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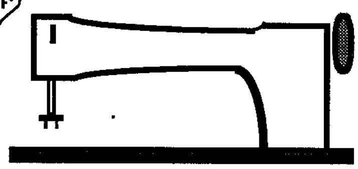


Dedicated to the Sport Balloon Home-Builder

Published every two months–$12 per year

THE BALLOON BUILDERS' JOURNAL

July-August 1995

In This Issue

Up and Coming

Detailed instructions are presented for the construction of a theodolite, the instrument used to take winds-aloft readings. Your editor is currently experimenting with a low-cost ($100) envelope temperature gauge.

Notices To Readers

Is It Time for a Formal Experimental Builders Organization?

During the coming year we will be surveying readers about the creation of a formal organization for balloon builders. How do you feel about this question? With over 170 interested readers, we believe such a group could provide considerable support to sport and pleasure flyers.

Readers Can Determine their Expiration Date

We have updated our mailing labels to display expiration dates. On the upper right hand corner of the mailing label are the letters 'EXP' followed by a number. That number is the last issue number in your current subscription. The current issue number can be found on the cover page. This issue is number '13'.

Current Readership

Currently, we have 178 subscribers to *The Balloon Builders Journal*

The Arras Lightweight Basket

From details provided **by Bill Arras,**
7843 SW 77th. St., Redmond, OR 97756

This lightweight basket design is based on welded chrome-moly aircraft steel tubing and can be built using traditional aircraft construction techniques.

Bill Arras has shared construction details concerning his 24 inch by 36 inch lightweight basket. The basket, which weighs 35 pounds was constructed from 1 inch diameter chrome-moly aircraft steel tube with a wall thickness of .035 inches. Joints and attachments were formed by welding. The pictures show the frame dismounted for travel. The whole basket fits neatly into a compact carrying case.

The bottom steel frame provides support for a lightweight plywood floor. Cables attach to the basket bottom by means of bolts through steel straps which wrap around the bottom horizontal tubes. These cables, one in each corner, transfer the flying loads to a burner ring, constructed from a bicycle rim. The basket top rail is covered with insulation foam, which is both lightweight and inexpensive. Crossed steel cables, like those used on Brian Boland's baskets, provide rigidity to the basket structure. These cables terminate at weld points in each corner of the basket. Aircraft grade turnbuckles are used to remove any 'play' in the system.

The top rail is supported by four vertical tubes, one at each basket corner. Note that the basket corners are square. This makes for simple fitting of the fabric basket cover around the basket perimeter. It also reduces the reliance on Velcro™ fastener to keep the cover in place.

The photos provide some construction details. The tube corners are constructed with a welded butt joint made from a 45° angle cut in the tubing. A triangular steel 'fillet' is also welded into the corner. It acts as guide for the cables to the burner ring. The fillet also provides the attachment point for the chains which carry the fuel tanks. A short length of tube is welded to the fillet to act as a slip joint for assembly of the vertical tubes.

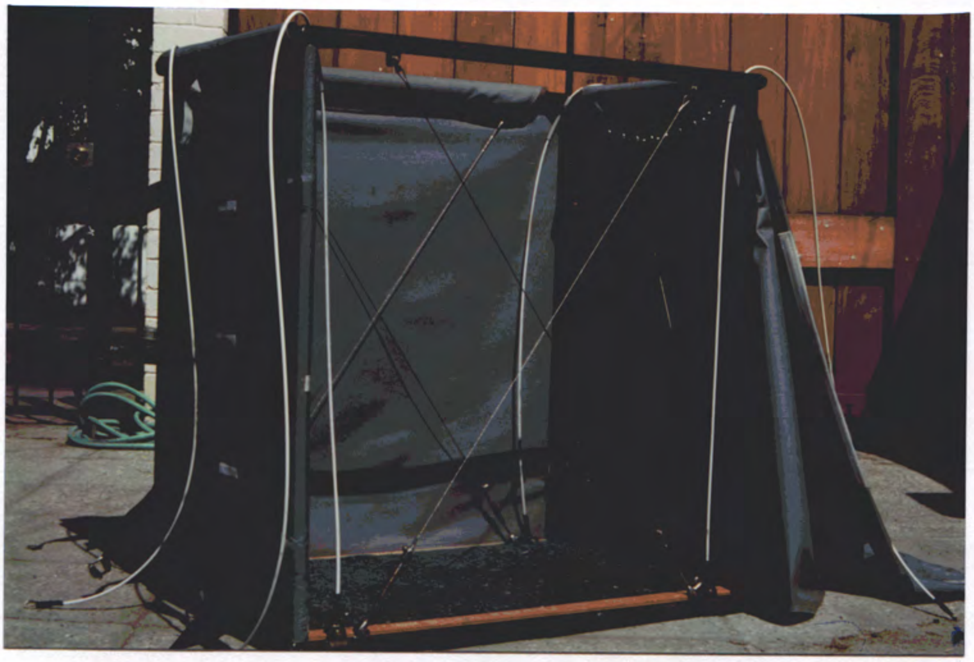
Editor's Comments on the Design

This basket is an early prototype so there is room for improvements. Because the tubing is below the floor it provides good support, allowing for a light weight floor. But this makes the bottom tubes the basket skid plate, leaving them subject to wear and abrasion. A skid pad made of wood or plastic to protect the metal framework might be beneficial. Because the framework is below the floorboard, there is no 'lip' around the outer edge of the floor. Bill reported a tendency for a foot to slip out between the floor edge and the fabric basket side. (Because of the crossed cable assembly on each side , this problem appears to be more of an annoyance than a safety issue) He has solved this problem by placing short, 'slip in' vertical panels on each long side.

The limited number of vertical tubes, one at each corner, makes for a long span on the top horizontal end rails. This span may be too long to support the weight of a full fuel tank without bending the tube on a hard landing. Bill has circumvented this issue through the use of chain for a tank carrier. The chain also provides flexibility in positioning tanks. This feature was important when Bill recently set a new world's duration record. He was carrying 11 of the Worthington ten gallon tanks on this basket–approximately 750 pounds in tanks and fuel.

The basket utilizes $^3/_{32}$ cable for the crossed cable stiffeners. He originally used $^1/_{16}$ inch diameter cable, but had two of these break on a hard landing. Both cables separated in the middle of their length. This failure is a reminder of the strength contained in Nicopress™ fittings. These squeeze-on attachments clearly make cable terminations which are stronger than the cable itself.

Center: The basket cover has been folded back to display details of the construction. ***Upper left:*** The disassembled basket as it packs up in its carrying case. ***Upper right:*** Top corner details. A thin metal plate acts as attachment points for the chain carrying the fuel tanks. A quick link acts as a guide for the cable to the burner ring. ***Lower left:*** Shows details of the tank attachment system. ***Lower Right:*** Details the lower basket corners. Note the strap which carries the loads to the burner ring. A small welded plate attaches the crossed cables which provide basket rigidity. Aircraft turnbuckles allow tightening up the assembly.



The FAA Part 103 Ultralight Balloon Challenge

By Bob LeDoux, Editor,

2895 Brandi Lane, Jefferson, OR 97352 CompuServe 73474,76

Can a heavy pilot achieve 2.25 hours of flying duration in a balloon system that meets the U.S. ultralight regulations? And yes, the balloon must have a basket.

Introduction

In our last issue, we discussed the limitations of FAR Part 103 ultralight balloons. Reviewing these limits it became clear these 'aircraft' can serve a very useful purpose. For the pilot flying solo, for sport or pleasure, over a rural area, the Part 103 balloon represents a low cost and low effort alternative to the heavier and more expensive factory models.

In our last issue we also proposed to put these limits to the test by designing an ultralight balloon with 2.25 hours of duration for a 225 pound pilot. In this issue we will attempt to create such a system.

This is an interesting challenge. Part 103 specifies a 155 pound empty weight limit. Assuming normal envelope temperatures, the 2.25 hour duration will require more than 10 gallons of fuel. The required fuel volume puts a squeeze on our weight limit. If, for example, we choose to carry two of the standard ten gallon Worthington tanks for our fuel supply, their empty weight of 54 pounds leaves us with about 100 pounds for everything else, including envelope, basket, and burner. Our task is to create a distribution of weights between components which makes the whole thing work.

Figure 1. Kaye Knotts is holding Mike Emich's envelope, part of his very light balloon system. While Mike chose to obtain an 'experimental' airworthiness certificate for this balloon, it will qualify under FAR Part 103.

Let's suppose we achieve an empty aircraft weight of no more than 155 pounds. We then have to add 20 gallons of fuel and the pilot. We end up with a takeoff weight of 400 to 500 pounds. Depending on local weather conditions and altitude, that gross weight will require an envelope volume of between 15,000 and 35,000 cubic feet.

If we perform some basic mathematical gymnastics we discover that we can build a lightweight envelope for a 15,000 to 35,000 cubic foot envelope which weighs 30 to 60 pounds. Achieving that goal, we are left with between 70 and 40 pounds for the basket, burner and other fixed equipment, not counting tanks. Thus our preliminary mental gymnastics show us our lightweight balloon system is possible.

Design Tools

In the remainder of this article we will take the reader through our design process. In keeping with the tradition of past *Balloon Builders Journal* articles, we employ charts and tables as part of this process. Central to our design is the *Ultralight Balloon Computation Worksheet* on page 10. If you would like to follow along or design your own ultralight balloon, make copies of the worksheet. Follow us through as we design our system. Then, design your own system, using your own selection of components and your personal design goals.

In addition to the worksheet on page 10 we will use the following additional tools:

Table 1 (page 5), is a sampling of new and used balloon components. Some of these items are suitable for our design. Some items might be too heavy for an ultralight, but are included for comparison purposes. Feel free to augment this list with your own choice of components.

Table 2 (page 6), is a chart to determine the lifting capability of heated air. It is used to determine the size of the envelope for our balloon system.

Chart 1 (page 8), is used to estimate the finished envelope weight, in pounds, given a desired volume, in cubic feet. Two lines are graphed. One line is for an envelope constructed of uncoated 1.1 ounce fabric. The other line is for an envelope constructed from 1.3 ounce coated fabric. Implicit within this graph is that light-weight fabric construction is required to meet our goal. We will discuss this graph in more detail later.

Step 1: Determine the Weight of The Basket

If we hope to find a certified balloon basket suitable for an ultralight balloon our hopes are quickly dashed. It is difficult to meet our weight limit using a basket constructed of traditional materials. A reasonable weight limit is 40 pounds, including the burner support mechanism. One of the smallest current factory baskets, the Aerostar Aurora weighs about twice that amount.

Your editor built a 30 inch square basket from stripped rattan (reed). This basket weighs about 70 pounds. In order to keep weight low, small diameter reed was used, and the skids were constructed from lightweight hardwood (alder). The burner frame was constructed from thin gauge aircraft steel tubing and weighs about 4 pounds. The reed represents 30 pounds of the final basket weight. For an ultralight balloon this basket is too heavy.

Component	Weight (pounds)
Baskets	
Aerostar Aurora	79.0
Boland 20" by 30"	25.0
Boland 24" by 36"	35.0
Webbing Harness	6.0
Burners	
Aerostar Aurora	23.0
Aerostar HPII	20.0
Raven HP Square Shooter	18.0
Balloon Works T3-017	10.2
Avian (circa 1984)	9.6
Hoses	
Aeroquip 2-Tank Manifold	3.0
Tanks	
10 Gallon Worthington	26.5
'40 Pound' Worthington	19.0
20 Gallon Raven Horizontal	40.0
15 Gallon Stainless Steel	42.0
23.5 Gallon Stainless Steel	55.0

Table 1; Various balloon components, some of which could be used in an ultralight system.

One possible basket choice is the current generation of lightweight metal frame units. Brian Boland produces a 20 inch by 30 inch basket which weighs about 28 pounds, with burner ring. (A photo of this basket is shown in *Figure 1*.) If you are a builder, you might want to look at Bill Arras' design which is described earlier in this issue. His basket, like the Boland design, achieves rigidity through the use of crossed steel cables. But unlike the aluminum Boland design, Bill used chrome-moly aircraft steel tubing for his construction. I estimate that the materials to build a 20 inch by 30 inch basket of the Arras design would cost about $300.

For the builder, with limited construction experience, the Boland basket represents a good choice. We will choose it for our ultralight balloon system. The 20 by 30 inch basket weighs 25 pounds. We add 3 more pounds for the bicycle-rim burner ring. On our *Worksheet* on page 10, we enter '28' pounds under item 1a.

The Burner

A review of current generation factory burners is very revealing. Burners are getting very heavy. The Aerostar *Zone 5*™ double burner weighs 46 pounds. While we would never use such a burner on our ultralight balloon system, this weight is very telling about the direction of factory balloon design. Hoisting a set of Cameron double burners into position is a two man operation. Even the little Aerostar *Aurora* burner weighs a substantial 23 pounds, much of which is the burner supporting hardware. It is not our intent to criticize Aerostar or Cameron. The recent trends towards custom designed burner hardware, with their elegance and ergonomic details, have been bought with increasing weight and increasing cost. While these trends may be appropriate for products intended for commercial operations, we have no room for these weights in our lightweight balloon system.

A look at *Table 1* reveals a couple of interesting lightweight burner candidates.

Forey Walter makes the lightest burners on the commercial market. His Avian burners are simple, though a few readers might consider them a bit 'homespun'. These burners employ ball valves rather than the traditional rubber 'O' ring-type valve often found in other systems. Local owners report low maintenance due to the ball valves. Because of the limited production numbers, these burners are often hard to find. But with weights as low as 9 pounds they are worthy of consideration.

Next up on the weight scale is the discontinued Balloon Works T3-017 burner which weighs a bit over 10 pounds. This burner fits the Boland basket without modification. The Balloon Works burner is not cheap. Current used price is about $500 for a serviceable burner. They are also in short supply. We understand that some parts, in particular, the pilot light orifices, are getting hard to find. The T3 burner is not quiet and its output is overkill for our balloon system. But unless we are willing to build a burner from scratch, it represents a good choice.

For our balloon system, we choose the T3-017 burner and add another 3 pounds for the propane feed hose. We enter '13' pounds in item 1b of our worksheet.

Tanks

In terms of cost the standard Worthington 10 gallon aluminum tank appears to be a good choice. These tanks are generally marked with an empty weight of 26.5 to 27 pounds. Used, certified balloon tanks sell for about $250. Brand new tanks, stamped 'Not For Aviation Use' can be purchased for about the same price, from the right dealer.

When designing for minimum weight its useful to measure tank efficiency. This is the weight of the tank compared to the fuel it carries. For example, the 10 gallon Worthington weighs 27 pounds and carries 10 gallons. Thus the tank weighs 2.7 pounds for every gallon it carries. The smaller this number the more efficient the tank.

Pounds of Lift per 1,000 Cubic Feet: 180 Degrees F.					
Air Temp->	50	60	70	80	90
Altitude					
5,000	13.2	11.9	10.7	9.6	8.5
4,000	13.7	12.4	11.2	9.9	8.8
3,000	14.2	12.9	11.6	10.3	9.1
2,000	14.7	13.3	12.0	10.7	9.5
1,000	**15.3**	13.8	12.4	11.1	9.8
Sea Level	15.9	14.4	12.9	11.5	10.2

Table 2: This table displays the lifting force, in pounds for 1,000 cubic feet of heated air at 180°F. This lifting force is displayed for ambient temperatures of 50° to 90° F. and from sea level to 5,000 feet. MSL.

One of the most efficient tanks remains the Raven (Aerostar) 20 gallon laydown stainless steel tank. The older tanks are marked with an empty weight of 40 pounds and hold 20 gallons. Thus this tank weighs 2.0 pounds for every gallon of fuel it carries, making it more efficient than the Worthington. These tanks are also reasonably priced, at about $350 and up on the used market. We expect the price on these tanks to remain 'soft.' Given the new options in vertical stainless steel tanks, these horizontal tanks should remain a good buy.

Unfortunately, because of their size and horizontal construction, they don't lend themselves to small basket designs. A few pilots have turned this shortcoming into a feature by 'riding' the tank as a basket. This technique may reduce the weight of the balloon, but often at the cost of pilot protection during windy landings.

Some readers may not be aware of the '40 pound' Worthington recreational, boating and camp equipment tank, This tank looks similar to the standard balloon tank, but it is a couple of inches shorter. The spud configuration on top of the tank is quite limiting. There is only room for one valve. The tank carries 40 pounds or about 9.3 gallons of fuel at an empty weight of 19 pounds. These tanks are very efficient with a weight of 2.0 pounds for each gallon of propane carried.

The new generation stainless steel balloon tanks are both expensive, and often not as efficient as the tanks already mentioned. The typical 15 gallon standup tank weighs about 42 pounds for an efficiency factor of 2.8 pounds per gallon. The Aerostar 23.5 gallon tank weighs 55 pounds for a factor of 2.3 pounds per gallon. This is a fairly efficient tank and the volume is a good choice for a duration balloon. But all that fuel in a single vertical tank can cause some balance concerns when designing a small balloon.

For our balloon we choose two 10 gallon Worthington tanks, each which weigh 26.5 pounds for our balloon system. We also assume a bit of weight for the tank-to-basket mounts. We enter a total weight of '54' pounds on line 1c of our worksheet. We also enter '20' gallons for the fuel volume.

Item 1d, on the *Worksheet* is for additional equipment mounted in the basket. We don't contemplate much additional equipment except perhaps a lightweight drop line. As a conservative design load we will add '3' pounds to item 1d.

We haven't said much about instrumentation. Many pilots would be willing to fly this type of balloon system without an instrument pack. A wrist watch altimeter could be worn. Envelope temperature instrumentation could be eliminated if the envelope is sized to operate a fairly low temperature. More on this later.

In item 1e we calculate the total weight for the basket. Adding up items 1a through 1d we arrive at a total empty basket weight of '98' pounds.

Try to keep your basket empty weight below 105 pounds,. Otherwise, you may have difficulty keeping the overall balloon weight within the legal limit.

Step 2: Determine the Maximum Flying Weight

Its not uncommon to run into a chicken-egg question in any aircraft design. We have such a problem here. We need to estimate the gross aircraft weight so we can determine the envelope volume needed to carry that weight. But we can't estimate the total aircraft weight until we know the envelope weight. But we can't estimate the envelope weight until we know the envelope volume. But we can't estimate the envelope volume until we estimate the gross weight...

We need to make a rough weight estimate so we can continue our calculations. The proposed estimates under item 2a are simple: Enter under item 2a, '35' pounds if a 'hang balloon' is being designed. If uncoated fabric is used over a basket, enter '47' pounds. If coated fabric is used over a basket enter '54' pounds.

In Step 2b we calculate the weight of fuel. We enter '86' pounds, which is the 20 gallons contained in the tanks (in step 1c) times the propane weight of 4.3 pounds per gallon.

Step 2c is the pilot weight. We started this example by assuming a pilot weight of 225 pounds. But the pilot may be carrying extra clothing for cold weather flying, and perhaps a radio, or other personal equipment. We add 10 extra pounds for these possibilities and enter 235 pounds in item 2c.

Item 2d is the maximum balloon takeoff weight. We add together items 1e, 2a, 2b, and 2c to arrive at a gross weight of '466' pounds.

Step 3: Calculate the Required Envelope Design

We must now estimate the envelope volume required to carry our 466 pound balloon.

We have proposed a 2.25 hour duration for our balloon. In order to achieve this fuel consumption level on 20 gallons of fuel, a fairly low envelope temperature is required. For our design purposes we have assumed an average equilibrium takeoff envelope temperature of about 180°F. *Table 2* (on page 6), is designed to estimate lifting force for this temperature. This table displays the lifting force per 1,000 cubic feet of heated air for varying altitudes and ambient temperatures. We will assume a 50°F day as typical, flying from a field at 1,000 feet MSL. Under these conditions, each 1,000 cubic feet of air heated to an average of 180 degrees will lift 15.3 pounds. (This value is highlighted in the table.) We enter '15.3' in cell 3a. *Table 2* can be used to generate the lifting force for your own set of circumstances.

In 3b, we divide our gross weight of 466 pounds by 15.3. The answer is '30.457'. This result is the volume of the envelope in thousands of cubic feet. In step 3c we multiply 30.457 by 1,000, (move the decimal point 3 places to the right) to generate the required envelope volume. In this case it is '30,457' cubic feet.

We can calculate the envelope weight by referring to *Chart 1* on page 8. This chart displays two lines. The upper line is for an envelope constructed of 1.3 ounce coated fabric. the lower line is for 1.1 ounce uncoated fabric. The 'X' axis is the envelope volume in cubic feet and the 'Y' axis is the envelope weight in pounds. To calculate your envelope weight, find the envelope volume (from step 3c) on the 'X' axis, follow that volume up to the chosen line and read across to the 'Y' axis for the weight. Our example of 30,457 cubic feet weighs about '49' pounds. We enter '49' pounds in step 4a.

If you choose to mix your fabric, perhaps run coated fabric down to the equator and uncoated fabric from there down to the mouth, then your expected envelope weight will run between the two lines. Depending on the mix of fabric, you can estimate your envelope weight by judging the distance between the two lines.

Chart 1 makes certain assumptions. To achieve these weights requires careful effort. In addition to the lightweight fabric called out on the chart, the builder must also exercise restraint in adding additional weight. Lightweight load tape, like 3/4 inch wide 5038-III tape is essential. Other items, such as the envelope to basket cables, deflation top operating line, and crown line, should be as light as possible.

Adding the '49' pounds in step 4a to the empty basket weight of '98' pounds in step 1e generates a total weight of '147' pounds, which is entered in item 4b. This is below the legal limit of under 155 pounds. Its not wise to try to design right up against the weight limit. The builder should leave a few pounds for design error. Aircraft have a way of 'putting on weight' between the design and building stages.

Our design calculations are almost complete. Look at step 4a and step 2a. If the two envelope weights vary by more than a couple of pounds, enter the number from step 4a as your initial estimate in step 2a. Now, recalculate the worksheet down from step 2a. Your required envelope volume will change and so will your estimated weight. But these changes should be minor.

Our initial design phase is about finished. Past issues of *The Balloon Builders Journal* have covered, in considerable detail, the layout and construction of custom envelope sizes. In particular, refer to our last issue for

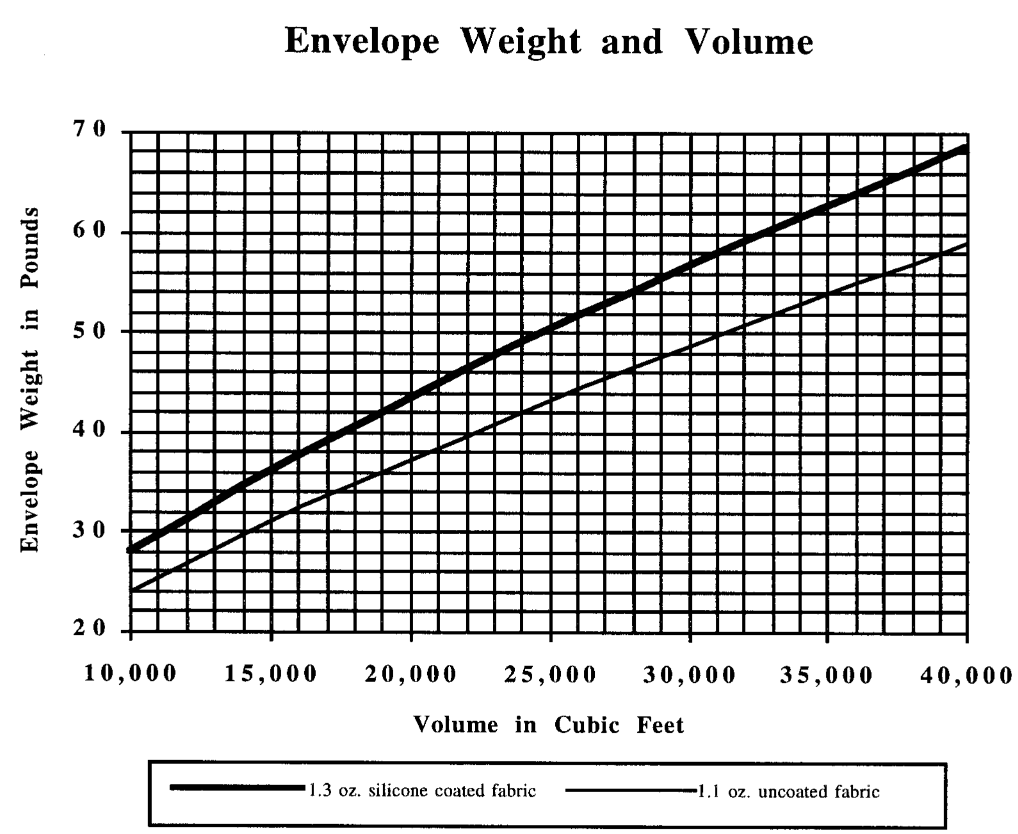


Chart 1: This chart allows the reader to estimate the constructed envelope weight, in pounds, for a range of envelope volumes, in cubic feet. Two lines are provided. The top line is used with 1.3 ounce per square yard silicone coated parachute fabric. The bottom line is used with 1.1 ounce uncoated parachute cloth.

a basic summary of the stages of such a project.

How Does Pilot Weight Affect the Ultralight System?

In preparing this article we have emphasized the practicality of the ultralight balloon by seeking reasonable fuel duration for a heavy pilot. Let's replace the 235 pound pilot with a much lighter, and more typical, 170 pound pilot. How does the overall system change? The heavy pilot required an envelope of 30,500 cubic feet. This envelope, constructed from uncoated fabric, weighs about 49 pounds. For the light, 170 pound pilot, the envelope volume drops to about 26,200 cubic feet with an envelope weight of about 45 pounds. In other words, reducing our gross weight by 65 pounds only reduced the weight of the envelope by 4 to 5 pounds.

Thus, the difference in system weight between the light pilot and heavy pilot is minimal. This has implications for other areas in the design. For example, suppose your design has come up against the 155 pound weight limit while using a heavy burner. By giving up an 18 pound burner and replacing it with a 10 pound burner, you could gain enough weight latitude to increase the pilot load from that of a light women of 110 pounds to a heavy man of more than 200 pounds.

Regarding Envelope Temperatures

In order to achieve more than two hours of flight duration on 20 gallons of fuel we chose to use a low envelope temperature. At takeoff this temperature would be about 180 degrees. Assuming that altitude and ambient temperatures don't change, at the time of landing, this temperature should drop to about 160 degrees due to fuel usage. This assumes about 5 gallons of fuel remaining.

According to our calculations, its possible to fly this envelope without an envelope temperature gauge. We recommend, however, that a temperature 'tell-tale', heat tabs which change color once a set temperature has been reached, be installed in the envelope top to keep track of the temperature extremes.

On a 70 degree day at 2,000 feet, the equilibrium temperature should be about 215 degrees. At 6,000 feet it would be 235 degrees. On a 90 degree day, some care would be required. At a gross weight of 466 pounds, the envelope temperature would be about 240 degrees. Thus, our calculations show that a typical pilot has to work to seriously 'over-temp' the envelope. If you plan on high altitude flights or making high rate climbs, then a continuous monitoring temperature gauge would be a good idea.

How about an Ultralight with More Fuel?

We propose the following for the reader looking for an additional challenge. Is it possible to design an ultralight balloon which increases the fuel capacity to around 30 gallons? One approach to this question is to look at fuel tank tradeoffs. Our two Worthington tanks weigh 54 pounds. A system constructed with a Raven horizontal tank of 20 gallons, and one of the Worthington recreational tanks would provide 29.3 gallons of fuel for a weight of 59 pounds. That's only 5 pounds more. Its up to the reader to figure out how to put those two tanks into some form of a basket.

Regarding Units of Measure

A comment is due regarding units of measure. The mathematically astute reader might prefer measuring lifting force in pounds per cubic feet or in metric system units. However, most of our readers better understand the 'lift per thousand cubic feet' measure. In other words, the typical reader has a better understanding that '1,000 cubic feet will lift about 15.3 pounds', than '1 cubic foot will lift .0153 pounds'. If you are a professional numbers person, I hope you will bear with our choice of units.

Summary

We should note that we haven't yet constructed the ultralight designed in this article. But your editor's envelope projects, as well as review of other reader projects demonstrate the weights listed in *Chart 1* are achievable. Other builders have built balloons which meet the 155 pound ultralight limit. Using the ideas contained in this article you should be able to do the same.

We have demonstrated that the careful builder can build a practical balloon system for operations under FAR Part 103. Even a heavy pilot seeking fairly long duration can achieve these ends. Such a system is capable of being carried in the back of a small van, or even in the trunk of a car. Such a system can be flown with minimal ground support, as a very economical flight package.

Ultralight Balloon Computation Worksheet

Step	Instruction	Measure
1	**Determine the Weight of the Basket**	
1a	Enter the weight of the basket with burner ring.	________ Pounds
1b	Enter the weight of the burner and fuel hoses.	________ Pounds
1c	Enter the weight of the empty fuel tanks. Enter the total volume of the fuel tanks in gallons here:____	________ Pounds
1d	Enter the weight of other mounted equipment (i.e. instruments, drop line etc.).	________ Pounds
1e	Calculate the weight of basket assembly (add the above weights together).	________ Pounds
2	**Determine the Maximum Flying Weight**	
2a	Enter an initial weight estimate for envelope. (If a realistic estimate is not available, use 35 pounds for hang balloon, 47 pounds for uncoated fabric, and 54 pounds for coated fabric)	________ Pounds
2b	Calculate the fuel weight by multiplying the tank volume, in gallons, in step 1c, by 4.3.	________ Pounds
2c	Add the weight of the pilot and personal equipment.	________ Pounds
2d	Calculate the maximum aircraft takeoff weight by adding together steps 1e, 2a, 2b, and 2c.	________ Pounds
3	**Calculate the Required Envelope Volume**	
3a	Enter the generated lift in 'pounds per thousand cubic feet 'as taken from *Table 2.*	______ Pounds Lift per 1,000 Cubic Feet
3b	Compute required envelope volume in 'thousands of cubic feet' by dividing step 2d by step 3a.	______Volume in Thousands of Cubic Feet
3c	Compute actual envelope volume by multiplying step 3b by 1,000.	______ Volume in Cubic Feet
4	**Compute the Final Empty aircraft Weight**	
4a	Determine the expected envelope weight for the envelope in step 3c from *Chart 1.*	________ Pounds
4b	Calculate final empty weight by adding steps 1e and 4a. (This value must be less than 155 pounds to meet FAR Part 103).	________ Pounds

Letters to the Editor and Other Bits of Information

A Letter from Australia

June 7, 1995
Bob,

Just thought that I would let you know of the progress down in the southern half.

I have converted the gore pattern spreadsheet [BBJ Issue #1] to metric (just because that is the way that we work here) and have added a couple of additional sheets one which gives a graphical representation of the size and another which gives fabric usage stats based 12, 15, 16, 20 and 24 half gore designs.

To keep the measurements tidy I ended up going with a 16 gore, 42,353 cu ft design. I took delivery of 700 yards of silicon coated fabric a couple of weeks ago. Cutting has been going slowly so far. A 9 lbs 1 oz addition to the household has made sure of that.

On the approvals front the CAA [Australian aviation authority] has just employed a new chairman, an American by the name of Leroy Keith. First indications are that he is very pro-experimental aircraft. So much so that he has given a couple of the staunch opponents of the system here 2 weeks to come up with written reasons detailing why Australia shouldn't adopt the US system immediately. This is a radical change from what we have been getting for about 3 years.

Keep you posted

Steve Griffin
CompuServe 100240,1725

Envelope Builders Should Consider Buying a Decimal Measuring Tape

This comment is addressed to the builder using the English system of measurement, which requires dividing inches into fractions. If you use tools like *The Gore Pattern Spreadsheet* from Issue 1 of *BBJ* you will be forced to convert decimal feet to feet and inches. For example, at one vertical gore station, the pattern width might read 14.627 inches. One approach to this problem is to take a table of fractions and convert the printout into that format. Thus, our example would read 14 and 5/8 inches (with a small error). But a much nicer solution would be to have a decimal measuring tape.

The Stanley Tool Company markets a tape measure which is graduated in tenths and hundredths of inches. While typically hard to find, it is available from several aircraft supply companies. **Aircraft Spruce and Specialty** in Fullerton CA, markets the 12 foot long tape for $11.70. plus shipping. Their part number is P/N 33-272. Phone 800-824-1930. The creative builder should also spend $5 more and buy their aircraft catalog. Though intended primarily for the fixed wing airplane market, the catalog contains many items of use. The catalog buyer also receives a $5 coupon toward purchases.

Material Sources for Builders

BBJ has received word that fabric broker **Kenny Santos** is no longer willing to broker fabric to balloon builders. We understand the small lots sizes being purchased by builders along with their inexperience in dealing with the commercial textile market has made these sales unprofitable. We want to thank Kenny for his past efforts in offering fabrics to balloon builders.

We have mentioned **Westmark Fabric** as a fabric source in a number of our past issues. Their mailing address is Westmark Corporation, P.O. Box 98, Sterling, CT 06377-0098. Telephone 800-423-7829.

The Balloon Repair and Maintenance Association Newsletter (1241 High St. Oakland, CA 96401) for June 1995 noted these other sources of materials for balloon builders:

French quick connect links and marine hardware is available from **Wichard, Inc,** Simsbury, CT. Phone 203-658-2201.

Rattan and reed are available from **Frank's Cane & Rush Supply,** 7252 Heil Ave, Huntington Beach, CA 92647. Phone 714-847-0707. They offer a small catalog.

Copies of the **FAA Advisory Circular 103-7, 'The Ultralight Vehicle',** are available from Balloon Excelsior, 1241 High St., Oakland, CA 94601. Phone 510-261-4222. Cost is $5 to cover copy and mailing costs.