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Production Training for BRET Metal Stoves

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PREFACE

The Botswana Renewable Energy Technology (BRET) project is jointly funded by the Government of Botswana (GOB) and the U.S. Agency for International Development (AID). The BRET project is a part of the Ministry of Mineral Resources and Water Affairs (MMRWA). Technical assistance and project management are being provided by Associates in Rural Development, Inc. (ARD), of Burlington, Vermont, under AID contract number 633-0209-C-00-1024-00.

This report is based on the work of ARD fabrication and production engineering specialist Eric Brunet. Mr. Brunet spent seven months in Botswana with the BRET project, working closely with local tinsmiths, on the design, adaptation and fabrication of various versions of wood-conserving metal cook-stoves, from October 1983 through April 1984.

Judith Oki, extension support supervisor, and James Sentle, stove/solar technician, both of the BRET staff, shared in the effort to produce this training report.

Two other technical reports resulted from Mr. Brunet's work during his consultancy. "BRET Metal Stove Production Guide for 'B' and 'Delta 3' Stoves" provides in detail how a metal stove is put together, covering all the steps from production of templates to embossing the BRET logo on the outside wall of the stove. "Technical Adaptation: BRET Wood-Conserving Metal Stoves" follows chronologically the development process initiated at the start of the BRET project with the identification of needs

and renewable energy resources, followed by the identification and selection of technological options. The development of the "B" model wood-conserving metal stove had its origins in an earlier metal stove, taking that prototype as its base. A second adaptation of the "B" model was carried out to correct the low-production cycle of traditional tinsmiths, as well as to work up to the mass-production capacity of well-established metal workshops in Botswana. The "Delta" stove series illustrates this backstep, arriving at national dissemination of metal cookstoves. Both of these additional reports are available from the BRET project.

Work Undertaken

The initial scope of work outlined for this consultancy called for assistance in the final development of sheet metal cookstoves and the sorting out of the earthen stove issue by performing the following specified tasks:

- to review and evaluate stove work and testing to date, for both metal and mud stoves;
- to modify design and conduct retesting, if modifications in stove design seem warranted;
- to develop a metal stove market-testing and dissemination program; play a major role in directing and carrying it out; supervise and train project personnel to continue the training process; work with other established training centers in Botswana, where possible; and incorporate the production of sheet metal stoves;
- to develop a system for social, technical and energy evaluation of stove work;
- to work with BRET staff on all aspects of this effort;
- to provide a draft of a final, written report for BRET staff prior to departure; and

- to provide a final draft of the above report to ARD/ Burlington immediately upon return to the United States.

For the sake of clarity, this report relates only to the work performed with metal stoves. Another report covering construction, testing and training with earthen stoves is being prepared by Carmen Penty, who contributed time and effort on the mud stove development.

Accomplishments

During this seven-month consultancy, the following tasks were accomplished:

- review and reprinting of fill-in forms for water boiling tests;
- revision of follow-up forms for users of metal stoves;
- collection of feedback from other development organizations, such as PFP, RIO and BEDU;
- production of six prototype metal stoves of models "B" and "Delta" series;
- preparation of an initial set of three different templates;
- training of 11 producers in making a total of 125 metal stoves (May 1984);
- production of 10 wire BRET logos for metal stove identification;
- design of a BRET logo for stationery, vehicles and T-shirts;
- draft of a metal-stove user leaflet;
- draft of a metal-stove publicity leaflet;
- completion of four metal-stove workshops;
- completion of nine separate water-boiling tests on metal stoves and assisting in BRET water-boiling tests with 12 local cooks;
- participation in BRET passive solar housing workshop (metal and earthen stove fabrication);
- production of plans for all the stoves tested; and
- production sketches of the various steps needed to make BRET metal stoves.

I. INTRODUCTION

This report summarizes the BRET experience in training local tinsmiths to produce a wood-conserving sheet metal stove. The training of producers is one of many steps in the BRET technology development process. Details of previous steps (which include needs identification; prototype design, development and testing; and preliminary user testing) are found in other BRET documents.

Briefly, the "B" stove is built so that common three-legged cast iron pots, sizes one, two and three, fit inside, resting on supports. The stove has an inner and an outer wall, which add insulation and strength while making the stove safer for use around small children. The stove is designed so that the components closest to the fire, i.e., those which will wear out most quickly, can be replaced easily. The principal advantages of the stove over the open fire are that it:

- uses about 30 percent less wood in actual user tests;
- cooks faster, saving about 15 minutes per meal; and
- is portable, making it very practical in a country where people travel long distances between their village homes, agricultural lands and cattle posts.

The training approach described here has been selected to suit the sheet metal fabrication techniques as well as the elementary tooling skills possessed by the Mazezuru people. This group is believed to be the only one in the informal sector in Botswana having the skills to accurately produce the line of metal stoves that has evolved.

Detailed descriptions of the training workshop schedules for the Mazezuru tinsmiths and for the Partnership for Productivity (PFP) group are included as Appendices A and B.

Observations on the first batch of stoves are detailed in Appendix C. Appendix D contains the production follow-up schedule.

II. TRAINING CONSIDERATIONS

At present, there are no portable, metal wood stoves used or produced in Botswana, although there are cooking units available which use wood and other fuels. Training was required to instruct the artisans how to produce units in sufficient numbers for widespread demonstrations, to encourage private-sector production of the BRET "B" stoves, and to learn about the process of sustained production.

In addition to teaching the tinsmiths how to apply their existing skills to quality production of the stoves, the training sessions were designed to determine:

- what rate of production per person could be expected;
- difficulties encountered in production;
- the degree of interest in pursuing this line of production; and
- what improvements and modifications could be made to the stove itself to provide producers with the best use of time, materials and technical resources.

III. TRAINING METHODS

A. Approach

BRET staff could not point to a formula for how to train experienced tinsmiths, but other stove programs in Africa have provided some guidelines as to what should be included in such a course, and systematic methods used for other kinds of technical skills training provided guidance on the preparation, instruction and evaluation.

The preparation phase of the training included focusing on the desired results, planning the logical learning stages, and isolating the most critical components of the construction process This involved a detailed analysis of the construction process and the specific tools and materials used in each step. Detailed tool and materials lists are described in section III.C.

When dealing with experienced tinsmiths, teachers must show interest and confidence in the learners, and must treat them as mature individuals, encouraging questions and discussion. Key aspects of the instruction included clear explanations of what was to be accomplished in each stage of stove construction; clear demonstrations; emphasis on key or complex parts; and actual practice, with careful observation and spotting of errors or problems for immediate correction.

Throughout each day of the training, and particularly by the end, it was necessary to make certain that the trainees had performed to the required standards. It had been determined that only those tinsmiths whose work was of high quality would

be contracted to produce BRET stoves, would be given certificates, and allowed to use the BRET stove logo.

B. Use of Templates

With the development of the "B" stove from plans to prototypes, templates were developed to ensure correct measurements. Mazezuru already make use of templates to produce flour bins, buckets, tubs and bells. The templates for a metal stove are obviously more complex, since more working parts are involved. However, it is felt that the use of templates is the only way to increase the confidence of the trainee and ensure uniformity of the stoves. It also decreases substantially the time required to train the tinsmith and to produce stoves. For the moment, innovation of the stove has been downplayed, since that requires knowledge of the thermal effects of changes, and BRET wishes to retain responsibility for that at this time.

Trainees are first required to produce their own set of templates from a master set, and then to know what gauge of metal is used for each stove part. It is all too easy to modify one detail unconsciously and have the whole assembly fit improperly.

IV. SELECTION OF PARTICIPANTS

A. General Qualifications

As mentioned earlier, the stove was initially designed to use the skills of existing tinsmiths, and the training program was designed specifically for that. The general qualifications required of participants included:

- possession of the tools of the trade and a place to work;
- possession of the required skills, e.g., ability to fabricate a sheet metal bucket;
- willingness to and interest in participating in the three-day training workshop; and
- ability to spend time producing stoves for BRET.

During the course of a market study conducted for BRET by Partnership for Productivity (PFP), interest in stove production was generated among PFP clients who had no previous metal working/tinsmithing experience. Because of the high degree of interest in developing a stove production business, the decision was made to conduct a specialized version of this training for PFP clients. That training is described in the appendices.

B. Targeting Production Locations

Mazezuru products can be found virtually everywhere, but the producers are located primarily in the major villages and towns. Therefore, it was decided that those major villages and towns closest to current BRET activities would be selected. A decision was taken, then, to train tinsmiths in Gaborone, Molepolole, Mahalapye and Serowe.

C. Identification of Participants

With a few variations, described below, the process of participant identification involved visiting known Mazezuru producers and known sales points for metal products. At the sales points, a particularly high quality product would be identified, and then the BRET staff person would ask who the producer was and where he stayed. Once the producers were located, they were shown the stove, asked if they would be able to and interested in making it, and whether they would invest time in a two-day training program. This process was much like a treasure hunt. It took one to three staff days per location, and may or may not have resulted in the identification of the most highly skilled tinsmiths, but was certainly effective in locating good candidates. A problem that arose consistently was actually getting those people identified to the training. Once training participants were identified and dates agreed upon, a return visit one to three days before the training session was required.

Gaborone--In Gaborone, there was a slight advantage as one producer had been identified when BRET needed 30 stoves for preliminary home-use tests in the villages. This man, Mr. Sithole, was helpful in identifying other potential participants. The Botswana Enterprise Development Unit (BEDU) Mobile Metal Workshop training staff was interested in the product and training, and recommended

some of their clients as potential training participants. The BEDU trainers were invited to the Gaborone training so that, in the future, they could also train tinsmiths as their work carried them around the country.

Molepolole and Mahalapye--The process used was that described above. The workloads of the craftspeople, and the occasional absence from town of an individual, made several trips necessary. Generally, however, each tinsmith could find at least one more; and in both locations, at least four or five people showed initial interest.

Serowe--The Mazezuru headman in Serowe was reluctant to become involved in this venture, as he felt that his people had more pressing and certain work to undertake. This experience of requiring a headman's clearance was a unique one, not encountered elsewhere. Although one wonders about the legitimacy of the claim, it can be said, at least, that at the time, the Mazezuru in Serowe were not interested in or willing to undertake the training. The BRET staff expects that if the stove is successful and demand becomes high, there may be some reconsideration.

V. SUMMARY OF TRAINING SESSIONS

Gaborone (January 16-17, 1984)

There were two participants, two trainers and two observers (from BEDU). Two more particpants were expected but failed to show up.

This first training session provided BRET staff with:

- corrections to the template sets;
- an accurate time frame for producing a set of templates (approximately 3.5 hours per person) and one complete stove (approximately 5 hours per person).

Both stoves produced were of excellent quality, and were tight fitting. Both producers were enthusiastic about their product and how well all parts fit together.

A total of 50 stoves was ordered from the two producers, and the wholesale price for BRET was set at P12.00 with grill, and P15.00 was agreed upon as the retail price.

The principal managers of the BEDU Mobile workshop were invited to provide experienced advice on the training process as well as point out any flaws in the metal stove construction technique. Apart from a few tips which helped in improving the final stove design, the BEDU managers strongly recommended against attempting to train people who are not already artisans to build stoves. Such people would be difficult to train because they are unaccustomed to the strengths and limitations of tools and materials, and may not understand the importance of precise measurements.

Molepolole (March 13-14, 1984)

There were three participants and two trainers present.

The experience gained from the first training session, in Gaborone, made the Molepolole session a breeze. The group achieved a particularly high rate of workmanship. One of their products is a cheap cylindrical bucket made from odd-sized pieces of galvanized metal sheets--basically the same construction as the "B" stove.

Two sets of templates and two stoves were produced. A new heavy-gauge pot pad was suggested, but unless the tinsmith finds the ideal discarded casting (one particular valve head proved efficient), the part is difficult to produce. 1.6mm gauge metal is the limit for work with a hammer and bare hands.

Figure 1. Tracing Templates

Figure 2. Cutting with Snips

Figure 3.
Trimming the Part

Figure 4.
Cutting the Grate with Chisel

Figure 5.
Marking with Edge Gauge

Figure 6.
Forming the Top Ring

Figure 7.
Punching Holes in the Grate

VI. CONCLUSIONS

1. The BRET "B" stove is a good performer, well adapted for local use and the capabilities of local artisans and manufacturers.

2. The "B" stove was literally designed with the Mazezuru in mind, and the training approach is well suited for this group.

3. Most Mazezuru have enough work to do with their current production lines, and stoves are likely to remain a secondary activity, with trickle production, unless they are more lucrative than the other activities.

4. All stoves produced during the training were true to the original samples.

5. Organization of work during the cutting and assembling of the stoves is somewhat haphazard and could use some streamlining.

6. Given that there are other items in each Mazezuru line of production, the realistic production estimate is 1.5 days per stove. Unless a producer is set up to make metal stoves only, it is difficult to evaluate his real output potential.

7. With adequate production, the BRET "B" stove could enter competition, just as water pails and wash tubs produced by the informal sector are currently competing with imports.

8. All the metalsmiths showed very good performance when working together. Some are more adept at punching, others at making

grooved seams. The number of parts involved in making the stove will probably produce some specialization, as is commonly the case in other countries where metal stoves are produced.

9. All three groups (Gaborone, Molepolole and Mahalapye) have the essential tools for producing their normal wares, and require the following to produce the metal stoves:

--hole punch (13-24mm) to make grates;

--some kind of anvil with holes to make grates;

--scriber (or sharp nail) to draw contour of templates (templates used currently are not so complex that they require this tool, thus most tinsmiths do not have it);

--sharp chisel for the 1.6mm gauge grate metal (current production items are not this thick; snips will not do the job);

--specialized tools for punching the holes in the grate (It is almost impossible to do a good job without some kind of cast iron anvil with suitable holes for supporting the work, and a strong hole punch. 13-14mm punches are not available commercially, and mild steel rod is not strong enough to withstand the repeated pounding without bending. The best alternative was to demonstrate how to dismantle a shock absorber.).

10. When a larger order comes, such as 50 stoves, the capital invested is somewhere in the P400.00 range. This sum seems rather out of reach for those people who normally purchase one or two sheets at a time. To permit faster turn-out of stoves, two methods were tried: providing a list of materials along with cash, or providing just an assortment of materials to produce a certain number of stoves. It must be noted that in the case of the "B" stove, a base of 50 stoves is linked to the size of 1.6mm sheet metal where 50 grates can be cut out.

11. The hesitancy of PFP clients to come forward for training, and the slow production rate of the Mazezuru, indicate that some consideration must be given to a more fundamental training program, or revision of the stove design.

12. It may not be possible to rely on the Mazezuru for production of an adequate supply of stoves.

13. It is difficult to define the materials used for the stoves since, unfortunately, the number of parts cut from one sheet of metal does not match absolutely on the basis of 50 stoves. It is easier to figure materials required on a basis of 100 stoves. For example, in figuring for 50 stoves, one can get:

50 grates per sheet of 1.6mm metal, exactly
23 top rings per sheet of 0.8mm
21 bottoms per sheet of 0.8mm
18 inside walls per sheet of 0.8mm
8 outside walls per sheet of 0.5mm

If one figures materials on the basis of 100 stoves:

# of parts	part	# of sheets
8	outside walls per 0.5mm sheet	12
18	inside walls per 0.8mm sheet	5
20	top rings per 0.8mm sheet*	5
50	grates per 1.6mm sheet	2
21	bottoms per 0.8mm sheet	5

*3 top rings are not cut, to allow for 5 more outside walls.

VII. RECOMMENDATIONS

1. In order to increase and sustain production of the metal stove, additional manufacturing possibilities and required training should be pursued, and a modification of the stove, currently underway, should be completed.

2. The stove construction process should be simplified to enable training of those who currently do not have skills, e.g., PFP clients, and the very interested group of villagers in Ditshegwane. This process has begun and test results indicate that simple modifications can be made to accommodate lesser skills while retaining efficiency.

3. Training should be targeted at people who will make stove production their major work.

4. Other metal-working organizations that are tooled for sheet metal fabrication should be investigated. Production possibilities could be explored with organizations such as

   BRIDEC: two brigades--

   Mochudi: Kgatleng Development Board
   PO Box 208, Mochudi tel. (037) 356

   Mahalapye: Madiba Educational Training Center
   Private Bag 12, Mahalapye tel. (041) 285

5. Different metal-working enterprises which are interested in producing the stove with the modifications:

--TUMELO STEEL INDUSTRIES:* PO Box 1324, Gaborone tel. 51890
--MOSUPATSELA ENGINEERING:* Attn: M. Moatshe, Dintwe

*BEDU Industrial Site

5. (continued)

--ELECTRO MECHANICAL ENGINEERING: Gaborone, PO Box 869
--Metal Founders (Pty) Ltd., Selebi-Phikwe (2700), PO Box 231
--Lobatse Engineering (Pty) Ltd., Lobatse (2144), PO Box 336
--PSL Botswana (Pty) Ltd., Selebi-Phikwe (2700), PO Box 163
--Metal Kraft (Pty) Ltd., Francistown (225), PO Box 202

APPENDIX A

BRET Metal Stove Workshop Schedule

METAL WOODSTOVE WORKSHOP GENERAL SCHEDULE

SESSION	OBJECTIVES/ACTIVITIES	DURATION	MATERIALS
°Introduction to Trng	Check in/Getting acquainted Short Lecture on Workshop Goals	2 hours	Pens, 2 Cameras, Chairs Workspace, Note Pads
°Introduction to Stoves	What materials are required for Stoves, tools: How the Stove operates, How it was developed.	½ hour	Metal Sheets, Set of Templates Tools
°Tracing and Cutting Templates	Participants will start to trace templates and cut them and identify any problems, shortcuts, etc.	3 hours	Stop Watches, Metal Sheets, Set of Templates, Tools. Metal Grill, Record Sheets.
°Tracing and Cutting Parts	After Templates have been checked, participants will begin to cut parts.	3 hours	Stop Watches, Metal Sheets, Set of Templates, Tools. Metal Grill, Record Sheets.
°Sub assembly and assembly of stoves	Participants will accurately complete subassembly, demonstrating quality of techniques. Then, they will assembly the stove in the correct sequence. Trainees will say all the problems they have encountered and what they think might be the solution.	2 hours	Stove Parts, Cut by Trainers
°Wrap Up/Next Steps	Metal smiths will be required to produce 25 stoves initally-labor cost and material cost will be discussed (This has been found to be half and half). The metal smiths should give their earliest day of completion for the first batch.	2 hours	Flyers, Posters, Note Pads, Pens, Chairs

METAL WOOD STOVE WORKSHOP

SESSION 1. Introduction to Training

Objectives:

- Welcome and get acquainted with trainees.
- Share workshop goals.
- Provide a rationale for the workshop.
- Review the Schedule.
- Discuss how we will work together.

Approximate Time:

One hour

Staff:

2

Workshop space, seats, blackboard, chalk, printed schedule, note pads, cameras, metal tools, stoves, wood, tea kettle, coffee, tea, milk, cups, spoons.

Procedure:

A. Getting acquainted. When participants arrive, the metal stove is used heating water for coffee or tea. Invite participants to make a cup of coffee or tea, and take a seat.

   Trainers will introduce themselves and welcome participants to the workshop. Ask each participant to introduce himself. Are they related between each other. Say for how long he has been working with metal. Is he happy with his job? What products does he make and which sell best? It is the only business he has lined up and why?

B. Tell participants what the goals are, ie., train producers, gather some information from people actually trying to produce stoves, get and share information about marketing.

C. Share the workshop schedule, ie., explain that they will spend about one and half days learning to produce the stove, and about a half day discussing next steps and marketing.

D. Ask if there are any questions about the workshop.

E. Explain that notes will be taken. All phases of work will be photographed to provide illustration as well as a slide set for future references.

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SESSION I. (con't)

F. Check to see that everyone brought the necessary tools they normally use or what tools are missing.

Share the arrangements for lunch, transportation.

Ask if there are any questions about the logistics.

Note:

BRET will make available the following tools:

- 3 scribers
- 2 snips
- 2 chisels
- 2 files
- 2 hole punch (o.4) for rivets
- 2 hole punch (12.5) for grate
- 1 metal ruler
- 1 seam tool (groover)
- 1 set of letter punches
- 1 center punch
- 4 Embossing Logos (BRET)

BRET will have on hand the following materials for training:

- One sheet of 1.6mm steel (Black) for grate.
- One sheet of 0.5mm galv. for outside walls.
- Two sheets of 1.0mm (Black) inside parts.
- Two sheets of 0.8mm galv. for templates and parts.
- One sheet of expanded metal for grill.
- One length of 6mm round metal for hoop handles.
- Four meters of gauge 10 galv. wire for rims.

Other items:

- Two sections of rails (120cm long)
- One metal drum (empty)
- One old valve head for punching holes.
- One sample stove. Two sets of templates.
- One kg of flathead rivets.

SESSION 2.

Objectives:

Trainers will describe the rationale for the stove, and reasons women will be interested in buying it; they will explain how the stoves operates, and the materials and tools required to make the stove.

Approximate Time:

30 minutes

Staff:

2

Materials Required:

Old stove prototype.

One complete stove.

Templates, tools, various gauges of metal as sample.

Procedure:

A. Give a short history of the stove, explaining why it was developed, the design changes made. Participants should be shown previous models of the metal Wood Stove and discuss technical improvements made on metal gauge selections, construction method, and durability features. How it was tested.

B. Describe and show what parts are made from what materials. Show how it fits together.

C. Ask how it fits into their normal work. Record answers.

D. Check to make sure that everyone understands why the different parts are made from the selected materials and why there should be no substitute. If this is clear, move on to next session.

24

SESSION 3.

Objectives:

[The key to successful production of the Metal Wood Stove is the correct understanding of the templates and their effect on the end product] By the end of this session participants will be able to accurately reproduce templates for all parts of the stove, select the proper gauge of metal to be used for each template. BRET will learn from this session how long it takes a producer to copy one set of templates.

Approximate Time:

3 hours

Staff:

2

Materials Required:

One set of templates for every two participants - scribers, fold line gauges, metal ruler, individual tools, metal files, 0.8 galv. metal sheets, data recording sheets and stop watches.

Procedure:

Explain the objectives of the session. Distribute templates and ask participants to begin tracing and cutting. Trainers will check each participant, answer problems and take photos. Also, make general observations about skills and techniques. When task is finished, discuss as a group, shortcuts, problems, solutions, and share relevant observations.

Evaluation:

Data recording sheets will provide BRET with average time for template production. Constant monitoring will ascertain that copied templates are accurate and ready for the production session.

Shortcuts will be determined, problems encountered solved and noted, if any.

Note:

Make sure participants have enough shaded working area. Four people can work on one sheet starting at both ends.

It is recommended to rough cut the whole metal area needed first.

SESSION 3. (con't)

Note - con't.

Tracing the contour of the template is best done on the ground by putting one's weight on the template so it does not shift.

Heavy pressure on the scriber will assure correct line and readability when cutting. The line should be clear and crisp.

The notch marks indicate fold lines and are used on templates only.

Use a metal file to obtain a smooth edge; it will be less dangerous for your hands.

SESSION 4.

Objectives:

By the end of this session, participants will be able to:

- Accurately reproduce stove parts from templates, with proper metal gauges.
- Punch holes at the precise locations.
- Mark all fold lines with ruler and fold line gauge.

BRET will learn from this how long on the average it takes a producer to copy and cut out parts for one stove. (In the case of many stoves, time will drop substantially.)

- Participants will also know how many parts can be cut out from each type of sheet metal (50 grates, 1.6mm sheet). Also, in the case of unavailability of such and such gauge of sheet metal, alternative substitute will be prescribed (ie., If there is no I.0 sheet one would use 0.8 and vice versa) The producers will use the mark to emboss the stove's outside wall.

Approximate Time:

3 hours

Staff:

2

Materials:

Templates, individual tools, scribers, fold line gauges, 0.5, 0.8, 1.0, 1.6 metal sheets. Expanded metal for grill, workshop tools, rail section, data recording sheets and stop watches.

Procedures:

Once trainees have satisfactorily completed cutting templates, they can begin to trace and cut parts. They will select material, and trainer will check to make sure it is from the correct gauge sheet. Remaining time, basically as in session 3, with trainers supervising, answering questions, taking notes, etc.

The group will discuss what were the major difficulties encountered and bring forward solutions. Some evaluation of alternative metal cutting techniques will be brought forward.

SESSION 4. (con't)

Note:

As for copying templates, use a firm hand on the scriber to obtain a sharp line.

A scrapped engineblock or valve head offers good support for prepunching holes. Flatten the template afterward.

If the trainee is not used to a metal punch, he is probably accustomed to using a nail or just the rivet. A hole punch gives better accuracy. It can be easily made from a discarded car shock-absorber shaft.

SESSION 5. Sub-assembly and assembly of Metal Wood Stove

Objectives:

This last step in Metal Wood Stove (MWS) construction will show the rationale for accurate template work and preparation of all parts before assembly.

Little difficulty should be encountered, and for sales purposes, all stoves should receive the same level of workmanship.

Steps for sub-assembly:

1. Door/Hinge/Lock/Latch
2. Form 3 pot pads.
3. Form grate supports.
4. Punch grate.
5. Install handles on grill.

Steps for assembly:

6. Outside wall/bottom plate.
7. Inside wall grate supports.
8. Top ring/pot pads.
9. Run wire on outer wall/hoop.
10. Final assembly.

Approximate Time:

2 hours for steps 1-5.

2 hours for steps 6-10.

Staff:

2

Materials Required:

Same as in session 3. Hole punch and old valve head, wire for stove edge, R. rod for hoop handle. Workshop tools, data sheet and stop watches.

Procedure:

A. Describe and demonstrate the above step in the sub-assembly. Ask for questions.

B. Participants will begin sub-assembly. Trainers will check work, answer questions, etc.

SESSION 5. (con't)

Procedure - con't.

C. When the parts are accurately sub-assembled, trainer will review and demonstrate the assembly sequence.

D. Participants will begin assembly. Trainers will check each person's work, paying special attention to top ring edge, folding bottom to outside wall, and joining door width.

E. When assembly is complete, summarize problems, solutions, techniques, in a group discussion.

Notes: (sub-assembly/main difficulties)

Step # 1. Door hinge making is easier done by using a groover to have the metal tab follow the hinge pin.

2. Pot pads are a bit tricky at first. Fold front and side. Form wings at right angle on the edge of rail. Then form hump on the hollow flat edge of the rail using both hands and a big push.

4. Grate holes are easily done by blinking the hole location on a big hole, then centering the depression on a pushrod hole with the hole punch.

6. Outside wall to bottom plate: Bend bottom plate at right angle (6mm) on the edge of rail.

Position outside wall inside bottom plate and check proper fit by spreading bottom of door apart. The door should be square and at the same time there should be a gap of 1mm around the flared outside wall bottom. Fasten rim wire to bottom of door working from the center (wire is approximately 17cm long). Reposition outside wall, and pinch the flange at three or four locations. Lock assembly by pinching the bottom of the door on either side of the bottom plate rim wire. Close down the flange gradually to prevent buckles and wrinkles from forming. Work on the flat side of the rail and turn constantly The panned-down joint is best finished with a cross peen hammer.

Turn the rail right side up (round top) and slip in the stove. The bottom plate tight against the edge. The outside wall on the running surface. Bend the seam over gradually by turning the stove constantly while flattening with the hammer.

The outside wall is now ready for fastening the door and hoop handle.

8. Top ring form the inside fold first following the 9mm line and bending with the hammer over the edge of the rail. Turn constantly to produce an even job. This will rigidify the ring. Flip the ring over and do the same for the outside 9mm edge. Pay special attention not to overstretch the metal and that the work is straight and true. Test fit before riveting pot pads. The inside wall is usually easier to fit than the outside one.

SESSION 6. Wrapping up: next steps with the MWS

Objectives:

1. To obtain a listing of producers' usual sales outlets and ask for other places/ways to advertize.
2. To agree on price and weekly production basis of MWS (and templates if required).
3. Fill in on BRET advertizing plans (Daily news, MWS fact sheet, MWS user flyer).
4. To select metal workers to produce an agreed number of stoves, agree on date completed.

Approximate Time:

2 hours

Staff:

2

Materials:

Note pads, MWS fact sheets, user flyers, cameras.

Procedure:

A. Remind participants reasons they thought women would buy the stoves. Then, lead a discussion, moving through all the points listed above. Record carefully all comments, agreements, and dates for completion. Remind participants of BRET logo, and that it must be on all stoves.

B. Ask participants to evaluate workshop-what was helpful, not helpful. Are they confident about producing stoves and any outstanding questions. (Record)

APPENDIX B

BRET Metal Stove Workshop with PFP--Gaborone

April 17-19, 1984

1 Participant, 1 Trainer.

Following BRET's market study in Old Naledi in November 1983, was agreed that the PFP extension team would identify potential trainees to undertake the metal stove workshop. It is only recently that a potential candidate was found--after many failed attempts.

Following the development of the newest BRET stoves, "Delta 3" and "Delta 6," it was decided to train the metalsmiths on that particular model which had been tested as a prototype. (See "Technical Adaptation: BRET Wood-Conserving Metal Stoves," available from BRET office.)

Two sets of templates were produced with great detail as the work progressed, starting with an outside wall similar in dimension to that of the "B" series. Minute measurement errors were corrected as had been done previously, to provide the metalsmith with a trouble-free production and assembly technique. More time was therefore spent checking and rechecking all parts to ensure accuracy.

One Mazezuru from Molepolole was quite impressed with the new version but when presented with the task of bending the 1cm thick rod used for pot support, the hammer and rail solution was not too effective.

Alternatively, holding the part in a 5-inch vise will do an excellent right-angle job with light hammer blows.

A cheaper solution would be to adapt the rod bending technique used in concrete reinforcement--using the valve head, or discarded engine block, steel pins, and some claw lever. It works!

APPENDIX C

Observations on the First Batch of 33 Units

1. The stoves have good uniformity, and the grates are well made.
2. About 10 stoves were made with 0.5mm sheet metal (pot pads and top ring), which is substandard.
3. Other minor mistakes: The grate support is located higher that it should be, raising the grate to 6 cm instead of 5.5 cm. Some of the logo embossing was done the wrong way around. Most doors were a bit out of square due to ill positioning of bottom plate/outside wall.
4. Production cycles have been found to be rather low (1.5 days per stove per person). BRET staff's impression is that the producers prefer making their standard wares because they find them less bothersome to assemble.

APPENDIX D

Production Follow-Up Schedule

Participants	3/84	4/84	5/84	6/84	7/84	8/84	Observations
Gaborone team	33		(17)		(50)		
Molepolole team		25			(50)		BRET "B" until July shift to "Delta" series (3 and 6)
Mahalapye team			(25)		(40)		
Old Naledi/PFP			set-up	(40)	(40)		"Delta 3" from start, introduce "Delta 6"
Botswana Steel Furniture MPG		proto-type test	(200)	(200)	(200)		Industrial version of "Delta 3" only
BRIDEC			set-up	?	?		Participation not established yet.
Others			investigate				Part of final report. (See section VII of this report.) Potential industry producers with quotes and production rates.