracy of $\pm$0.1 $^{\circ}$C.
c) Single pan balance 1 kg capacity (dial with least count of 10 g.).
d) Measuring jars; 1-1, 2-1 and 5-1 capacity.
e) Stop-watch or time measuring device.
f) Pairs of tong, metallic tray and sticks, etc.
g) Piece of clean cloth.

A-3.2 Fuel and Its Preparation

2.1 The fuel shall be *Kail/Deodar/Mango/Acacia* cut from the same log into pieces of 3x3 cm square cross-section and length of half the diameter/length of combustion chamber so as to be housed inside the combustion chamber. The fuel pieces shall be dried by the following method:

1/ Bureau of Indian Standards. Manak Bhavan, 9 Bahadur Shah Zafar Marg. New Delhi 110 002. October 1991.

a) Weigh total quantity of wood (say '*M*' kg.).
b) Pick up one piece and mark '*X*' by engraving and take its mass (say '*m*' g.).
c) Raise the temperature of oven up to 105°C.
d) Stack the wood pieces in a honey comb fashion inside the oven.
e) Maintain the oven temperature at 105°C.
f) After 6 hours, remove the marked '*X*' piece, weigh it and note reduction in mass from '*m*' g, if any. If reduction is observed put the marked piece in the oven again and repeat the weighing of '*X*' marked piece after every subsequent 6 hours period till the mass is constant and no further reduction in mass is observed.
g) At this stage, weigh the total quantity of wood and note loss of mass from '*M*' kg.
h) Determine the calorific value of the prepared wood with the help of bomb calorimeter.

A-3.3 Determination of Burning Capacity Rate

If the fuel burning rate per hour is not given by the manufacturer, the method described below shall be used to estimate the burning capacity of the chulha.

A-3.3.1 Stack the combustion chamber with test fuel as described in A-3.2 in honey comb fashion up to 3/4 of the height or in a pattern recommended by the manufacturer.

A-3.3.2 Sprinkle 10 to 15 ml. of kerosene on the fuel from the top of chulha/fire box mouth.

A-3.3.3 Weigh the chulha with fuel, let the mass be M_1 kg.

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

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

Heat input:
per hour = 2 (M_1 - M_2) x CV kcal/h

Where
M_1 = the initial mass of the chulha with test fuel in kg.

M_2 = the mass of the chulha, after burning the test for half an hour in kg. and

CV = calorific value of the test fuel in kcal/kg.

(**Note:** this weighing applies only to portable metal stoves)

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 the table given below, depending upon the burning capacity rating of the chulha as determined in A-3.3.

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 2,000	180	100	356	2.0
2.	2,001 " 2,800	205	110	451	2.8
3.	2,801 " 3,200	220	120	519	3.7
4.	3,201 " 3,800	245	130	632	4.8
5.	3,801 " 4,200	260	140	750	6.1
6.	4,201 " 4,800	285	155	853	7.7
7.	4,801 " 5,400	295	165	920	9.4
8.	5,401 " 6,000	320	175	1,100	11.4
9.	6,001 " 6,600	340	185	1,200	12.50
10.	6,601 " 7,200	350	195	1,310	14.00
11.	7,201 " 7,800	370	200	1,420	16.00
12.	7,801 " 8,400	380	210	1,530	18.00

A-4 Procedure

A-4.1 Take the test fuel according to burning capacity rating for one hour. Divide the test fuel in 4 equal lots. Let the mass be '*X*' kg.

A-4.2 Stack the first lot of test fuel in the combustion chamber in honey comb fashion or as indicated by the manufacturer.

A-4.3 Select and weigh the vessel with the lid and stirrer in accordance with the table above. A minimum of two such vessels in a set will be required. Put the recommended quantity of water at 23 ± 2°C (f_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 Feeding of fresh test fuel lot shall be done after every 15 minutes.

A-4.6 The water in the vessel shall be allowed to warm steadily till it reaches a temperature of about 80°C, then stirring is commenced and continued until the temperature of water reaches 5°C below boiling point at a place. Note down time taken to heat the water up to final temperature (less than 5°C below the boiling point) f_2°C.

A-4.7 Remove the vessel of A-4.6 from the chulha and put the second vessel immediately on the chulha. Prepare first vessel for subsequent heating.

A-4.8 Repeat the experiment by alternatively putting the two vessels taken in A-4.3 till there is no visible flame in the combustion chamber of the chulha. Note down the temperature of the water in the last vessel. Let it be f_3°C.

A-5 Calculations

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

A-5.1.1 *(In SI Units)*

If: w = mass of water in vessel, in kg;
W = mass of vessel complete with lid and stirrer, in kg;
X = mass of fuel consumed, in kg;
c_1 = calorific value of wood, in kcal/kg;
x = volume of kerosene consumed, in ml;
c_2 = calorific value of kerosene, kcal/kg;
d = density of kerosene, g/cc;
f_1 = initial temperature of water in °C;
f_2 = final temperature of water, in °C;
f_3 = final temperature of water in last vessel at the completion of test, in °C; and
n = total number of vessels used.
(Specific heat of aluminium = 0.896 kJ/kg°C).

(1 kcal = 4.186 8 kJ)

Heat utilized = $(n - 1)\ (W \times 0.896 + w \times 4.186\ 8)\ (f_2 - f_1)$
$+ (W \times 0.896 + w \times 4.186\ 8)\ (f_3 - f_1)$kJ

Heat produced = $4.186\ 8\ [(X \times c_1) + (xd/1000 \times c_2)]$kJ

Thermal efficiency, percent ( ) = $\dfrac{\text{Heat Utilized}}{\text{Heat Produced}} \times 100$

$$= \frac{\{(n - 1)\ (W \times 0.896 + w \times 4.186\ 8)\ (f_2 - f_1) + (W \times 0.896 + w \times 4.186\ 8)\ (f_3 - f_1)\} \times 100}{4.1\ 868\ \{(X \times c_1) + xdc_2/1000\}}$$

A-5.1.2 *(In Metric Units)*

If: w = mass of water in the vessel, in kg;
W = mass of vessel complete with lid and stirrer, in kg;
X = mass of fuel consumed, in kg;
c_1 = calorific value of wood, in kcal/kg;
x = volume of kerosene consumed, in ml;
c_2 = calorific value of kerosene, kcal/kg;
d = density of kerosene, g/ml;
f_1 = initial temperature of water, in °C;

f_2 = final temperature of water, in ^oC;
f_3 = final temperature of water in vessel at the completion of test, in ^oC; and
n = total number of vessels used.
(Specific heat of aluminium = 0.214 kcal/kg^oC)

Heat utilized = $(n - 1)\ (W \times 0.214 + w)\ (f_2 - f_1) + (W \times 0.214 + w)\ (f_3 - f_1)$ kcal

Heat produced = $[(X \times c_1) + (xd/1000 \times c_2)]$ kcal

Thermal efficiency, percent ( ) = $\dfrac{\text{Heat Utilized}}{\text{Heat Produced}} \times 100$

$$= \frac{[(n - 1)\ (W \times 0.214 + w)\ (f_2 - f_1) + (W \times 0.214 + w)\ (f_3 - f_1)] \times 100}{[(X \times c_1) + (xdc_2/1000)]}$$

A-5.2 Power Output Rating

The power output rating of a chulha is a measure of total useful energy produced during one hour burning of fuelwood. It shall be calculated as follows:

Power output rating = $\dfrac{F \times CV \times}{860 \times 100}$ kW

Where
F = quantity of fuelwood burnt, kg/h;
CV = calorific value of fuelwood, kcal/kg; and
= thermal efficiency of the chulha, as calculated above.

Annex B (Clause 11.2), Test for Combustion Efficiency

B-1 CO/CO_2 Ratio Measurement

B-1.1 Equipment

B-1.1.1 The chulha shall be tested with its grate filled with fuelwood equivalent to 1/4 of the burning capacity of wood as determined in A-3.3. Before starting the test, a vessel of the type and size as described in A-3.4 and containing water sufficient for the test shall be placed over the chulha. In addition, a collecting hood (see Fig. 5) suitable for the chulha under examination shall be used.

B-1.1.2 The hood shall be so designed that, while not interfering in any way with the normal combustion of the chulha, it collects a fairly high proportion of the flue gases. Also it shall be such that the sample collected represents the whole of the combustion gases and not those from one particular point. When using the hood, the damper provided shall be set, or additional flue pipe added, so that spillage of the flue gases around the skirt is minimized.

B-1.2 Procedure

B-1.2.1 With the hood in position over the chulha under investigation, the fuelwood shall be lit as given in A-4.1 to A-4.5 till a stable flame is achieved and the kerosene is completely burnt, then a sufficient number of samples shall be collected.

B-1.2.2 Any of the recognized methods may be used for gas analysis. For carbon monoxide, it is recommended that co-indicator of prescribed accuracy or the iodine pentaoxide method or catalytic method, for example the Drager method, Katz method, or infra-red analysis may be used. Carbon dioxide may be tested with Orsat apparatus, Haldance apparatus or by the infra-red analysis.

B-1.2.3 Each chulha shall be tested separately. The carbon monoxide and carbon dioxide contents of the product of combustion shall be determined by the methods capable of an accuracy of 0.001 percent and 0.05 percent, respectively of the volume of the sample.

B-2 Test for Total Suspended Particulate Matter (TSP)

B-2.1 Equipment

B-2.1.1 To determine total suspended particulate in ambient air, a Handy sampler is used. The Handy sampler consists mainly of an impinger (transparent nozzle type), a filter holder, filter paper (Gelman GN-4, 37 mm and 64678 or its equivalent Whatman) and a motor unit (which involves rotameter and suction pump). These accessories of the instrument shown in Fig. 6.

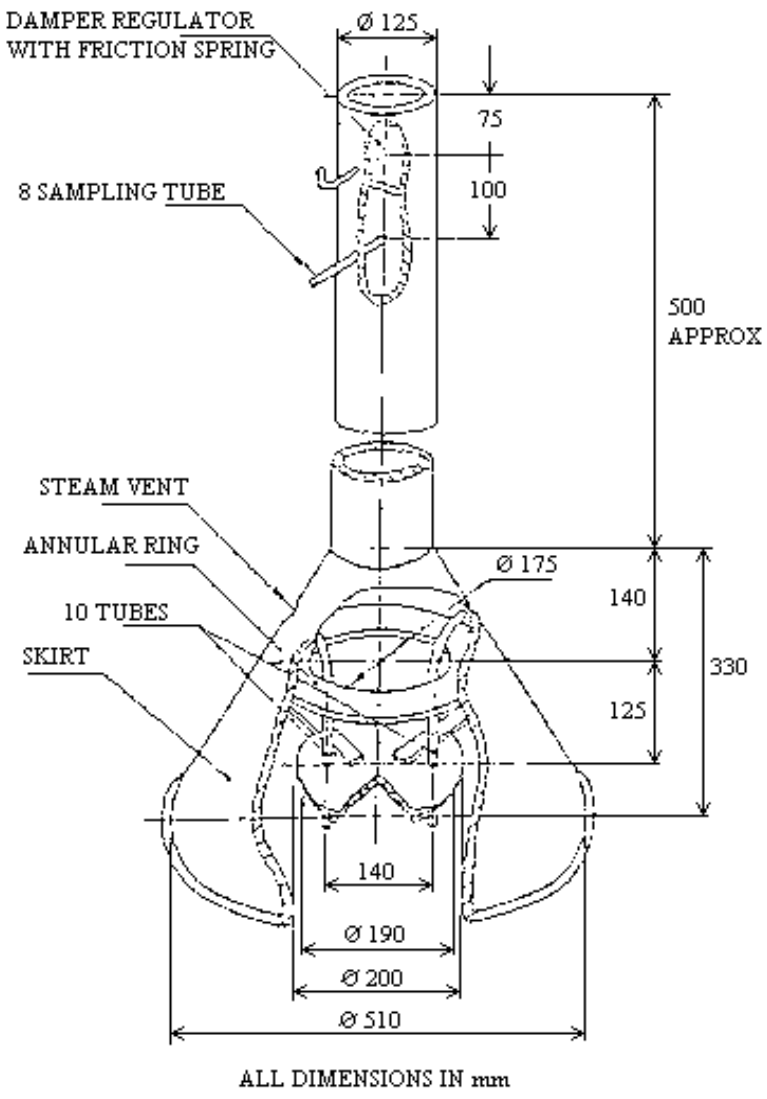


Figure 5: Hood for CHULHA

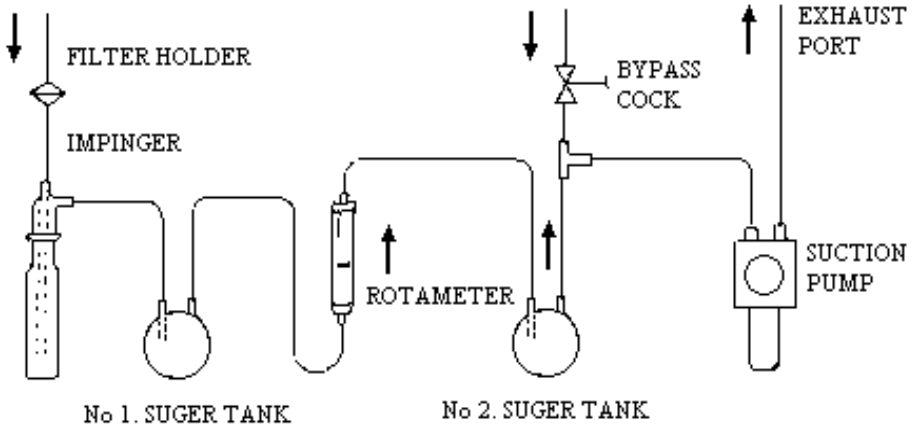


Figure 6: Flow Diagram for Handy Sampler

B-2.2 Preparation Before Operation

Filter paper (very neat and clean) is very carefully weighed on an electronic balance having an accuracy of 0.01 mg. and is placed between a filter holder. The filter holder and No. 1 surge tank (as shown in flow diagram) are connected to the impinger and the other arrangements of the accessories are checked out as per the flow diagram.

B-2.3 Procedure

Timer can be set for desired sampling time. It is set for one hour. Sampling time can be set to various times within 60 minutes by turning the knob clockwise. The flow rate of suction of ambient air is set by a rotameter, which can be used up to 2.5 l/min, maximum, for the purpose of this specification. The instrument maintaining the conditions described above is placed at a distance of 30 to 45 cm from the burning chulha and at a height of 30 to 37.5 cm from the ground level of the chulha. After the completion of one hour the filter paper is taken out and is again weighed on the same electronic balance, on which it was weighed initially.

B-2.4 Calculation

The total suspended particulate matter is computed by measuring the mass of collected particulates and the volume of air sampled in the ambient air, in the following manner:

If: Initial mass of filter paper in g. = X
Final mass of filter paper, in g. = Y
Flow rate of ambient air, litre/min = Z

(Flow rate zl/min is to maintained for 1h).
Then the mass of collected particulate, in g.

$= (Y - X) \times 1000$ mg.

Total volume of air $= Z \times 60$ l $= 60Z$ l

$= \frac{60Z}{1000}$ m^3 (since 1000 l = 1 m^3)

Total suspended particulate $= \frac{\text{Mass of collected particulates (mg)}}{\text{Volume of air sample } (m^3)}$

$= \frac{(Y - X)\ 1000 \text{ mg}}{60\ Z\ m^3/1{,}000}$

$= \frac{(Y - X) \times 10^6}{60Z}\ \frac{mg}{m^3}$

Annex C (Clause 11.3.1), Method of Measurement of Surface Temperature

C-1 Preparation of Chulha

C-1.1 The chulha 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 chulha which are likely to be touched during cooking operations shall be measured by using a thermometer or any other suitable device for measuring the surface temperature. The temperature of each of these parts shall be measured three times 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 a sufficient period of time until the maximum temperature is reached.