"Re-designing the three-ring release system"
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Over the passed several years we have heard and read about individuals that have had difficulty in breaking away from their main parachute. The accounts describe individuals that, much to their dismay, have encountered forces on their cutaway handles that were beyond their capability to pull.

Many speculations have been offered regarding the cause of this phenomenon. Possible explanations have included: high "g" loading, higher wing loadings, smaller, more elliptical canopies, twisted risers, etc., etc.

No one has a definitive answer. In 1998 however, The Relative Workshop commissioned a re-evaluation of the mini three-ring release system. The result of this study was a better understanding, and a new specification for the manufacture of three-ring systems.

The adoption of cable housings (plastic or metal) in the risers, has also become a *de facto* standard, under the premise that twisted risers *may* play a role in increased pull forces. While no one could tell you with certainty that this is truly an issue, the feeling in the industry was "better safe than sorry". Many manufacturers to date have doubts as to the validity of the "twisted riser scenario" and its effect on cutaway pull force.

In early 2002, our design team, led by Michel Auvray (mini three-ring designer) set out to actually address pull forces at the cutaway cable. The result, after more than a year of development and testing, is the miniforce™[1] system.

This patented new system actually addresses the engineering behind the three-ring release system and effectively reduces forces on the cutaway cable by an average of approximately 35% at any given loading. This reduction in cutaway force has been validated by our test team, at riser loadings of up to 10g and beyond!

The basis for the improvement is an increase in lever arm distance at the middle ring. (See figure1)

[1] Miniforce™ is a registered trademark of Aerodyne International

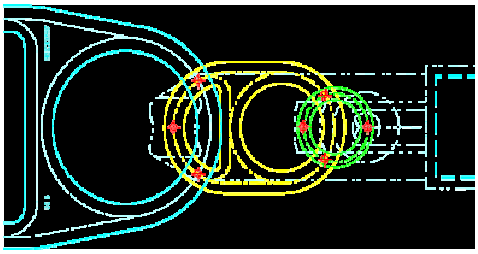

Figure 1

As you can see the center ring is actually lengthened. If we look at the engineering study that was done in 1998, we see the distance (d3) is now longer than on previous three-ring geometry. (See figure 2)

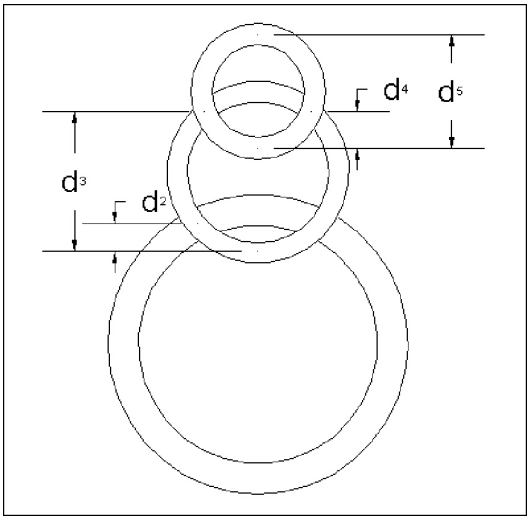

Figure 2

Following the mathematics that were used to develop the current three ring specifications, we can now calculate the predicted loop force for the new system as follows:

$$\left| \frac{F_L^*}{F_L} = \frac{\left(\frac{d_3}{d_2} - 1 \right)}{\left(\frac{d_3^*}{d_2} - 1 \right)} = \frac{(d_3 - d_2}{(d_3^* - d_2} \right|$$

Reference: Collins, Kyle, “Advanced Three-Ring Technology”

We can now compare the calculated (predicted) loop force for the old and new systems. This loop force is directly proportional to cutaway pull force.

(See Figure 3)

Loop Force Comparison	Current 3-ring			miniforce™ system			Change		
F_{Rx} Riser Load	F_L (lb.) Q = 90°	F_L (lb.) Measured	F_L (lb.) Q = 45°	F_L (lb.) Q = 90°	F_L (lb.) Avg	F_L (lb.) Q = 45°	Percentage Reduction in Loop Load Q = 90°	Avg	Q = 45°
245 lb.	4.66	5	5.45	2.89	3.14	3.39	-37.90%	-37.20%	-37.90%
495 lb.	7.27	7.5	8.52	4.55	4.95	5.34	-37.40%	-34.10%	-37.40%
745 lb.	11.08	11	12.99	6.94	7.54	8.13	-37.40%	-31.50%	-37.40%
995 lb.	13.16	15	15.42	8.28	8.99	9.7	-37.10%	-40.10%	-37.10%

Figure 3

The new miniforce™ system is constructed from forged stainless steel and can be seen in Fig. 4 (below).

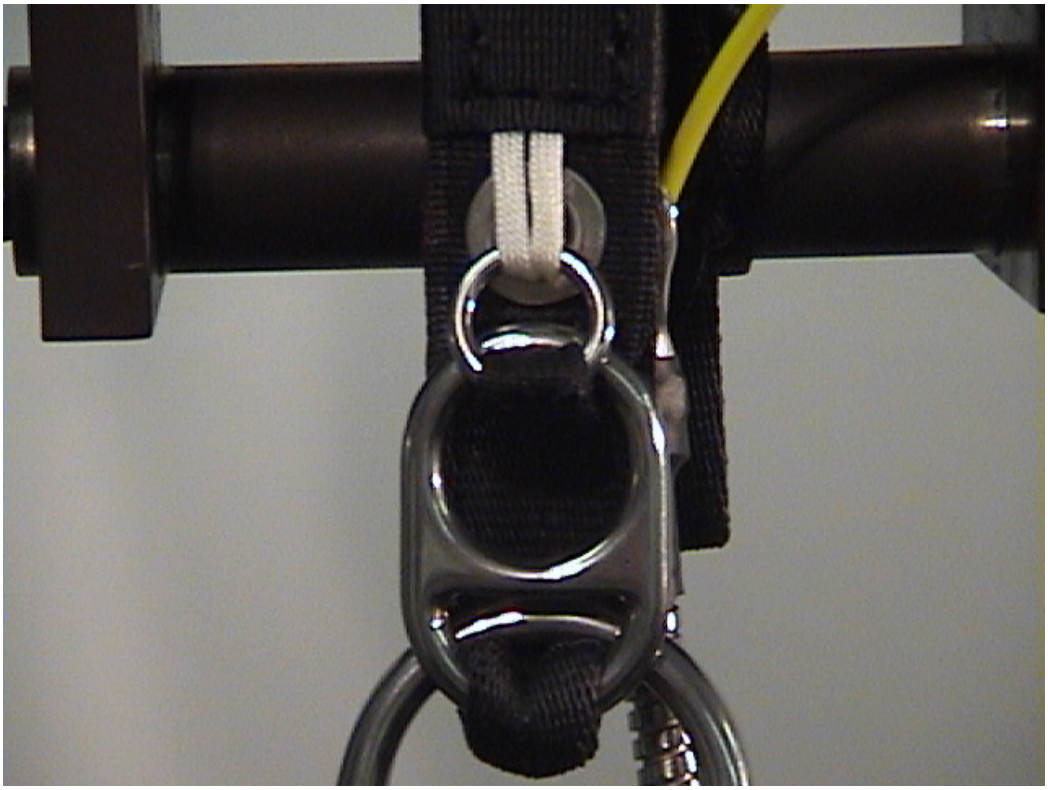

Figure 4

miniforce™ system patent pending aerodyne

Actual testing performed, verifies the predicted reduction in cutaway force.

See Figure 5.

Standard Mini 3-ring system						
Loading on 1 riser		Measured force on yellow release cable in pounds				
Newtons	Pounds	TEST 1	TEST 2	TEST3	TEST 4	AVERAGE
500	112.4	1,21	0,77	1,10		**1,03**
1000	224.8	2,42	1,65	1,65		**1,91**
1600	359.7	2,53	2,75	2,42	3,19	**2,73**
2000	449.6	3,08	2,75			**2,92**
3000	674.4	7,93	6,61	8,92		**7,82**

Aerodyne miniforce™ 3-ring system							
Loading on 1 riser		Measured force on yellow release cable in pounds					Reduction of force
Newtons	Pounds	TEST 1	TEST 2	TEST3	TEST 4	AVERAGE	
500	112.4	0,44	0,66	0,77		**0,62**	**39%**
1000	224.8	1,21	1,32	0,88		**1,14**	**40%**
1600	359.7	2,20	1,87	1,32		**1,80**	**34%**
2000	449.6	2,42	2,42	1,54	1,54	**1,98**	**32%**
3000	674.4	3,19	3,74	3,08		**3,34**	**57%**
Average reduction of force on cable, Low and High removed = 37%							

Figure 5

The results speak for themselves! When we analyze the results of both theoretical and practical testing, we find the following design goals have been met.

- Reduction in breakaway pull force by 37% (avg) in all test modes.
- Manufacturing tolerances have been opened, resulting in greater reliability while maintaining the mechanical advantage of the system.
- Minimal cost impact to harness container manufacturers.
- Compatibility with existing systems in use.
  Cable housings must be able to move up 1/2" (minimum), from current location.
  Riser covers must not be located too close to three-ring assembly in order to ensure free release during harness distortion.
- Easily tested by harness container manufacturers (same tests as current system)

The engineers at Aerodyne have broken new ground and developed the most exciting improvement in release technology since the three-ring itself. We can now have a more efficient system, reducing cutaway pull forces in all situations. All of this technology is available as a standard feature on the new Aerodyne Icon harness/container, but most major harness/container manufacturers have already begun planning the inclusion of the miniforce™ into their new systems. The design team at Aerodyne has taken safety to heart by not only developing the system itself but also by designing the miniforce™ to be compatible with all existing mini three-ring harnesses. By

simply installing a new pair of miniforce™ equipped risers, all of the force reduction benefits will be gained[2].

[2] Check with your harness container manufacturer for compatibility.