THE GREAT PARACHUTE DRIFTOFF

CHUTES, CHUTES, AND MORE CHUTES

FLAT ✯ GUIDE SURFACE ✯ HEMISPHERICAL ✯ SKIRTED ✯ "X" TYPE

by Bruce (not Kelly) Kilby #2999

All photos, graphs, and tables by the author except as noted.

Introduction

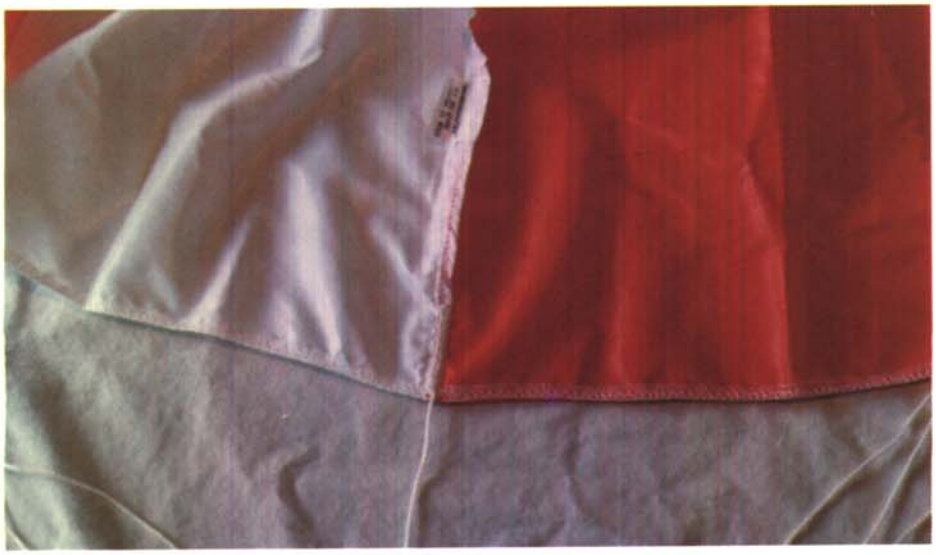
As we all know, a safe recovery is a required part of every rocket flight. Parachutes are the most common recovery device and one of the most misunderstood. Many of us don't know how to select the right kind or size of 'chute for a particular rocket flight.

There are a lot of parachutes out there. Do they all work? Which one is best and why? How big a 'chute should we use? Do you need the most expensive 'chute or will the one that came with your kit be OK? Do 'chutes live up to their advertisements? I hope we will answer these and other questions about parachutes. We might even dispel a few myths in the process.

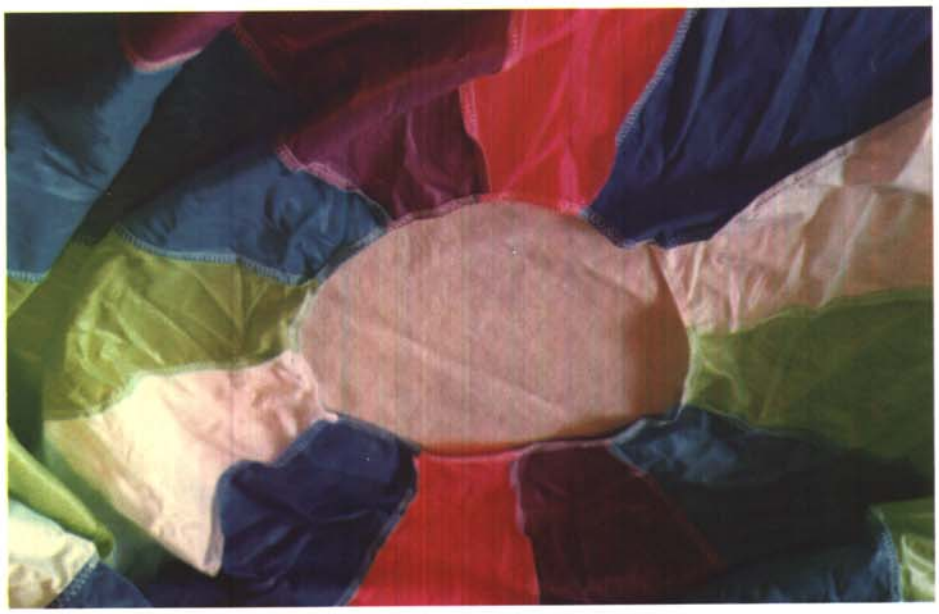
What We Tested

For this test we looked at 38 parachutes from nine manufacturers and one military surplus dealer. The most common 'chutes tested were of the flat round variety. We also looked at guide surface, hemispherical, skirted, and "X" form designs. Each manufacturer (and dealer) was asked to submit 'chutes sized for: a one to two pound rocket, a five pound rocket, a ten pound rocket, and a fifteen pound rocket. Some manufacturers do not offer the full range of 'chutes requested, so they sent what they had. Aerocon (the military surplus dealer) sent us one of everything they handle.

Author Bruce Kilby sets up the drag race for the drift test. All three are Rocket R&D Hornets. ***(Photos by Rick Boyette)***



Spherachutes 36" *(red and white)* and 96" six-color 'chutes showing hems and shroud line attachment. These are well made 'chutes.



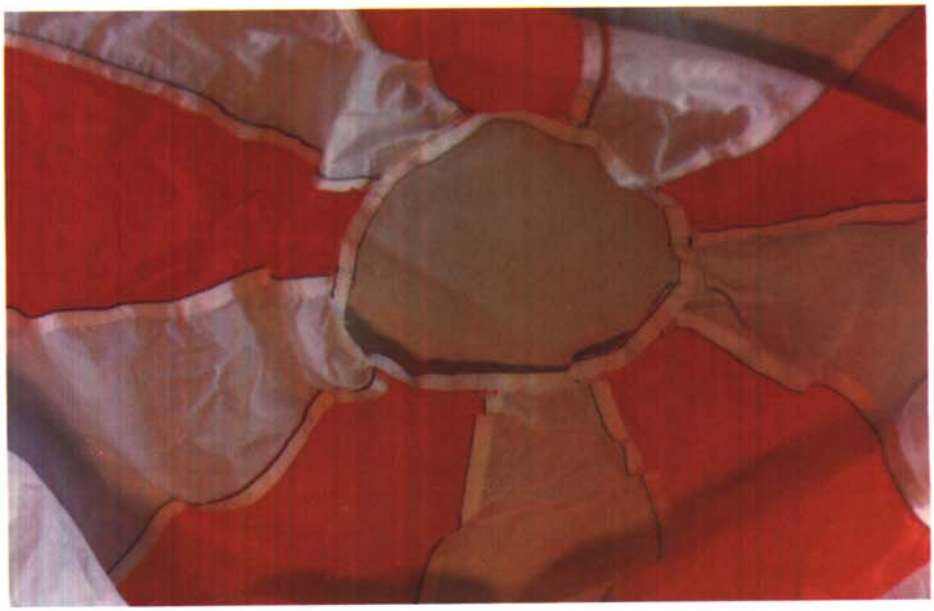
PML 84" Gradual Deployment 'chute *(below)* seams and shroud line attachment; shown folded with GD strap *(above)*. This is also a very well made 'chute.

Parachute Types

Aerocon is the only non manufacturer participating in the tests. They are a military surplus dealer. Even their small paper 'chute is made to military specs. The other 'chutes in the comparison tests were manufactured primarily for use in hobby rocketry.

Flat 'Chutes - The cheapest and most common 'chute in use today is the flat round parachute. It is usually made from a single piece of ripstop nylon cut into either a circle or polygon. Most have the shroud lines attached at the hem. As a group, the flat 'chutes are the weakest because of the shroud line attachment. However, all the 'chutes (including the flat ones) passed the 50 MPH shock/load test (see the section on *Strength*, page 43). Their size is their diameter.

Guide Surface - One of the most unusual designs in this test is the guide surface 'chute from Aerocon. It is the only such 'chute in this test. A guide surface 'chute is a hemispherical 'chute with an inverted half cone attached to the bottom. This design has the lowest drag of the 'chutes in this test, *but it is* the most stable. Examples of military use for this 'chute might include stabilizing a bomb or torpedo in high speed



etry a guide surface 'chute is best used as a drogue 'chute for a large rocket, but it can also be used as a very stable main 'chute. The Aerocon six-foot 'chute is obviously designed for very high speed deployment and should be among the softest opening 'chutes tested. The size is the circumference over the top of the canopy.

Hemisphere 'Chutes - Because of their similar appearance and function, I lumped the PML conical 'chutes in with the hemisphere 'chutes. As the name would imply, hemisphere parachutes are in the shape of half a sphere. Most are sewn from wedge shaped panels. The hemisphere 'chutes tested had a spill hole at the top of the canopy. Parachutes with spill holes are less likely to oscillate and should have a slightly softer opening. The hemisphere and conical 'chutes in the test are stronger than the standard flat 'chutes tested. The size is the circumference over the top of the canopy.

The three larger PML 'chutes were of the GD (Gradual Deployment) design. Not only does this design deploy slower (and softer) than most other 'chutes tested, but they are built like a brick outhouse. All the seams are reinforced with nylon straps.

Skirted 'Chutes - The B2 Rocketry Company SkyAngle™ is the only *skirted* design in this test. This 'chute has a round flat canopy with three triangular panels, or skirts, added to the circumference. In addition to adding surface area and a very interesting look, these skirts spread the load of the shroud lines over the circumference of the canopy. Additionally, the three (950-pound) shroud lines continue over the top of the canopy. These parachutes should have the same opening shock as the flat round 'chutes. The only drawback to this 'chute is that it uses 1.1-pound ripstop nylon for the canopy and skirts. I believe that the design distributes the load in such a way that this lighter fabric should not fail during normal use, but the thinner nylon is more likely to snag or burn during ejection (see *Fabric Weights*, page 43). Their size is the diameter of the flat round canopy top.

'X" or Cross-Type Parachutes - Because of their similar shape and function I

Rocketman 'chutes, hems, shroud line attachments, and reefing locks.

lumped the Rocketman 'chute in with the "X" type 'chutes. The standard X 'chute is made up of two rectangular panels of fabric overlapping to form an X. The X design should have the softest deployment of the 'chutes tested. The standard X 'chute from Top Flight should be about as strong as their standard flat 'chutes because their shroud line attachment is similar. The Top Flight X-type 'chutes have eight shroud lines.

The Rocketman 'chute is an X-type 'chute with cups. Forgive me for saying this, but these cups look like the cups of a bra, and in the larger sizes they pulsate. The Rocketman 'chutes have only four shroud lines but they are much stronger than most other shroud lines. The four nylon strap shroud lines on the 'chutes I tested were attached to the reinforced canopy hems. This design did pass our 50 MPH shock load test, however, Ky Michaelson of Rocketman has redesigned the 'chutes. The shroud lines on the newer 'chutes are continuous over the top of the canopy. This is a great improvement. If you have a choice use the newer design, especially on the larger 'chutes. Rocketman 'chutes use the lighter 1.1-pound ripstop nylon. Again the design is well reinforced so that the canopy should

B_2 SkyAngle 60-inch 'chute. Shown are the spinner and reefing slide, the shroud line attachment at the skirt, and the shroud lines crossing at the top of the canopy.

not rip during normal use, but I believe it to be more prone to snagging or burning during ejection (see *Fabric Weights*, page 43).

The Test

We tested these parachutes in three areas: drift, strength, and descent rate. In Table 4 *(Prices and Ratings)* on pages 50-51, we also included our ratings for quality of construction, strength, and appearance.

Drift

Before beginning our drift test we heard more than one person explain why one brand of 'chute didn't drift as far as other brands. Likewise we heard several opinions that all 'chutes drifted about the same.

It made sense that all 'chutes would drift about the same. Within a few seconds of deployment the rocket and 'chute should accelerate to match the wind speed. Once flowing with the wind the 'chute would be in essentially still air relative to the wind. As such, the wind would have little if any effect.

To prove or disprove this theory, I set up a series of drag races using three identically prepared Rocket R&D Hornets. Each flight used an AeroTech F40 motor. We used three different types of 'chutes in each salvo.

Just before each drag race we took an approximate reading of the wind speed at ground level. We timed the descent from deployment to touchdown. Also, we recorded the total drift distance. The total drift distance and drift time were used to calculate the drift rate in feet per second. Since the altitude of deployment and descent rates varied the only fair way to compare drift was to compare drift rates.

The drift distance was difficult to measure because the exact point on the ground above which the 'chute opened was hard to determine. This forced an err into my calculations, but this err should generally be less than 15%. Most of the calculated drift rates were within about 10% to 15% of the ground level wind speeds (see Table 1, page 45). Allowing for that err, the drift rates were about equal to the wind speeds. We concluded that there is no substantial difference (if any) in drift rate between the parachutes tested.

Observations made at the field

reinforced this conclusion. By standing back and watching, we could see that the three 'chutes, wadding, and smoke appeared to drift at the same rate. It was kind of neat to see all three 'chutes drifting in formation.

Many of us have noted that one rocket might have a much longer drift than a similar rocket using another brand 'chute. The difference is in the descent rate. One manufacturer advertises a lower drift rate. In reality, this 'chute has a faster rate of descent for the same size 'chute. If a rocket is under 'chute half as long, it will have half the drift. The drawback is that the rocket lands twice as hard.

So, to cut rocket drift use a smaller 'chute, or open the main 'chute closer to the ground. Two stage recovery may give the best combination of low drift and soft landings. For a discussion on electronic deployment, see "The Great Electronic Recovery Flyoff" in the last issue of *HPR* (November 1998, pp. 39-54).

We were unable to include the B2 Rocketry SkyAngle 'chutes in our drift test because they arrived too late. Mike Barton of B2 Rocketry agreed with us that his 'chutes would have performed in a similar manor.

Strength

In addition to the shock load test, we rated the 'chutes for strength based on quality of construction and materials used (see Table 4, pages 50-51). To test strength, we hooked a harness to the rear of the Kilby Family Rocket Transport Van, hooked a 'chute up and threw the 'chute out the window at 50 MPH. We felt that opening a 'chute at this speed probably would damage most rockets or break the shock cord. During the test we broke a ¼" bungee cord using a North Coast Rocketry 20-inch 'chute and a 950-pound Tubular Nylon (or Cato) cord using a LOC 78-inch 'chute. I didn't throw the Aerocon 16-inch 'chute out the window. I chickened out and started with it already behind the van.

All the 'chutes tested passed this strength test, even the paper 'chute from Aerocon. The only 'chutes that showed any stress were the two North Coast Rocketry 'chutes. Both had some visible stress in the stitches holding the shroud lines. These 'chutes had the weakest shroud line attachment but they still passed the test.

Fabric Weights - Most of the canopies in this test are made from 1.7-pound ripstop nylon. Several 'chutes use 1.1-pound ripstop nylon. Most of these 'chutes with the lighter fabric are reinforced. Based on my testing, however, I believe that the lighter fabrics are more prone to being snagged or burned during ejection unless they are in a deployment bag. These tears and burns are generally small and should have little if any effect on the function of the 'chute. In all fairness the 'chutes with the lighter fabrics will pack tighter. This is a consideration in some of the designs that use a lot of fabric.

Shroud Lines - The highest concentration of loads in a parachute is in the shroud lines and their attachment points. Their number and strength as well as the type of attachment greatly affect the overall strength of a parachute. Generally the more and stronger the shroud lines, the less stress on each line and its attachment point. That is why most of the larger 'chutes have more shroud lines than the smaller 'chutes of the same design. The only drawback to larger numbers of shroud lines is that they may be more likely to become tangled, but proper packing should lessen this danger. Rocketman and B2's SkyAngle 'chutes are unique in this respect. They only have four and three shroud lines respectfully. To compensate, Rocketman and B2's SkyAngle 'chutes use very strong nylon shroud straps. Also, B2's SkyAngle 'chutes use continuous shroud lines. Ky of Rocketman tells us that their new 'chutes also use continuous shroud lines, but the ones tested did not.

Most of the 'chutes in this test have the shroud lines sewn to the canopy at the hem. This type of attachment is the weakest but still passed the 50 MPH stress test. Some 'chutes using this design showed some stress at the attachment point after the stress test. These attachments may be more prone to failure after repeated use. Simply checking (and repairing) these 'chutes between flights should prevent a failure.

The next step up is to sew or tie the shroud lines at a reinforced point on the canopy. None of the 'chutes using this type of attachment showed any sign of stress. These 'chutes should be more reliable long term.

Generally, the best design is to continue the shroud lines over the top of the canopy. As with the reinforced attachment, 'chutes using the continuous design showed no sign of stress and should not fail at this point.

Depending on the number of shroud lines and the method of attachment, attaching the shroud lines at a reinforced point on the hem can be as strong as continuing the shroud lines over the top of the canopy. Some designs such as the hemispherical 'chutes may not open normally with continuous shroud lines.

Load/Descent Rate

Most manufacturers recommend 'chute sizes for different weight rockets, but how accurate are these recommendations? We didn't have a wind tunnel available so we again used the old reliable Rocket Transport Van. We extended a wooden beam out the open side door of the van and attached a fishing scale to the end. Next, we attached a wheel driven electronic speedometer accurate to 0.05 MPH.

My son, Mathew, and I began our test on a calm south Florida Saturday in January. It was cool but not cold and about 20 feet above Sea Level. We chose a road that was shielded from what breeze there was.

I drove while Mathew read the scale. We made at least four runs with each 'chute at each speed. The high and low readings were discarded. The table shows the average of the remaining runs.

I recommend landing most rockets with a descent rate of about 20 feet per second. Fragile rockets or harder landing sites may require a slower descent rate. Stronger rockets may tolerate a harder landing. A descent rate of less than 15 feet per second may result in the side sliding (or sailing) of the 'chute.

Recommendations

If price were no object, most of us would probably use the best, the strongest, and the most attractive 'chutes available. That translates to some of the more expensive 'chutes in our test. As they say, "You get what you pay for." However, all the 'chutes test-

ed passed the 50 MPH shock test. All the 'chutes can support your rocket for a gentle landing, and all the 'chutes tested have about the same drift rate. For the majority of flights the cheapest 'chute will work just as well as the most expensive 'chute tested.

So, if you are flying on a budget, the least expensive 'chute available should meet your needs. If your pockets are a bit deeper, use the best 'chute that you can justify.

Thank You

I would like to thank the members of Tripoli West Palm for their help. And as always, I couldn't have done any of this without the help of my family and the cooperation of the parachute manufacturers and dealers. Happy landings!

Information

For more information about the products compared in this article, contact the individual manufacturers/dealers at:

Aerocon
P.O. Box 204
Hollister, CA 95024
(408) 450-0704

AeroTech Inc.
1955 S. Palm St. Suite 15
Las Vegas, NV 89104
(702) 641-2301

B2 Rocketry Company
105 Junco Way
Savannah, GA 31419
(912) 447-1036

LOC/Precision
P.O. Box 255
Macedonia, Ohio 44056
(330) 467-4514

North Coast Rocketry
1295 H Street
Penrose, CO 81240
(800) 525-7563

Public Missiles Ltd.
349 Cass Ave. Suite C
Mt. Clemens, MI 48043
(810) 468-1748

Rocketman
8337 Penn Ave. South
Bloomington, MN 55431
(800) 732-4883

Rocket R&D
209 N. Main St.
Homer, IL 61849
(217) 896-3041

Spherachutes
P.O. Box 621956
Littleton, CO 80162
(303) 798-2889

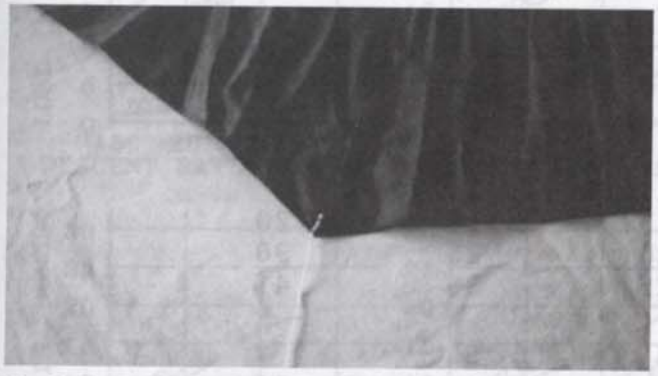
Top Flight Recovery
S12621 Donald Road
Spring Green, WI 53588
(608) 588-7204

Appendix

The Appendix contains the tables and graphs referenced in the article and are found on the following seven pages.

Chute & Size	Drift: feet	Time: sec.	Drift: ft/sec	Approximate Wind Speed:
Drag race #1				
North Coast: 24"	510	40	12.8	10 MPH; 14.5 F/S
Rocketman: R3C	595	37	16.1	
Aerocon: 16"	358	27	13.3	
Drag race #2				
Spherachutes: 36"	256	63	4.1	< 5 MPH; < 7.2 F/S
Rocket R & D: 24"	226	58	3.9	
Aerotech: 20"	214	57	3.8	
Drag race #3				
Top Flight: 36" X	904	64	14.1	10 MPH; 14.5 F/S
PML: 34R	1143	67	17.1	
LOC: 18"	766	47	16.3	
Drag race #4				
Top Flight: 24" R	325	46	7.1	5 MPH; 7.2 F/S
PML: 34R	536	62	8.6	
Rocketman: R3C	342	44	7.8	
Drag race #5				
Spherachutes: 36"	645	62	10.4	7.1/2 MPH; 10.8 F/S
Top Flight: 36" X	653	54	12.1	
North Coast: 24"	365	38	9.6	

Table 1 - Drift Test



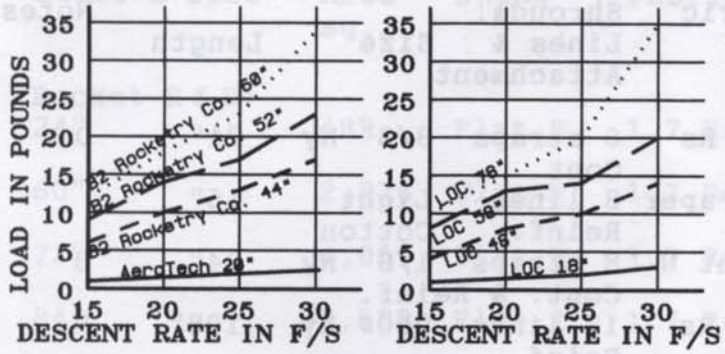
North Coast Rocketry 22" shroud line attachment. This is the weakest looking shroud line attachment of the 'chutes in the test. It showed signs of stress after the 50 MPH shock load test. Below: Rocket R&D 84-inch 'chute showing hem and shroud line attachment.

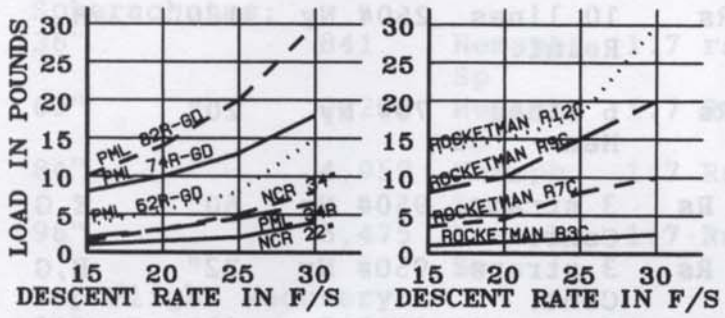
LOC/Precision 78-inch 'chute showing hem and shroud line attachment. Below: Top Flight Recovery "X" hems and shroud line attachments.

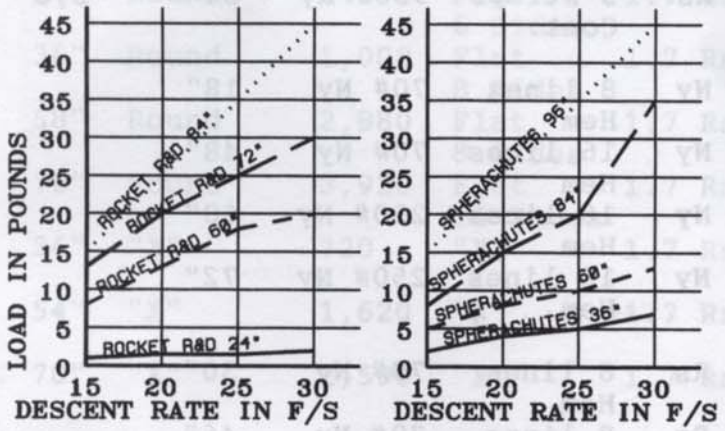
Chute & Size	Loads in pounds / Descent rates as shown. 15 f/s 10.2 mph	20 f/s 13.6 mph	25 f/s 17.1 mph	30 f/s 20.4 mph
Aerocon:				
16" Olive	1/2	1	1.1/2	2
24" Paper	1	1.1/2	2	2.1/2
48" Center line	3	4	8	10
6' Guide Surface	7	11	16	22
16'	40	55	A	A
Aerotech:				
20"	1	1.1/2	2	2.1/2
B2 Rocketry Co:				
44"	6	10	13	17
52"	9	14	17	23
60"	12	18	23	34
LOC:				
18"	1	1.1/2	2	3
48"	4	8	10	14
58"	8	13	14	20
78"	10	15	20	35
North Coast Rocketry:				
24"	1	1.1/2	2	4
36"	1.1/2	3	5	8
Public Missiles Ltd:				
34R	2	3	4.1/2	6.1/2
62R-GD	3.1/2	5.1/2	8	15
74R-GD	8	10	13	18
84R-GD	10	14	20	30
Rocketman:				
R3C	1	1.1/2	2	2.1/2
R7C	3.1/2	4.1/2	8	10
R9C	8	10	15	20
R12C	13	15	18	30
Rocket R & D:				
24"	1	1.1/2	1.1/2	2
60"	8	13	18	20
72"	13	20	25	30
84"	15	25	35	45
Spherachutes:				
36"	2	4	5	7
60"	5	8	10	13
84"	8	15	20	35
96"	15	25	35	45
Top Flight Recovery:				
24" Round	1	2	2.1/2	4
36" Round	2	3.1/2	4	7
58" Round	5	10	17	20
70" Round	10	15	20	30
36" "X"	1	2	3	5
54" "X"	3	5	8	10
70" "X"	6	10	14	20

Note A. Scale did not read over 55 pounds.

Table 2a - Load/Descent Rate Table







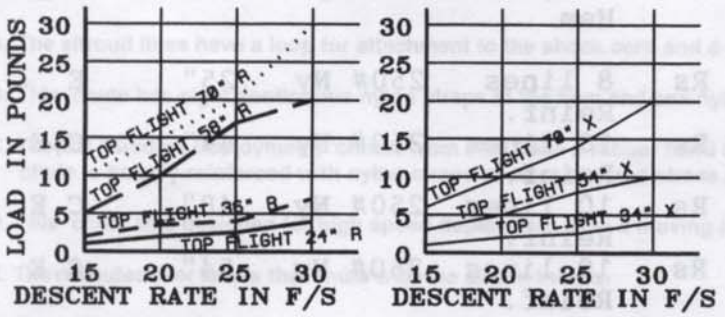
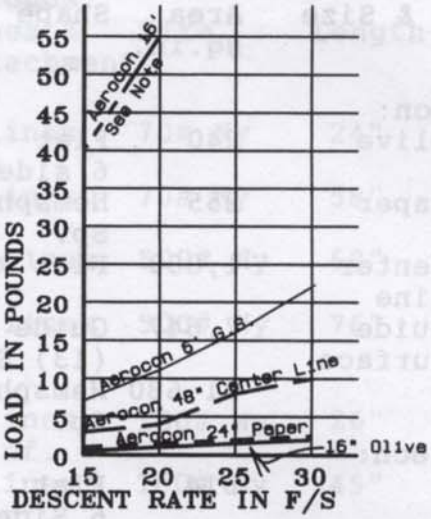
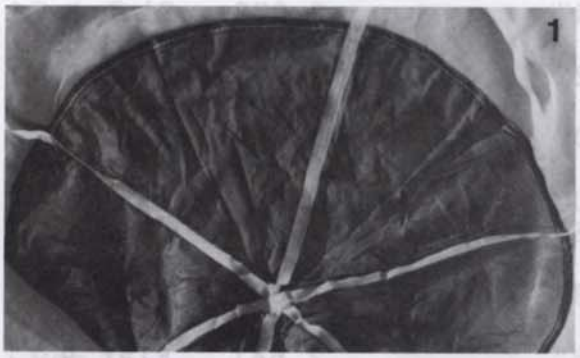
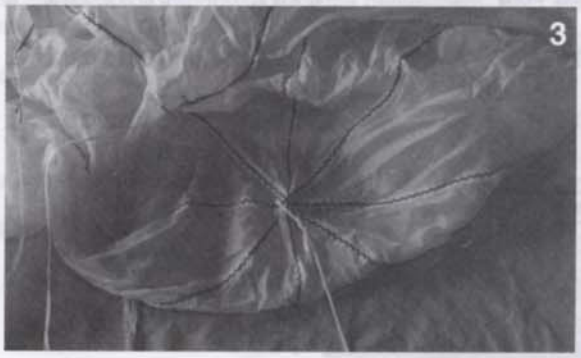
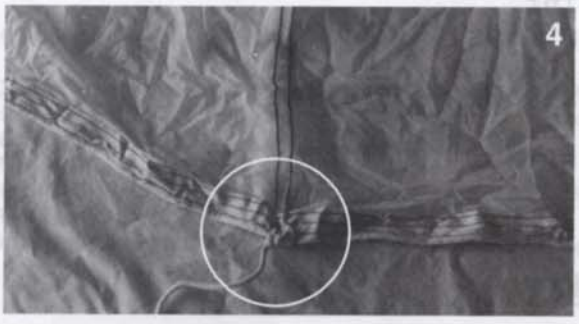


Table 2b - Load/Descent Rate Graphs









1. Aerocon's 16" Olive Drab parachute. Note the continuing "over the top" shroud lines. This 'chute was designed for deployment from a fast moving jet airplane. 2. Aerocon's 24" paper 'chute. 3. Aerocon's 48" center line parachute. Note the continuing shroud lines and the center shroud line. 4. Aerocon's 16' parachute shroud line attachment *(circled).*

Chute & Size	Area sq.in.	Shape	Fabric	Shrouds: Lines & Attachment	Size	Length	Notes:
Aerocon:							
16" Olive	240	Flat 6 sides	1.1 Rs	6 straps Cont.	3/8" Ny	21"	D
24" Paper	255	Hemsph. Sp.	Rs Paper	8 lines Reinf.	Light Cotton	16"	
48" Center line	1,809	Flat R	Light N	8 straps Cont. & Reinf.	1/8" Ny	34"	B
6' Guide Surface	7,647	Guide S. (13) Sp.	1.1 Rs	12 lines Reinf.	950# Ny	108"	H
16'	31,680	Hemsph. Sp.	Lt Rs	10 lines Reinf.	250# Ny	180"	H
Aerotech:							
20"	314	Flat 6 Side	1.1 Rs	6 lines Hem	70# Ny	20"	
B2 Rocketry Co:							
44"	2,072+ Skirt	Flat R W/ Skirt	1.1 Rs	3 straps Cont.	950# Ny	60"	E,G
52"	2,776+ Skirt	Flat R W/ Skirt	1.1 Rs	3 straps Cont.	950# Ny	72"	E,G
60"	3,769+ Skirt	Flat R W/ Skirt	1.1 Rs	3 straps Cont.	950# Ny	84"	E,G
LOC:							
18"	254	Flat 8 Side	1.7 Ny	8 lines Hem	70# Ny	18"	
48"	1,809	Flat R	1.7 Ny	16 lines Hem	70# Ny	48"	
58"	2,641	Flat R	1.7 Ny	16 lines Hem	250# Ny	60"	
78"	4,776	Flat R	1.7 Ny	16 lines Hem	250# Ny	72"	
North Coast Rocketry:							
24"	380	Flat 8 Sides	1.7 Rs	8 lines Hem	70# Ny	30"	
36"	907	Flat 8 Sides	1.7 Rs	8 lines Hem	70# Ny	46"	
Public Missiles Ltd:							
34R	977	Conical Sp	1.7 Rs	8 lines Reinf.	250# Ny	25"	E
62R-GD	2,126	Conical Sp	1.7 Rs	10 lines Reinf.	250# Ny	44"	C,E
74R-GD	2,760	Conical Sp	1.7 Rs	10 lines Reinf.	250# Ny	48"	C,E
84R-GD	3,844	Conical Sp	1.7 Rs	10 lines Reinf.	250# Ny	54"	C,E
Rocketman:							
R3C 42"	660	"X" Cupped	1.1 Rs	4 straps Reinf.	3/16" Ny	31"	A,F
R7C 82"	2,015	"X" Cupped	1.1 Rs	4 straps Reinf.	3/16" Ny	56"	A,F
R9C 118"	7,088	"X" Cupped	1.1 Rs	4 straps Reinf.	3/16" Ny	90"	A,F
R12C 134"	9,025	"X" Cupped	1.1 Rs	4 straps Reinf.	3/16" Ny	114"	A,F

Table 3 - Specifications

Chute & Size	Area sq.in.	Shape	Fabric	Shrouds: Lines & Attachment	Size	Length
Rocket R&D:						
24"	482	Flat R	1.7 Rs	8 lines Hem	70# Ny	24"
60"	2,826	Flat R	1.7 Rs	8 lines Hem	70# Ny	58"
72"	4,069	Flat R	1.7 Rs	12 lines Hem	500# Ny	68"
84"	5,538	Flat R	1.7 Rs	12 lines Hem	500# Ny	76"
Spherachutes:						
36"	841	Hemsph. Sp	1.7 rs	6 lines Reinf.	160# Ny	26"
60"	2,283	Hemsph. Sp	1.7 Rs	8 lines Reinf.	160# Ny	45"
84"	4,959	Hemsph. Sp	1.7 Rs	12 lines Reinf.	160# Ny	66"
96"	6,475	Hemsph. Sp	1.7 Rs	12 lines Reinf.	160# Ny	72"
Top Flight Recovery:						
24" Round	540	Flat 6 Sides	1.7 Rs	6 lines Hem	70# Ny	23"
36" Round	1,008	Flat 8 Sides	1.7 Rs	8 lines Hem	250# Ny	35"
58" Round	2,880	Flat 8 Sides	1.7 Rs	8 lines Hem	250# Ny	55"
70" Round	3,920	Flat 16 Sides	1.7 Rs	16 lines Hem	250# Ny	68"
36" "X"	720	"X"	1.7 Rs	8 lines Hem	250# Ny	35"
54" "X"	1,620	"X"	1.7 Rs	8 lines Hem	250# Ny	53"
70" "X"	2,596	"X"	1.7 Rs	8 lines Hem	250# Ny	68"

Notes:

A. The shroud lines have a loop for attachment to the shock cord and a sliding (reefing) lock.

B. This 'chute has eight continuous nylon straps at the hem and one nylon line at the center of the canopy.

C. The GD (Gradual Deployment) 'chutes from PML have a rubber band at the mouth of the canopy to slow the deployment. Also, this 'chute is heavily reinforced with nylon straps at all seams and stress points.

D. This 'chute was designed for high speed deployment from a moving jet airplane.

E. The manufacturer labels the 'chute with the size in inches.

F. Since the testing, Rocketman has redesigned the 'chutes to use a continuous shroud line attachment.

G. The shroud lines have a swivel for attachment to the shock cord and a sliding (reefing) lock.

H. Includes a deployment bag.

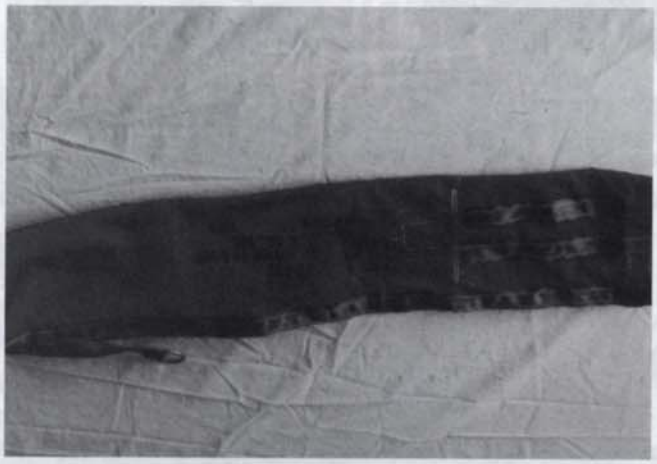
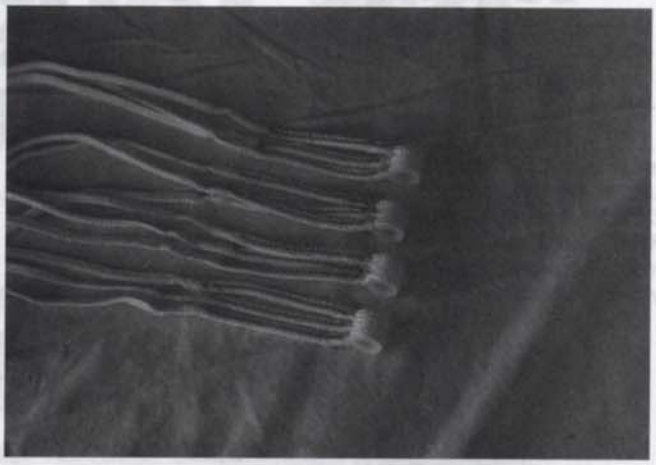
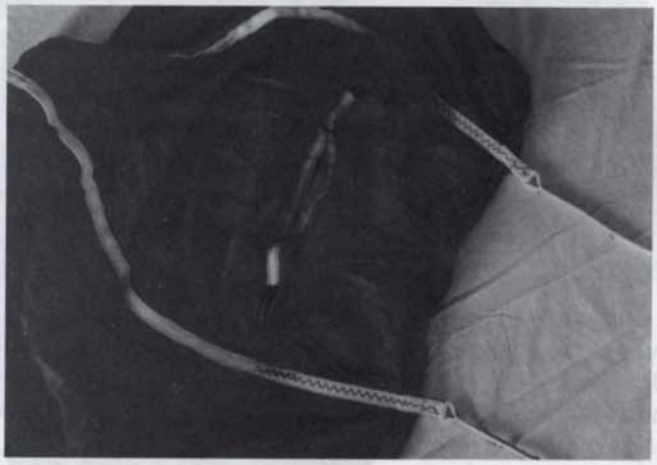
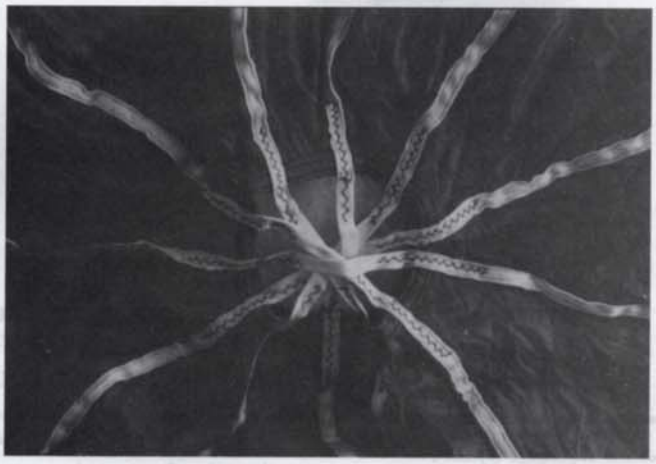
Cont = The Shroud lines are continuous over the top of the canopy.
Hem = The shroud lines are attached at the hem of the canopy fabric only.
Ny = Nylon.
R = Round.
Reinf = The shroud lines are attached at a reinforced point on the canopy.
Rs = Rip stop nylon (or Rip Stop paper).
Sp = This 'chute has a spill hole at the center of the canopy.

Table 3 - Specifications (continued)

Aerocon 16-foot 'chute used on the author's Level 3 project.

Chute & Size	List Price:	Quality:	Strength:	Appearance:
Aerocon:				
16" Olive	$ 3.00	4	4	1
24" Paper	4/$5.00	3	2 C	1
48" Center line	7.50	4	4 C	3
6' Guide Surface	35.00	4	5 C	4
16'	55.00	4	4 C	3
Aerotech:				
20"	$ 9.50	3	3 C	1
B2 Rocketry Co:				
44"	$43.20	4	5 C	4 A
52"	54.00	4	5 C	4 A
60"	70.20	4	5 C	4 A
LOC:				
18"	$ 7.15	1	2	1
48"	19.75	1	2	1
58"	28.75	1	2	1
78"	39.50	1	2	1
North Coast Rocketry:				
24"	$ 6.99	1	1	1
36"	14.99	1	1	1
Public Missiles Ltd:				
34R	$20.60	4	4	5 A
62R-GD	57.40	5	5	5 A
74R-GD	81.00	5	5	5 A
84R-GD	108.50	5	5	5 A
Rocketman:				
R3C	$30.00	4	4 B,C	3
R7C	45.00	4	4 B,C	5 A
R9C	55.00	4	4 B,C	5 A
R12C	95.00	4	4 B,C	5 A
Rocket R & D:				
24"	$ 7.50	3	2	1
60"	26.00	3	2	1
72"	34.50	3	2	1
84"	43.75	3	2	1
Spherachutes:				
36"	$20.00	4	4	5 A
60"	41.00	4	4	5 A
84"	77.00	4	4	5 A
96"	97.00	4	4	5 A

Table 4 - Prices and Ratings

Aerocon's 6' guide surface 'chute. Shown are the deployment bag, shroud line ends, shroud line attachment, and one of 12 side vents, and shroud lines crossing at top of canopy.

Chute & Size	List Price:	Quality:	Strength:	Appearance:
Top Flight Recovery:				
24" Round	$ 8.75	3	2	1
36" Round	14.75	3	2	1
58" Round	25.75	3	2	1
70" Round	34.75	3	2	1
36" "X"	16.25	3	2	4 A
54" "X"	25.25	3	2	4 A
70" "X"	38.25	3	2	4 A

Notes:

All ratings in this table are subjective personal opinions. Ratings are 1 to 5, with 5 being the best.

A. Multi-panel design.

B. After the testing, Rocketman improved their design by making the shroud lines continuous over the canopy. The ratings reflect the 'chutes as tested.

C. The thin nylon (or paper) is more likely to burn or rip at ejection than heavier canopies.

Table 4 - Prices and Ratings (continued)