



HUYS ADVIES

# HOW TO MAKE A HEAT RETENTION BOX (HRB)

*FOR TWO POTS SAVING >50% COOKING FUEL*

Technical Working Paper ~ Number 21



Report by:  
Sjoerd Nienhuys  
Renewable Energy Advisor

Date: April 2012  
(Revised)

[www.nienhuys.info](http://www.nienhuys.info)



# TABLE OF CONTENTS

<b>INTRODUCTION.....</b>	<b>1</b>
<b>1. HEAT RETENTION BOX .....</b>	<b>2</b>
1.1 <i>HRBox vs. HRBag.....</i>	2
1.2 <i>Box Criteria.....</i>	2
1.3 <i>Thermal Insulation.....</i>	3
1.4 <i>Testing and Demonstration.....</i>	3
1.5 <i>Higher Altitudes.....</i>	5
1.6 <i>Making Alternative Designs.....</i>	6
1.7 <i>Test Results .....</i>	6
<b>2. PROMOTION – COOKING CLUBS.....</b>	<b>7</b>
2.1 <i>Promotion of Energy-Efficient Cooking Methods .....</i>	7
2.2 <i>Setting Up Cooking Clubs.....</i>	8
<b>3. MAKING A HEAT RETENTION BOX (HRB).....</b>	<b>9</b>
3.1 <i>List of Material.....</i>	9
3.2 <i>Making and Assembly.....</i>	11

## **Abstract**

This Heat Retention Box (HRB) is based on thermal insulation using three metalized reflective foils separated by PE foam strips. The HRB can hold two pots (stacked), one large and one small. The thermal insulation value is approximately  $R_c = 2.2 \text{ m}^2 \cdot \text{K}/\text{W}$ , being similar to 9 cm of expanded polystyrene (EPS). The 50 cm high HRB can be used for a 6-litre pressure cooker and a 3-litre simple cooking pot. A 6-litre pressure cooker with food having a 7 kg mass and a starting temperature above 105°C will stay above the slow cooking temperature (>65°C) for at least four hours. Promotion and organisation of cooking clubs. Drawings of the components and self-assembly.

Example for making a 33 mm thin wall Heat Retention Box (HRB) from pre-painted hardboard, three reflective foils and thin timber pieces. This design can be series manufactured and assembled at the house of the villager, thus saving transport volume and avoiding damage during transport.

**Key Words: hay box, heat retention box, self-assembly, cooking club**

## **Cover Page Photo**

*Test model of a Heat Retention Box (HRB) with a 6-litre pressure cooker and 3-litre common cooking pot. The box is made with three reflective foils and has a wall thickness of only 33 mm.*

# INTRODUCTION

Household energy consumption in the Himalaya regions is mainly for food preparation (summer and winter) and space heating (winter). At altitudes above 1500 m, the fuel consumption for space heating is greater than required for cooking and bread making. At altitudes over 2500 m, space heating requires twice the amount of fuel than needed for cooking.

Fuel saving for space heating is mainly done by thermal insulation of the house. In mountain villages, the cooking stove acts also as a space heater in the winter. In poorly insulated houses, the stove needs to burn for many hours to keep the room warm. Therefore, in cold climate zones all over the world, traditional dishes (such as stews) have been based on long cooking periods.

With scarcity and the increasing cost of fuel, fuel savings should be obtained first by thermal insulation of houses, followed by improving the stove. If a house is well insulated, less heating (stove) time will be required. However, when people continue to prepare traditional dishes requiring long cooking periods, the saving on fuel will be less.

Since cooking is done during both summer and winter, more efficient or Improved Cooking Stoves (ICS) will save large amounts of cooking fuel. Changing cooking methods will also save large amounts of fuel, but many people do not want to change their recipes and adhere to the traditional method of cooking.

The solution to this problem is slow cooking in a thermally insulated box, a cooking method being used for hundreds of years in many countries. With improved thermal insulation technologies and materials, this technology is easily accessible.

*The stove radiates comfortable heat and families spend hours around the stove, cooking traditional dishes at the same time.*



During demonstration cooking exercises of local rice and potato-based dishes with the use of a pressure cooker and the HRB, up to 90% of the cooking energy was saved. Without using a pressure cooker, the energy saving was as much as 75% as compared with traditional cooking methods on a firewood, electric or gas stove.

There are many possible HRB designs, but good thermal insulation is the key factor for continued cooking once the cooking pot is taken off the heat source. This paper explains how to make a thermal insulation box for cooking. The HRB must:

- Keep food at slow cooking temperature ( $>65^{\circ}\text{C}$ ) for over three hours.
- Have an easy to manufacture design using local materials.
- Be easy to operate with regard to placing the pots inside.
- Be easy to clean.
- Look nice in the kitchen.

The development of village-based cooking clubs will create a platform for introducing the new cooking method to many households at one time, as well as the opportunity to develop nutritious and timesaving recipes.

# 1. HEAT RETENTION BOX

## 1.1 HRBox vs. HRBag

There are many possible heat retention box and bag designs. One advantage of the HRBox is that it is easier to insert and remove the pots than with a HRBag. The box can be used as an added worktop in the kitchen. On the other hand, the HRBag can be stored away flat and takes up little space.

Nevertheless, the HRBox can and should be used everyday, so there is little point in storing it away.

The key factor for any design HRBox or Bag is a continuous slow cooking temperature ( $>65^{\circ}\text{C}$ ) for several hours once the cooking pot is taken off the heat source. This factor depends on good thermal insulation.

Other factors in any design are:

- Easy to manufacture using local materials.
- Easy to operate with regard to placing the pots inside.
- Easy to clean.
- Looks nice in the kitchen.

## 1.2 Box Criteria

The outside of the box should be easy to clean. The use of pre-painted (gloss paint) hardboard or thin plywood is recommended because the paint is usually of durable quality. By using pre-painted board, cost savings will be obtained as compared with (spray) painting the box after assembly.

A special-dust free area and painting equipment is required for painting the boxes, both aspects being more costly than using the pre-painted material.

Formica-type boards are also available in many markets and often very decorative. Although much more costly than pre-painted hardboard, Masonite or High Density Fibreboard (HDF), these Formica-type boards are more durable and will resist strong cleaning agents. The HRB production company can supply a leaflet with different designs from which the clients can make a choice. Low-cost, non-painted designs can be supplied whereby the house owner can do his/her own paint finishing.

The box does not need side handles as pictured. When the box is empty, it can be easily moved; when full (with a hot pot inside), it should not be moved at all.

By having the pot supports on both the bottom and the top, the box can be turned upside down so the door opens to the other side.



*Non-painted Test Model with Magnet Door Closing*



### 1.3 Thermal Insulation

The HRBox is insulated with layers of highly reflective foil facing towards the heat source, being the hot cooking pot. The thermal insulation effect of the reflective foils is best achieved if there is a thin air space (15 mm) in between the foils. The insulation values below are based on polyester two-sided reflective foils.

The pot is placed immediately inside the HRBox once the contents begin to boil (95-100°C depending on the altitude) or when the pressure cooker is at full pressure ( $\approx 105^\circ\text{C}$ ). The small amount of air around the pot will immediately heat up. The heat radiated by the pot will be reflected by the foil and contained.

Each highly reflective foil (with PE backing) with a **1.5 cm air space on both sides** has an equivalent thermal insulation value of  $R_c = 0.9 \text{ m}^2\cdot\text{K}/\text{W}$ . With only one air space and the other side pasted onto a board, the insulation value is  $R_c = 0.4 \text{ m}^2\cdot\text{K}/\text{W}$ . Two foils with air space on both sides plus one pasted foil has in total an insulation value of  $R_c = 2.2 \text{ m}^2\cdot\text{K}/\text{W}$  with a thickness of only 3.3 cm. This is equivalent to 9 cm EPS (expanded polystyrene).

The high insulation value results in the cooking pot staying above  $65^\circ\text{C}$  (slow cooking temperature) for several hours; meaning the food inside the cooking pot continues to cook while no additional heat is produced. This saves cooking fuel and controlling time.

*HRBox with 4 cm EPS and Reflective Foil*



### 1.4 Testing and Demonstration

During a one-week period, rice and a side dish were prepared everyday for 16 trainees. Half the meals were cooked in the traditional manner and the other half with the aid of one of the test HRBoxes:

- (1) Carton HRBox made with three layers of PE backed reflective foil (photo above).
- (2) Hardboard HRBox with three layers of PE backed reflective foil (photo paragraph 1.2).
- (3) Cardboard HRBox filled with small pieces of EPS and PE foam around the cooking pot (photo right) requiring more volume.



The demonstration was realised with 1-litre water and ½ kg dry rice for all dishes. However, a little more water was required for the open pot continuing to cook on the gas stove because of water evaporation.<sup>1</sup>

In order to distinguish the three types of preparation for tasting purposes, one portion of rice was kept plain; in the second portion, a few green peas were added; and in the third portion, some small pieces of orange carrots.

The common (traditional) method of rice cooking was kept the same for all five tests: bring 1-litre of water to boil (about 4 min.), add ½ kg washed rice, bring to boil again (1-2 min.), allow to boil vigorously for 3-4 minutes, lower the gas and let the rice slowly simmer on half gas for 27 minutes. Total time on full gas was 7 minutes.

During the first cooking test, it was suggested to bring the rice to a boil (within 5 minutes on high gas), let it boil for another 3 minutes and then place it in the HRBox for two hours.<sup>2</sup>

Subsequent cooking and tasting tests showed that letting the rice boil a few minutes on the stove before placing the pot in the HRBox did not result in any benefit and only wasted gas.

The first table below represents the gas used; while the second table represents the amount of gas used with the HRBox.



Test with 3 Minutes Boiling

Plain Rice Cooked Traditional Method	Full Gas	Low Gas	HRBox No Gas	Convert Low Gas in 50% of Full Gas	Convert Low Gas in 33% of Full Gas
Bringing water to boil	4 min. +	0			
Bringing rice to boil	3 min.				
Simmering		27 min.		13.5 min.	9 min.
HRBox			0 min.		
Total Time Full Gas	7 min.			20.5 min.	16 min.

Rice Cooked in HRB	Full Gas	Low Gas	HRBox No Gas	Convert Low Gas in 50% of Full Gas	Convert Low Gas in 33% of Full Gas
Bringing both to boil	5 min.	0 min.			
Simmering		0 min.		0 min.	0 min.
HRBox			45 min.		
Total Time Full Gas	5 min.			5 min.	5 min.

By comparing the two tables, the energy saving can be calculated as follows:

When low gas is 50% of the full gas amount, the saving of full gas time is:  
 $(20.5 \text{ minutes} - 5 \text{ minutes}) / 20.5 \text{ minutes} = 76\%$ .

When low gas is 33% of the full gas amount, the saving of full gas time is:  
 $(16 \text{ minutes} - 5 \text{ minutes}) / 16 \text{ minutes} = 69\%$ .

<sup>1</sup> A double gas stove was used for the cooking test because the gas stove could be visibly and easily regulated. Doing the same on two similar firewood stoves would be very difficult to regulate. The gas stove gives a precise comparison of the amount of fuel used.

<sup>2</sup> This idea came from the Hay Box cooking advice from various sources. The extra cooking time is probably required if the thermal insulation quality of the Hay Box is not very high (below  $R_C = 1.0 \text{ m}^2 \cdot \text{K/W}$ ), but it is not needed with the HRBox. It is important, though, that all the food in the pot has reached 100°C. With the first boiling bubbles, this is not yet the case.

The precise difference between full gas and low gas could not be determined in this simple demonstration, but **in both cases the amount of gas saving was between 70% and 75%**.<sup>3</sup>

The percentages in gas saving will be the same for electricity or firewood saving. This means that only 25% to 30% of the amount of firewood will be required as compared with traditional cooking when good use is made of the HRBox.

The same level of energy savings is applicable when other foods (such as potatoes, lentils, beans, pasta, stew meat) are cooked using the right combination of fire and HRBox.

The HRBox cooking demonstration reached the following conclusions: The most energy was saved when:

- The washed rice was put directly into 1-litre cold water and then cooked on full gas, taking 5 minutes to come to the boil.
- Directly after the water with rice was vigorously boiling, the cooking pot was placed inside the HRBox for minimum 45 minutes.



The two constructions with the three layers of PE-backed reflective foil gave the best results. The hardboard box was the easiest to work with. The three reflective foil HRBox resulted in softer and tastier rice.

### 1.5 Higher Altitudes

Since for most food types cooking stops at 60-65°C, the quality of the HRBox is determined by the length of time the temperature stays above 65°C. In high mountain areas, the boiling temperature of water becomes lower with higher altitude.

Altitude above Sea Level	Boiling Temperature Celsius	Boiling Temperature Fahrenheit
Sea level = 0 m	100.0°	212°
2000 ft = 601 m	97.7°	208°
5000 ft = 1524 m	95.0°	203°
7500 ft = 2286 m	92.2°	198°
10,000 ft = 3048 m	90.0°	194°

For altitudes above 1500 m, the use of a pressure cooker is highly recommended as it further saves energy consumption with another 15-20% and saves time.

People living at an altitude of 1500 m already need to consider a 5°C lower boiling temperature for food preparation. When placing the hot pot with food in the HRBox, the pot temperature is about 95°C (= 5°C lower than at sea level) and drops quicker to 65°C.

The HRBox for higher altitudes therefore has an improved thermal insulation characteristic of  $R_c = 2.2 \text{ m}^2 \cdot \text{K/W}$ . This allows a heavy pot with food, totalling 6-7 kg, to stay warm above 65°C for at least 4 hours. Temperature drop tests will show that with a larger hot mass inside, the temperature will stay high longer.

<sup>3</sup> Because not all food is boiled in water, the total energy saving time for all dishes is about 50% when the HRB is systematically used for all cooking dishes.

## 1.6 Making Alternative Designs

When making other HRBox designs, it is important that the amount of solid material (timber) between the inside and outside is minimal to avoid heat leaks. In addition, the reflective foils need to stay separated. For the bottom (and top) of the box, thin sticks should be placed between the foils to support the cooking pot.

By means of an infrared meter, several points on the outside of the HRBox were measured and areas with heat loss detected. The design was then adjusted based on these measurements.



## 1.7 Test Results

The original design was made with a wall construction of painted board (outside), one foil pasted on the inside, 1 cm air space, one reflective foil with PE backing, 1 cm air space and one foil with PE backing on the inside. This design performed excellent.

Based on detailed calculations of the functioning of the reflective foils with and without PE backing, alternative designs were analyzed.<sup>4</sup> The most effective air space between the reflective foils is 1.5 cm to 1.7 cm. The first design with an air space of 1 cm only has therefore been changed to 1.5 cm. This brings the total wall thickness to 3.3 cm, including the 3 mm painted hardboard on the outside.

Boiling water (in the cooking pot) at an altitude of 1500 m has a temperature of 95°C. The tested HRBox with three reflective foils and two air spaces of 1.5 cm had a total pot weight (including content) of 5 or 7 kg. The following table gives the approximate temperature drops for weight of pot and starting temperature. The 105°C is for the pressure cooker. Measuring tolerance 1°C. The results will vary with different quality reflective foils.

Tests	Starting Temperature	Drop	Temperature at One Hour	Drop	Temperature at Two Hours	Drop	Temperature at Three Hours
5 kg	95° C	14	81° C	12	71° C	10	61° C
7 kg	95° C	12	83° C	10	73° C	8	65° C
5 kg	105° C	15	90° C	12	78° C	11	67° C
7 kg	105° C	13	92° C	12	80° C	11	73° C

*With a larger mass, the temperature drop is slightly less. The first temperature drop is the highest.*

The above indicates that food continues to cook in the HRBox for at least two to three hours. In addition, food remains very warm for four to five hours when placed directly from the fire into the HRBox. Cooking in the morning and eating warm at lunch is possible.

<sup>4</sup> For separate charts and graphs with the insulation values for reflective foils, see: [www.nienhuys.info](http://www.nienhuys.info) (insulation page).



## 2. PROMOTION – COOKING CLUBS

### 2.1 Promotion of Energy-Efficient Cooking Methods

The use of the Hay Box is well known for many decades. However, ample supply of low-cost heating fuel during the last century has caused the technology to be neglected. With the increasing cost of fuel and increasing time to collect firewood, the importance of energy-efficient cooking methods needs more attention.



Massive amounts of firewood are being consumed in the high altitude areas of the Himalayas. At least half the amount is for cooking only because of inefficient cooking and bread making methods throughout the year, resulting in deforestation and considerable time spent in fuel collection.



In areas where free firewood is no longer available and deforestation is almost total, villagers use dried cow-dung cakes and heather-like bushes for cooking. Both are resulting in soil de-fertilization, erosion and further environmental degradation, including climate change.

Energy-efficient cooking methods for high altitude areas include, in order of importance in terms of energy efficiency, the following instruments:

- A. Hay box or heat retention box or bag (HRB) with savings of 66-75%.
- B. Pressure cooker with savings of 70-80%.
- C. Improved cooking stoves with savings of 30-50%.
- D. Solar water heater (SWH) with savings of 10-20% (hot water for cooking).
- E. Stacking cooking pots (such as the Serai cooker) with savings of 10-15%.

Combinations of the above technologies, such as using the HRB with a pressure cooker, can reach savings of 90% of the cooking energy. Especially people paying for cooking energy, such as LPG or LNG in the more urbanized areas, will immediately recognize the economic savings of the improved cooking methods.

In order to promote these cooking methods, it is most effective to teach people the operational methodology of the equipment and allow them to experience the benefits. Changing cooking methods requires a change of behaviour. Instead of constantly stirring the pot and watching over the cooking fire, the cook places the hot pot in the HRB and has time to do something else.

“With the HRB, I can now cook the meal in the morning, place it in the HRB and leave for work. When I come home at lunchtime, it is all nicely cooked, warm and ready to eat. This saves me more than one hour per day.”

## 2.2 Setting Up Cooking Clubs

Explaining and planning the idea of a cooking club. Groups of 6-8 persons are formed living close together.

The project lends one unit of an energy saving equipment (HRBox, HRBag, pressure cooker, SWH, ICS) for a month or two, after which the club members can buy it or return it. The expectation is that all group members will buy the equipment.

The first time the cooking club comes together, the equipment is demonstrated and explained by an extension person. The results are eaten and the energy aspects commented upon.



The group makes on a daily or weekly basis their dishes and eats the result. Each member of the groups takes a turn using the equipment in her kitchen. Therefore, the group cannot be too large due to space limitation.

By comparing the dishes, the best recipes are developed. These recipes can later be compared with those of other cooking groups. The best recipes can be compiled into a booklet, which is then supplied along with the HRB or pressure cooker.

The group can obtain technical designs to copy the equipment if they have local craftsmen who can make it. A local craftsman can also be trained through an exchange training programme, whereby the craftsman gains the required skills by working for a short period in the workshop of an experienced HRBox producer. The experienced HRBox manufacturer can possibly supply the reflective foil to the village craftsman.



## 3. MAKING A HEAT RETENTION BOX (HRB)

### 3.1 List of Material

The following materials are needed for making a Heat Retention Box (HRB) measuring externally 45 cm x 45 cm x 50 cm. This will fit a 6-litre pressure cooker and a 3-litre cooking pot, as well as other combinations, within the internal free space of 35 cm x 35 cm x 40 cm.

#### **Materials Required**

- Pre-painted hardboard (gloss paint). This comes in various designs, including decorative wood patterns and plastic-type finishing. Plywood can also be used, but sawing it will cause ripped fibres along the edges.
- Highly reflective foil without PE foam backing – for the first and second layer.
- Highly reflective foil with 3 mm PE foam backing for the top layer. The advantage of this foil is that it stays flat better and is easy to work with.<sup>5</sup>
- 15 mm thick PE foam in small strips – for spacing material in between the foils.
- Contact glue (such as Tami-Bond or Bison-Kit).
- Carpenters glue (white synthetic) – to glue the hardboard to the wooden pieces.
- Piano hinge for the door – 4 cm shorter than the height of the door. Two small hinges are not recommended because these will not be adequately strong.
- Round-headed screws – for fixing the piano hinge. If flat-headed screws are used, these need to be sunken into the hinge to avoid clothing from the cook catching on it.
- Small nails – to assemble the different panels of the unit at home.
- Handle with screws – for opening the door.
- Closing pin – to keep the door closed.
- Timber pieces of 30 mm x 30 mm section – for all ribs of the box.
- Timber pieces of 15 x 15 mm – for pot separators/supports.
- Multiplex 10 mm thick – for making the door.
- 3 mm wire as locking pin.
- Piece of nylon string – to fix the lock to the box so it does not get lost.
- Plastic bag – for holding the loose pieces (handle, screws, nails, manual).

#### **Tools Required**

- Staple machine and 11-12 mm staples.
- Screwdriver for round-headed screws – to fix the piano hinge.
- Cutting knife or scissors – for dimensioning the PE foam and foil.
- Paint or varnish – to paint the thicker plywood door if not pre-painted.
- Measuring tape.
- 3.5 mm drill – for making the hole for the locking pin.
- Pliers – to twist the galvanised wire for the locking pin.

Larger size boxes can be made according to the same design by changing the dimensions. These will be useful for restaurants and other places where a lot of cooking is done or food has to be kept warm.

The following list provides the number of pieces for one HRBox. Dimensions in mm.

---

<sup>5</sup> The reflective foil is aluminum metalized plastic, such as used for packaging potato chips and chocolate, with a thickness of about 0.01 mm. Polyester foils are the best types. The shiny metalized surface reflects the infrared radiation. Double sided reflective foil has the highest insulation value with air spaces on both sides. The thin air space (15-17 mm) must be in front of each reflective side. The most reflective side must be towards the heat source, the inside. All aluminum foil will eventually tear with a lot of handling and therefore is less suitable.



#	Material	Long mm	Wide mm	Section mm	Quantity	Total, Inc. Cutting Loss
<b>Hardboard – 3 mm (pre-painted)</b>						
1	Rear panel	494	450	3 mm	1	497 x 453
2	Side panels	494	447	3 mm	2	497 x 900
3	Bottom-top panels	450	450	3 mm	2	906 x 906
					Total	1650 x 906
<b>Multiplex – 10 mm (pre-paint)</b>						
4	Door, 2 round corners	500	450	10 mm	1	453 x 503
5	Base for side panel jig	600	500	10 mm	1	603 x 503
6	Base for bottom-top jig	500	500	10 mm	1	503 x 503
7	Base for door jig	600	500	10 mm	1	603 x 503
					Total	2162 x 503
<b>Shaved Timber – 19 x 19 mm</b>						
8	Side panels vertical	494	-	30 x 30	4	1990
9	Side panels horizontal	390	-	30 x 30	4	1560
10	Bottom-top panels	384	-	30 x 30	4	1536
11	Door vertical inside	374	-	30 x 30	2	748
12	Door vertical outside	500	-	30 x 30	1	503
13	Door horizontal inside	384	-	30 x 30	2	768
					Total	7105
<b>Shaved Timber – 7 x 19 mm</b>						
14	Pot supports – total inside	300	-	15 x 15	12	3600
<b>Reflective Foil – No PE Backing, Two Sided Reflective</b>						
15	Side panels	456	409	0.1	4	
16	Bottom and top	409	409	0.1	4	
17	Door	417	367	0.1	2	
					Total	1100 x 815
<b>Reflective Foil with 3 mm PE Backing or Stronger Double Sided Reflective Foil</b>						
18	Side panels	456	409	0.1	2	
19	Bottom and top	409	409	0.1	2	
20	Door	417	367	0.1	1	
					Total	2200 x 815
<b>Other Materials</b>						
21	20 mm piano hinge	448	18	1	1	450
22	Wire for lock pin	100	-	Ø 3	1	100
23	Nylon cord for pin	400	-	Ø 3	1	300
24	Staples, galvanised	10	11	1	100	100
25	Staples final assembly	10	11	1	50	50 in factory
26	Nails for final assembly	20	-	Ø 2	50	50 at home
27	Round-headed screws	15	-	Ø 2.5	20	20
28	Handle for door	100	-	-	1	1 (2 screws)
29	Gloss paint for door <sup>6</sup>	-	-	-	0.01 ℓ	two coats
30	PE foam strips 15 mm	300	20	15 x 15	32	300 x 640

In addition, synthetic white carpenters glue and contact glue are required.

<sup>6</sup> Possibly the multiplex comes pre-painted; in that case, no painting will be required. If painting is required, a paint roller, sandpaper, base paint, paintbrush and cleaning agent will be required.





Hand staple machine with box of staples. Different models exist.

While the width of many of the smaller type staples is 11 mm, the length of the staples can vary from up to 15 mm.

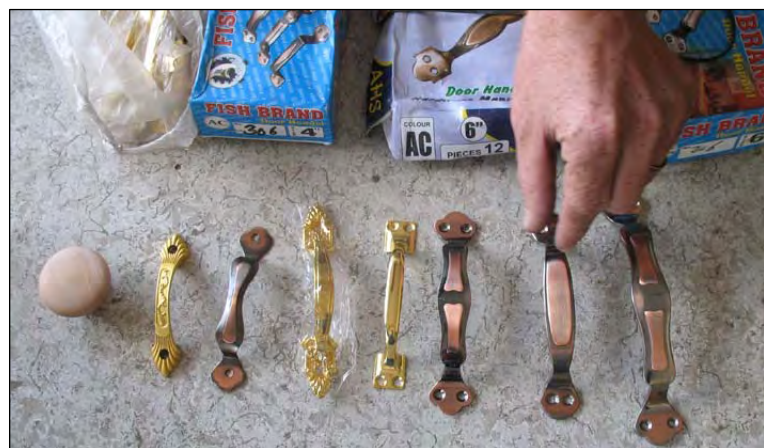
For making the panels, use white synthetic carpenters glue to position the pre-painted board to the timbers and then staple in place.

For full assembly, use the staples in combination with the glue as well. For home assembly, 20 mm thin nails should be used in combination with white glue.

Several types of handles are available in local hardware shops.

Only a small handle is required, placed in the middle of the height of the door and screwed into the timber with 15 mm screws.

The wooden knob will require a  $\varnothing$  3 mm through-bolt and nut for fixing.



### 3.2 Making and Assembly

The following seven sketches provide step-by-step assembly, making of jigs and packaging of a HRBox.

Skilled carpenters may be able to reduce the timber dimensions of the 3 cm x 3 cm shaved profiles, but then the other dimensions will also change.

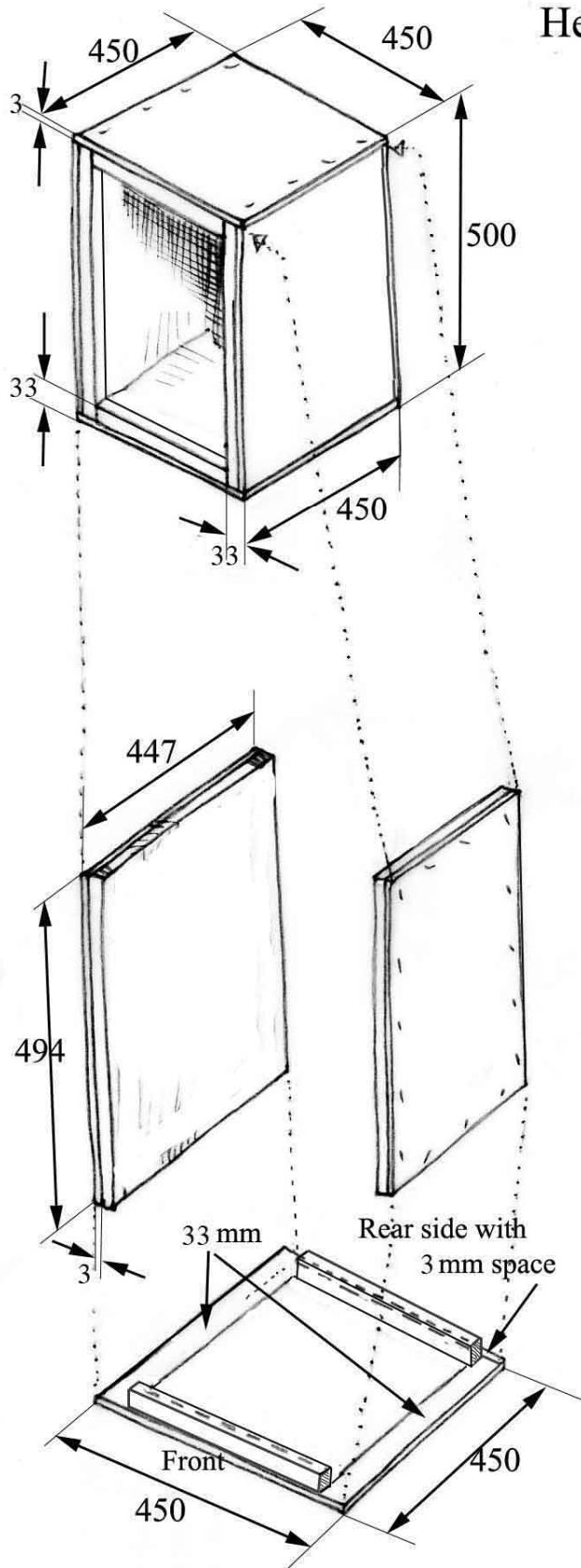
The same box design principle can be used for other HRBbox sizes. Restaurant kitchens might require larger boxes depending on the cooking pot sizes used.

Because the pot-support sticks have been placed on both the bottom and the top of the HRB, the box can be turned around. This way the opening direction of the door can be changed depending on the location in the kitchen.

With series production, the manufacturing cost will go down.

A catalogue page can be made with options of different sizes, colours or outside materials (Formica), either factory-assembled or for self-assembling.

## Heat Retention Box 2 pot stack



Outside material is pre-painted  
3 mm hardboard, gloss.

Connections of panels with  
staples or small nails.

Dimensions in mm

First foil pasted on board.  
with shiny side inwards

Timber shaved 30 x 15 mm

Hardboard glued and stapled  
onto timber strips.

Two side panels are the same

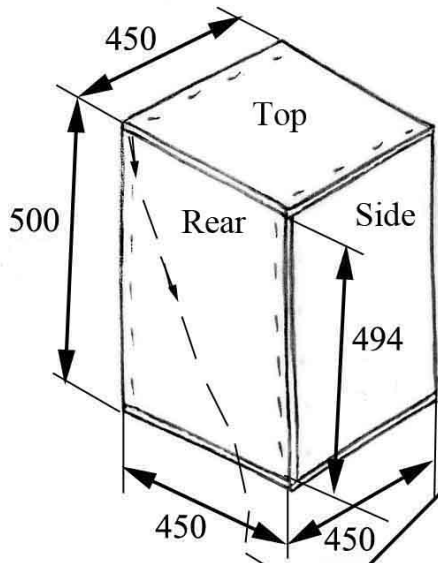
Bottom and top panels are  
the same dimensions

Rear panel adds 3 mm and  
total is 450 mm deep.

Reflective foil is pasted  
with contact glue on board

### Sketch #. 1

The side, bottom and top panels are assembled using the jigs. This will go much faster than fitting these by hand and minimises mistakes. Using a staple machine will speed up the work.



**Heat Retention Box 2 pots**  
Rear panel

Rearview of assembled box with rear panel stapled on sides

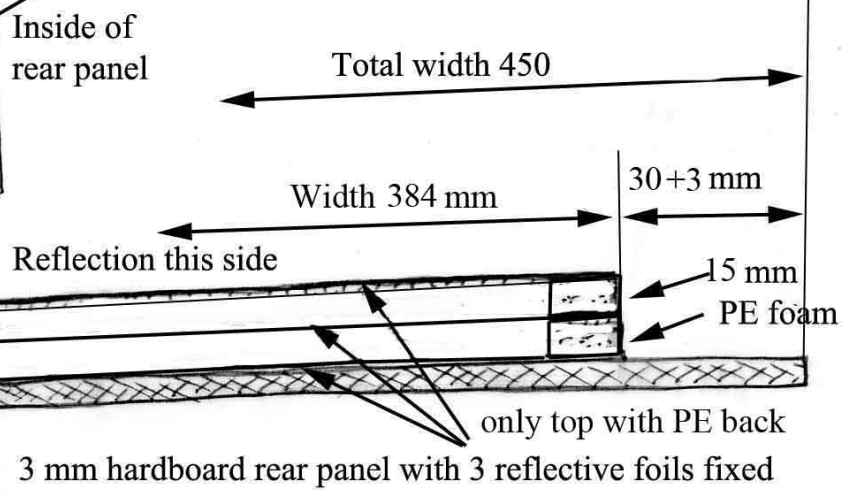
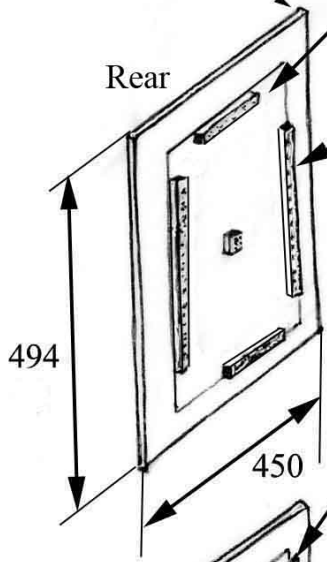
Apply reflective sheet on the inside with contact glue. 410 x 455

On the reflective foil paste small strips of PE foam of 15 x 15 mm

Glue new reflective foil without backing on PE foam strips.

On the 2nd reflective foil paste small strips of 15 x 15 mm PE foam

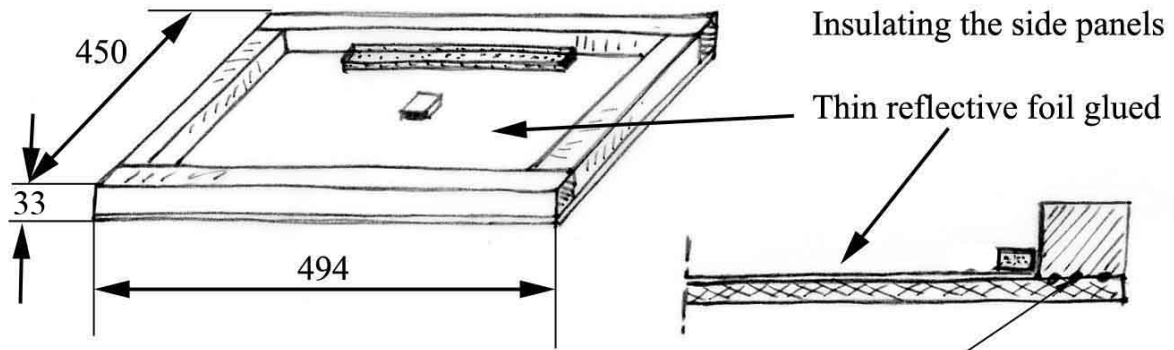
Paste third sheet of reflective foil with 3mm PE backing (stronger)



**Sketch # 2**

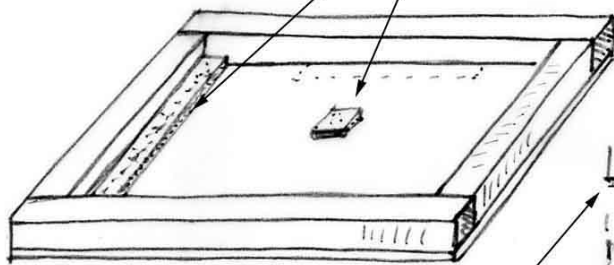
Two side panels

Heat Retention Box 2 pots stacking

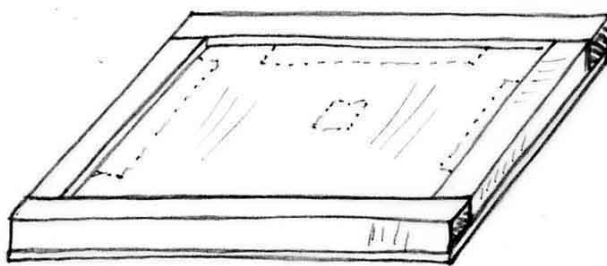
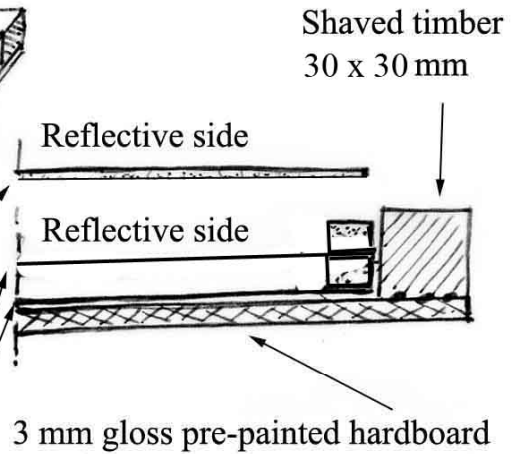


Reflective foil and PE foam 15 mm fixed with contact glue

Timber fixed with white synthetic carpenters glue and staples.



Reflective foil with 3 mm PE foam  
Two sided reflectiev foil without PE



Two equal side panels manufactured in series with the use of a jig.

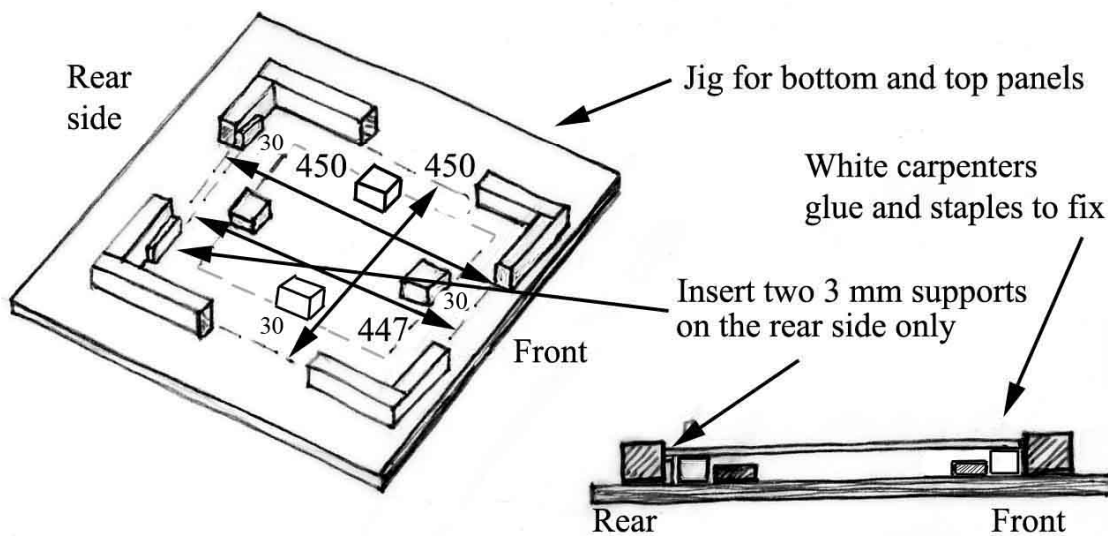
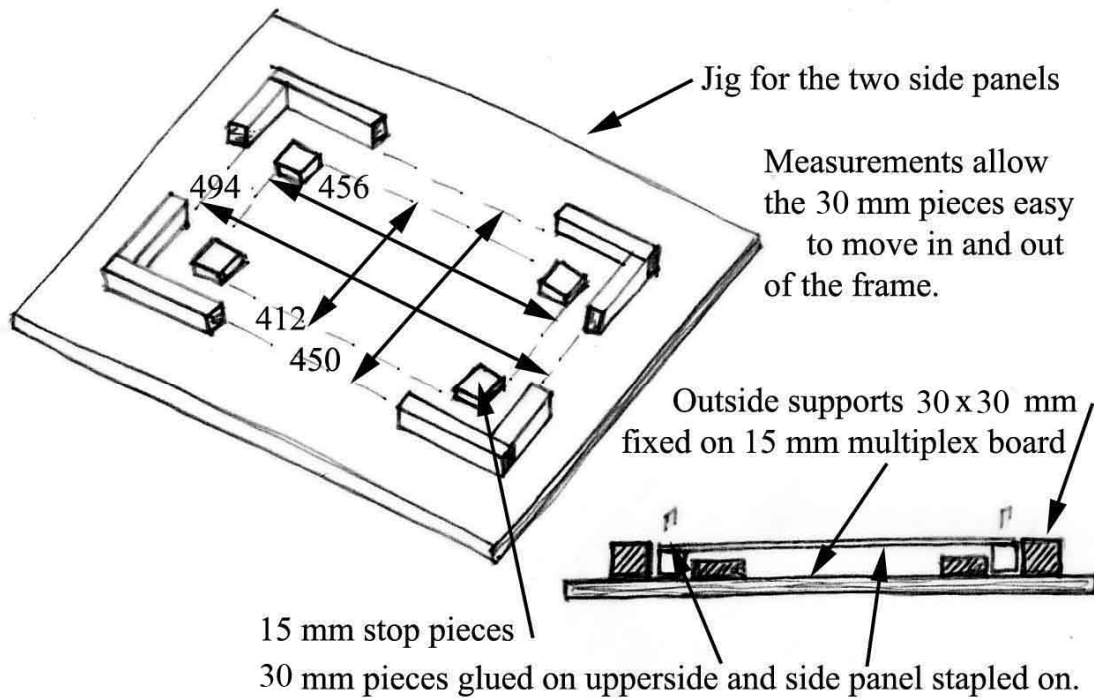
Sketch #3

The side, bottom and top panels are assembled using the jigs. This will go much faster than fitting these by hand and minimises mistakes. Using a staple machine will speed up the work.



# Heat Retention Box 2 pot stacking

# Assembly jigs.



## Sketch #4

With jigs the assembly will be much faster

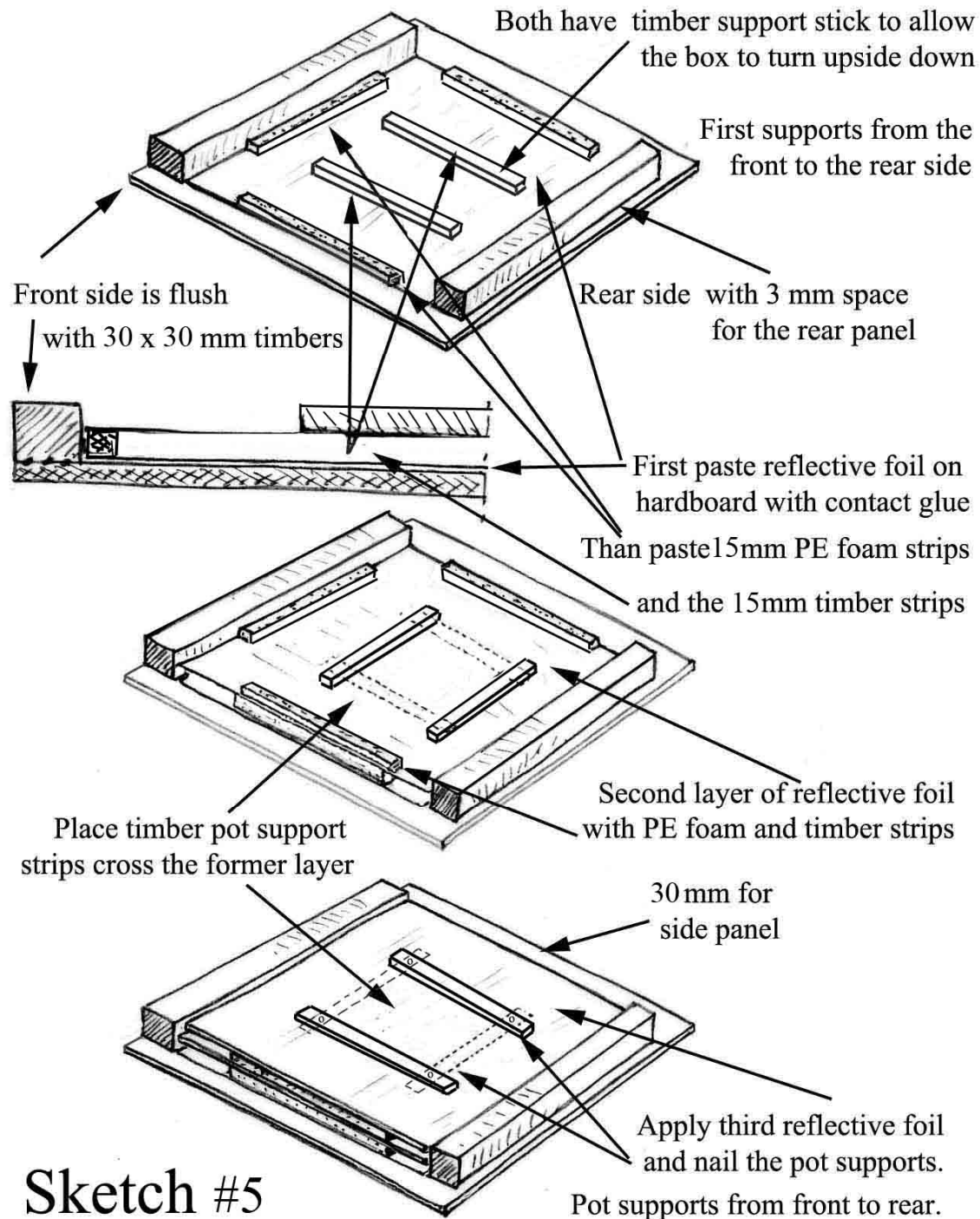
The stop pieces of the jig are made from leftover multiplex.

The 3 mm supports are made from leftover hardboard.

The 30 mm x 30 mm timber pieces are placed in the jig, glued and the hardboard stapled. In a similar way, a jig for the door can be made.

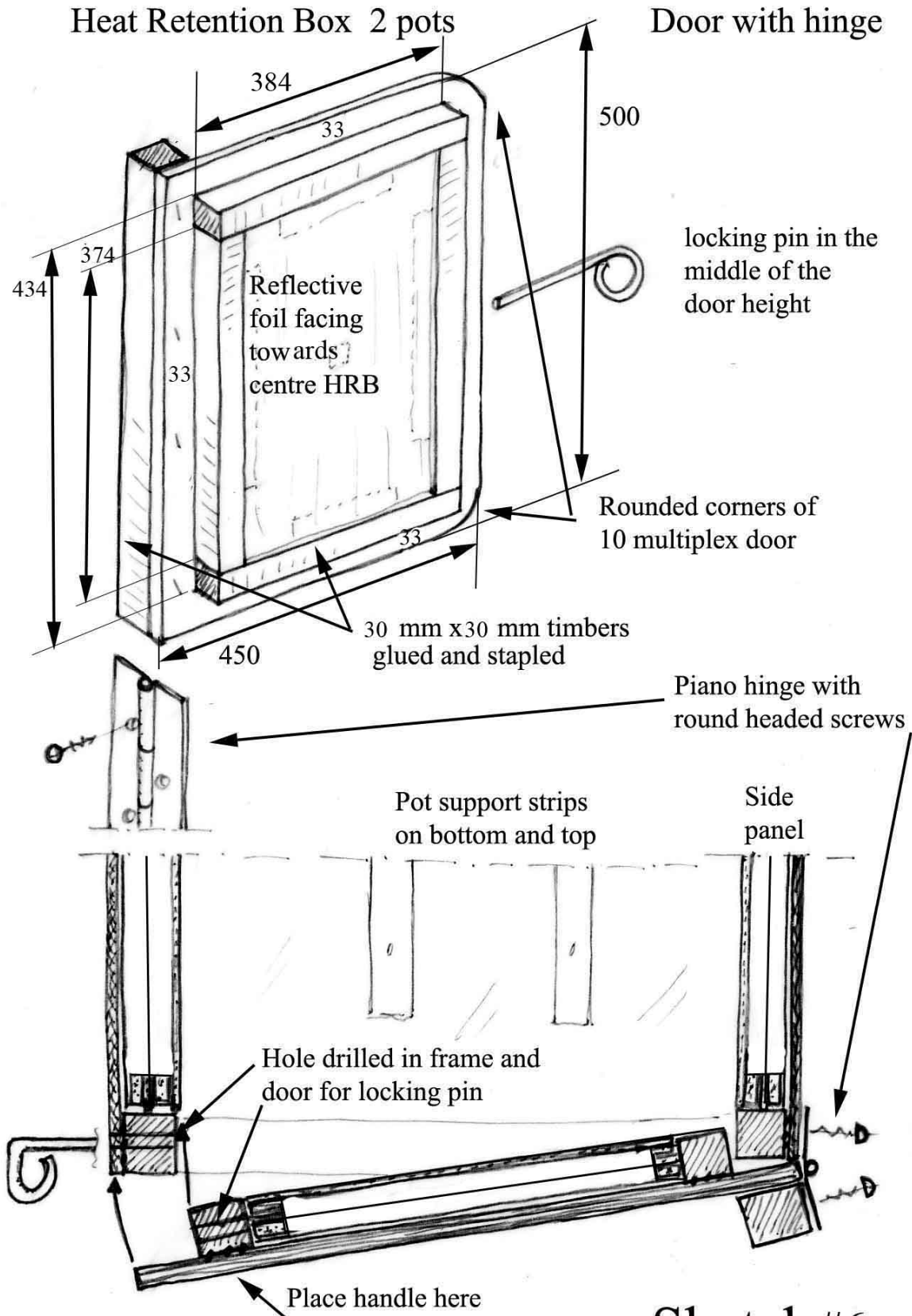
# Heat Retention Box 2 pot stack

# Bottom and top panels



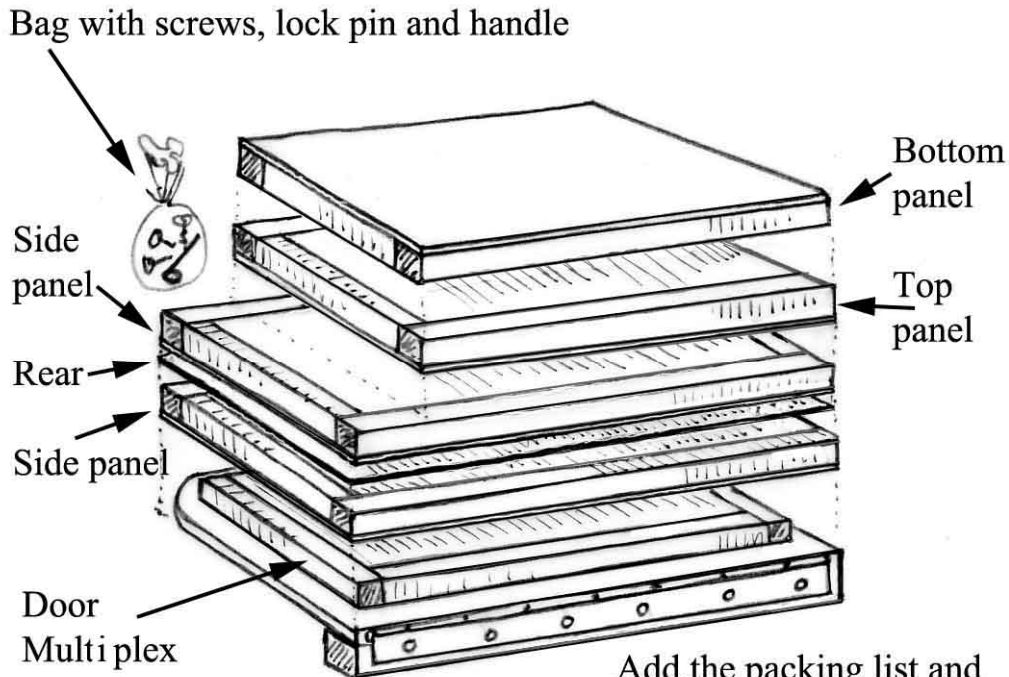
Sketch #5

By placing pot support sticks on both the bottom and top panels, the HRBox can be turned upside down if the door needs to be opened in the other direction, depending on its place in the kitchen.



Sketch #6

## Heat retention Box packing sequence



Add the packing list and the USER MANUAL HRB and wrap in PE foam for protection during transport.

### Sketch #7

#### **Packing List**

The packing list should be used to verify the packed materials. For making strong HRBoxes, the packing should include a small container of white synthetic carpenters glue. Gluing and nailing the panels together makes a very strong box.

#### **Assembly Manual**

A step-by-step assembly manual can be added. This is best made by means of a series of pictures with instructions.

The locking pin should be attached to a string and the string screwed to the box; this way the locking pin will not get easily lost in the kitchen.

The PE foam of the packing can be used as thermal insulation under a sleeping mattress or elsewhere. The assembly manual should explain the various usages of the PE packing as thermal insulation.

#### **Cooking Instructions**

After obtaining information from the various cooking clubs, cooking instructions and a recipe booklet should be supplied with the HRB.

\*\*\*\*\*