

PIA Technical Standard 104

Parachute Industry Association Publications

July 1, 1987 TS-104

TS 104 Canopy Volume Study 2007 MAR 16

Canopy Study

Background

In January 1985 at the annual winter meeting of the Parachute Industry Association, the Technical Committee proposed a comprehensive study of currently manufactured parachutes. This study would involve the volume, weight, and for squares, the area of the canopy according to PIA standards. The purpose of the study was to update the volume chart originally developed by the Jump Shack several years previously.

National Parachute Industries had developed a volume chamber that they had been using with a high degree of success in obtaining consistent relative volume measurements. They volunteered the use of this chamber in order to conduct this study.

The original proposal for the study was made by Sandy Reid, then of Westgaard Parachute. It was felt that Westgaard, not being a canopy manufacturer, would be able to conduct the study in their certified Parachute Loft under controlled conditions with a high degree of impartiality. This was accepted by the membership with the study to start as soon as the facilities were in place and samples provided by the manufacturers. It was originally thought that the initial study would be completed in a three month period.

See latest test results in [Attachment I](#)

Test Procedures

Volume

1. Canopies are stripped of all extraneous items such as risers, steering toggles, deployment bags, etc. Deployment devices that are permanently attached to the canopy such as diaphragms are included as are connector links and sliders on ram-air canopies.

2. Fluff the canopy.
3. Place the canopy into the chamber with the lines on top. Square canopies are placed into the cylinder tail first and round canopies are placed in apex first so that the air has a chance to escape. As you place the canopy into the chamber, distribute the material as evenly as possible.
4. Insert the piston into the cylinder.
5. Apply the weights to the top of the cylinder and compact the canopy to squeeze as much air out as possible. With this cylinder, which has a surface area of 70 square inches, we apply 210 lbs to compact the canopy for 30 seconds. This gives you a compression factor of 3 PSI.
6. Remove 140 lbs from the cylinder and let the remaining 70 lbs stabilize for 30 seconds. This gives you 1 PSI. Measure the height of the displaced volume from the bottom plate to the bottom surface of the piston. Measure to the nearest 1/16".
7. Repeat steps 2 - 6. Run 5 tests on each canopy. Throw out the high and low measurements and average the other three for your final volume. Round off to the nearest whole number.

Canopy Area-Chord

1. Lay the canopy flat on the floor. Smooth out one of the end cell end panels in order to measure the chord.
2. Anchor the trailing edge firmly in place. Grasp the bottom seam at the leading edge of the canopy and apply slight tension to the seam. Smooth out the airfoil section paying particular attention to the forward point of the airfoil.
3. Using a tape measure, measure from the furthest point aft at the trailing edge to the furthest point forward at the point of the airfoil section (the mean chord).
4. Measure to the nearest 1/2".

Canopy Area-Span

1. Lay the canopy flat on the floor.
2. Using an appropriately sized straight edge, measure the upper surface of each cell individually. Measure from seam to seam at a point 6" back from the leading edge.

Canopy Weight

1. A UPS shipping scale accurate to 2 ounces is used to determine canopy weight.

Current Study Results

As of July 1, 1987, 17 canopy manufacturers had cooperated in the study. To date 148 representative samples of 126 different models have been tested. Included are 22 samples of canopies manufactured within the last 12 months that are suspected to be suffering from "MBC" - Mystery Bulk Condition.

Mystery Bulk Condition

In the latter part of 1986, certain canopies were delivered that exhibited signs of increased pack volume. This "MBC" was first noticed by Riggers in the field when packing reserve canopies into certain sizes of containers. The fabric in these canopies had a distinctly different appearance from before. The finish appeared heavier, shinier, and even had a sound to it. It tended to crackle when crumpled.

An investigation was launched to determine what was causing this condition. At the January PIA meeting discussion was held concerning the problem. According to Para Flite, the basic specifications for the fabric were still the same. The weight, porosity, strength and thread count remained constant. That left only the finish.

Further investigation showed that in July of 86, Putnam Hertzell, the company that did most of the finishing of the fabric had gone out of business. The finishing process was shifted to two other companies, Duro and Kenyon. In speaking to these companies, it was revealed that the finish was different because the machinery used to finish the fabric used different processes. The Putnam machinery was an old European design and that at Duro and Kenyon were newer US designs. After having determined that there definitely was a difference in the old and new fabrics, it remained only to find out what the difference was.

In testing the 22 samples that were manufactured in recent months, the increases ranged from 7.11% to 19.53% with the overall average being 13.92%.

Conclusion

This MBC has been brought to the attention of the fabric brokers and finishers who are in turn working on a solution to the problem. At present there are no quick fix solutions. The type of equipment itself may preclude ever returning to the identical fabric as before. However the finishers feel that they may be able to minimize the condition.

While some of the manufacturers and their customers may not be too happy over these events, there is presently nothing they can do about it. This condition

currently affects all of the sport canopy manufacturers so they are all in the same boat. The area that there is a problem with is determining compatibility of canopy to harness and container.

Several of the container manufacturers have had problems with sizing lately and customers who were unhappy with what they have received. There is no easy answer for this situation. The container manufacturers are going to have to closely monitor the situation and build their systems with enough margin in them to cope with this increase. In regards to the main containers, the "window" of volume for a given container size is usually large enough to handle the increase unless the old canopy volume was at the very top of the window. In that case the canopy should then fit in the next size up. With reserve containers, however, the increase in volume may mandate the next size up container because the reserve containers generally have a smaller window for sizing. This may in turn result in incompatibility of volumes between the main and reserve containers.

There are two other items to be addressed. The first is that there is a feeling from at least one manufacturer that this condition goes away or is reduced after a number of jumps. With this premise in mind we measured a Para Flite Nimbus when new. That volume was 626 cu in. We measured the same canopy after it had 40 jumps and the volume was 605 cu in., so there may be some validity to this premise.

The second item is more complex. It would appear that with the properties of the new fabric and the random "stuffing" of the canopies into the volume chamber, that we experience the increases presently documented. However, when the canopies are laid out and the material smoothed out and folded for normal packing, that some of the increase is negated. This would help explain why some of the canopies, even though they should pack up bigger, continue to fit in the same size containers as before. More study needs to be done in both of these areas before we come up with further answers.

Note: See [Attachment I](#) - Test results 104.13, accepted 02/09/95.

TS-104: Canopy Study

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Manufacturer	Model	DOM	Volume	Line	Area
ADVANCED PARA SYS	BOGY 178R	93/03	392	SPECTRA	170
ADVANCED PARA SYS	LASER 250R	90/10	574	DACRON	247
ADVANCED PARA SYS	LASER 7R	92/12	550	DACRON	221
ADVANCED PARA SYS	LASER 9R	91/10	715	DACRON	290
ADVANCED PARA SYS	LAZER 7R	92/12	550	DACRON	221
ADVANCED PARA SYS	RASCAL 202	94/04	422	DACRON	201
ADVANCED PARA SYS	RASCAL 262	91/10	643	DACRON	259
ADVANCED PARA SYS	RASCAL 9	91/10	611	DACRON	228
AERODYNE RESEARCH	AR11 120	92/10	460	SPECTRA	117
AERODYNE RESEARCH	AR11 120	92/07	414	SPECTRA	119
AERODYNE RESEARCH	AR11 140	92/11	538	SPECTRA	136
AERODYNE RESEARCH	AR11 160	92/12	481	SPECTRA	158
AERODYNE RESEARCH	AR11 160	93/04	516	SPECTRA	157
AERODYNE RESEARCH	AR11 160	92/11	592	SPECTRA	156
AERODYNE RESEARCH	AR11 180	93/04	515	SPECTRA	171
AERODYNE RESEARCH	AR11 180	93/01	563	SPECTRA	174
AERODYNE RESEARCH	AR7 163	93/07	579	DACRON	161
AERODYNE RESEARCH	AR7 177	91/04	528	DACRON	175
AERODYNE RESEARCH	DIABLO 170	12/00	480	SPECTRA	
AERODYNE RESEARCH	PILOT 168	04/03	438	SPECTRA 825	
AERODYNE RESEARCH	SMART 110	04/04	300	SPECTRA 825	115
AERODYNE RESEARCH	SMART 150	01/04	392	SPECTRA 825	157
AERODYNE RESEARCH	TRIATHLON 120	95/04	396	SPECTRA	
AERODYNE RESEARCH	TRIATHLON 120	95/07	324	SPECTRA	127
AERODYNE RESEARCH	TRIATHLON 135	95/07	560	SPECTRA	147
AERODYNE RESEARCH	TRIATHLON 135	95/02	356	SPECTRA	142
AERODYNE RESEARCH	TRIATHLON 160	94/11	419	SPECTRA	168
AERODYNE RESEARCH	TRIATHLON 160	01/06	464	SPECTRA 825	
AERODYNE RESEARCH	TRIATHLON 190	94/07	509	SPECTRA	196
AERODYNE RESEARCH	TRIATHLON 220	96/02	566	SPECTRA	239
AERODYNE RESEARCH	TRIATHLON 260	96/09	697	SPECTRA	274
AERODYNE RESEARCH	TRIATHLON 99	95/05	295	SPECTRA	106
AERODYNE RESEARCH	TRIATHLON 99CRW	02/96	409	DACRON	107
AEROGLIDE	AG916	96/03	417	SPECTRA	417
AEROGLIDE	AG918	96/01	443	SPECTRA	443
AEROGLIDE	AG920	95/12	493	SPECTRA	493
AIR TIME	JEDI 105	96/11	337	SPECTRA	
AIR TIME	JONATHAN 136	91/11	333	SPECTRA	NA
AIR TIME	JONATHAN 150	92/02	376	SPECTRA	NA
ATAIR AERODYNAMICS	COBALT 120	00/08	346	SPECTRA	
BASIC RESEARCH	FLIK 220	03/03	600	DACRON	220
BASIC RESEARCH	FLIK 266		764	DACRON	266
BASIC RESEARCH	FOX 185	95/07	516	DACRON	189
BASIC RESEARCH	FOX 205	95/04	583	DACRON	212
BASIC RESEARCH	FOX 205	94/09	583	DACRON	212
BASIC RESEARCH	FOX 220	93/08	567	DACRON	225
BASIC RESEARCH	FOX 240	94/01	715	DACRON	247
BASIC RESEARCH	FOX 265	95/05	680	DACRON	269
BIG AIR SPORTZ	LOTUS 136	05/01	413	SPECTRA	
BIG AIR SPORTZ	SAMURAI 105	07/04	331	SPECTRA 525	
BIG AIR SPORTZ	SAMURAI 2001/150	10/01	435	SPECTRA 825	

CHUTE SHOP SA	MICRON 175	90/09	370	KEVLAR	170
EIFF	CLASSIC 180	96/02	572	DACRON	183
EIFF	CLASSIC 218	12/00	681	DACRON	225
EIFF	CLASSIC 238		656	DACRON	248
EIFF	CLASSIC 238	95/07	655	DACRON	246
EIFF	CLASSIC 259		716	DACRON	254
EIFF	CLASSIC 270	11/01	804	DACRON	277
EIFF	CLASSIC 270	12/00	804	DACRON	277
EIFF	CLASSIC 281	95/05	761	DACRON	287
EIFF	CLASSIC 304	95/09	788	DACRON	319
FLIGHT CONCEPTS	ESPRIT 170	94/12	496	SPECTRA	192
FLIGHT CONCEPTS	FIRELITE-R	95/06	424	SPECTRA	174
FLIGHT CONCEPTS	FURY-R	96/08	527	SPECTRA	220
FLIGHT CONCEPTS	MAN-O-WAR	96/07	792	DACRON	311
FLIGHT CONCEPTS	PRO SERIES 120	97/09	338	SPECTRA	113
FLIGHT CONCEPTS	PRO SERIES 135	97/09	370	SPECTRA	128
FLIGHT CONCEPTS	PRO SERIES 150	97/09	400	SPECTRA	142
FLIGHT CONCEPTS	PRO SERIES 170	97/09	428	SPECTRA	164
FLIGHT CONCEPTS	PRO SERIES 190	97/10/09	509	SPECTRA	189
FLIGHT CONCEPTS	PRODIGY 175	96/11/11	612	DACRON	164
FLIGHT CONCEPTS	PRODIGY 200	94/06	636	DACRON	187
FLIGHT CONCEPTS	SHARPCHUTER	95/11/01	583	DACRON	239
FLIGHT CONCEPTS	SHARPCHUTER-R	96/11	601	DACRON	244
FLIGHT CONCEPTS	STARTRAC 265	97/03	614	DACRON	257
FLIGHT CONCEPTS	STARTRAC I	94/05	713	DACRON	270
FLIGHT CONCEPTS	STARTRAC II	98/06	974	DACRON	
FLIGHT CONCEPTS	SUPER 7 - 107	97	276	SPECTRA	107.2
FLIGHT CONCEPTS	ZP MANTA 200	98/XX	564	DACRON	217
FREE FLIGHT	AMIGO 120	92/11	302	SPECTRA	126
FREE FLIGHT	AMIGO 134	96/06	338	SPECTRA	
FREE FLIGHT	AMIGO 134	92/11	334	SPECTRA	143
FREE FLIGHT	AMIGO 134	92/07	365	SPECTRA	
FREE FLIGHT	AMIGO 152	92/11	366	SPECTRA	161
FREE FLIGHT	AMIGO 152	92/08	380	SPECTRA	155
FREE FLIGHT	AMIGO 152	00/00	330	SPECTRA	137
FREE FLIGHT	AMIGO 172	92/11	408	SPECTRA	183
FREE FLIGHT	AMIGO 172	00/00	385	SPECTRA	181
FREE FLIGHT	AMIGO 206	92/08	481	SPECTRA	217
FREE FLIGHT	PRESERVE III	00/00	384	DACRON	24'
FREE FLIGHT	PRESERVE III-1	86/10	439	DACRON	24'
FTS	BOGEY 178	87/06	378	DACRON	174
FTS	BOGEY 229	87/06	474	DACRON	224
FTS	BOGEY 9	87/06	471	DACRON	193
FTS	LASER 250	87/05	526	DACRON	235
FTS	LASER 5	87/03	375	DACRON	170
FTS	LASER 7	87/04	490	DACRON	228
FTS	LASER 8	87/04	582	DACRON	261
FTS	LASER 9	87/04	629	DACRON	290
FTS	RANGER 7	86/12	576	DACRON	268
FTS	RASCAL 202	87/04	435	DACRON	206
FTS	RASCAL 262	87/04	594	DACRON	261
FTS	RASCAL 7	87/03	397	DACRON	186

FTS	RASCAL 9	87/05	553	DACRON	236
GLIDE PATH	ARIEL 135	91/11	408	SPECTRA	142
GLIDE PATH	ARIEL 150	91/08	414	SPECTRA	150
GLIDE PATH	ARIEL 170	91/11	461	SPECTRA	168
GLIDE PATH	CLIPPER	87/04	497	DACRON	188
GLIDE PATH	CLIPPER	85/03	432	DACRON	187
GLIDE PATH	CRICKET-M	87/06	385	DACRON	147
GLIDE PATH	CRICKET-R	91/11	347	SPECTRA	142
GLIDE PATH	EXPRESS 175		569	DACRON	160
GLIDE PATH	EXPRESS 187		601	DACRON	174
GLIDE PATH	FIRELITE-M	87/04	449	DACRON	175
GLIDE PATH	FIRELITE-M	86/08	410	DACRON	177
GLIDE PATH	FIRELITE-R	92/05	390	SPECTRA	170
GLIDE PATH	FIRELITE-R	87/06	426	DACRON	175
GLIDE PATH	FIRELITE-R	86/06	368	DACRON	177
GLIDE PATH	FURY/CRW	91/07	642	DACRON	214
GLIDE PATH	FURY/CRW	89/02	624	DACRON	196
GLIDE PATH	FURY-M	91/06	477	SPECTRA	218
GLIDE PATH	FURY-M	87/05	538	DACRON	220
GLIDE PATH	FURY-M	85/05	454	DACRON	213
GLIDE PATH	HUMMINGBIRD	92/11	357	SPECTRA	135
GLIDE PATH	HUMMINGBIRD	87/06	381	DACRON	137
GLIDE PATH	MAN-O-WAR	86/08	629	DACRON	319
GLIDE PATH	MANTA 288	87/05	701	DACRON	284
GLIDE PATH	MANTA 288	84/04	621	DACRON	278
GLIDE PATH	MAVERICK-M	87/03	500	DACRON	197
GLIDE PATH	MAVERICK-M	85/03	425	DACRON	194
GLIDE PATH	MAVERICK-R	88/08	468	DACRON	468
GLIDE PATH	MAVERONE	91/10	576	SPECTRA	250
GLIDE PATH	NOVA 120	92/02	331	SPECTRA	116
GLIDE PATH	NOVA 125R	93/01	292	SPECTRA	122
GLIDE PATH	NOVA 135	92/04	340	SPECTRA	133
GLIDE PATH	NOVA 140R		337	SPECTRA	137
GLIDE PATH	NOVA 150	92/05	429	SPECTRA	150
GLIDE PATH	NOVA 155 (PROTO		344	SPECTRA	149
GLIDE PATH	NOVA 170	92/02	448	SPECTRA	169
GLIDE PATH	NOVA 190	92/04	438	SPECTRA	190
GLIDE PATH	NOVA 99	92/09	379	SPECTRA	140
GLIDE PATH	RAIDER	92/03	515	SPECTRA	225
GLIDE PATH	RAIDER-M	87/05	559	DACRON	225
GLIDE PATH	RAIDER-M	86/05	484	DACRON	225
GLIDE PATH	SHARPCHUTER	86/08	503	DACRON	245
GLIDE PATH	STARTRAC I	91/07	740	DACRON	270
GLIDE PATH	STARTRAC II	91/07	722	DACRON	283
GLIDE PATH	WILDFIRE-M	86/09	414	DACRON	165
GQ UK/GQ SEC	SAC	85/01	395	DACRON	22'
GQ UK/GQ SEC	SECURITY LOPO	73/02	519	DACRON	26'
GQ UK/GQ SEC	SIROCCO	84/07	378	DACRON	178
GQ UK/GQ SEC	UNIT III	84/02	643	DACRON	240
GQ UK/GQ SEC	UNIT-F-111	79/11	546	DACRON	198
GQ UK/GQ SEC	X-210-M	83/07	424	DACRON	196
GQ UK/GQ SEC	X-210-R	83/04	458	DACRON	198

ICARUS CANOPIES	CROSSFIRE 109	00/09	324	VECTRAN	
ICARUS CANOPIES	CROSSFIRE 119	00/08	349	VECTRAN	
ICARUS CANOPIES	CROSSFIRE 126	00/07	363	VECTRAN	
ICARUS CANOPIES	CROSSFIRE 135	00/07	413	VECTRAN	
ICARUS CANOPIES	CROSSFIRE 149	00/07	414	VECTRAN	
ICARUS CANOPIES	CROSSFIRE 169		492	VECTRAN	
ICARUS CANOPIES	CROSSFIRE 92	00/03	316	VECTRAN	
ICARUS CANOPIES	R-119 RESV	11/04	298	SPECTRA 725	123
ICARUS CANOPIES	SAFIRE 139	99/04	391	VECTRAN	
ICARUS CANOPIES	SAFIRE 149	99/11	424	VECTRAN	
ICARUS CANOPIES	SAFIRE 209	99/06	528	VECTRAN	
JYRO	ICARUS 115	93/04	314	SPECTRA	127
JYRO	ICARUS ALPHA 10	94/04	287	SPECTRA	
JYRO	ICARUS-A 139	94/12	368	SPECTRA	
MISCELLANEOUS	FIREFLY-R	83/10	384	DACRON	175
MISCELLANEOUS	IMPULSE 180/CRW	91/04	481	DACRON	179
MISCELLANEOUS	JETSTREAM 250-7	86/09	532	DACRON	249
MISCELLANEOUS	PEGASUS	83/01	445	DACRON	220
MISCELLANEOUS	PRESERVE IV	82/12	343	DACRON	NA
MISCELLANEOUS	TWISTER 200	90/03	444	DACRON	202
MISCELLANEOUS	VECTOR TANDEM I	86/11	980	DACRON	350
NAA	PARAFOIL 200	83/08	547	DACRON	190
NAA	PARAFOIL 252	94/12	753	DACRON	260
NAA	PARAFOIL 252	90/03	793	DACRON	250
NAA	PARAFOIL 252	90/09	896	DACRON	240
NAA	PARAFOIL 252	85/04	677	DACRON	236
NAA	PARAFOIL 262	93/03	793	DACRON	266
NAA	PARAFOIL 272	85/04	761	DACRON	272
NAA	PARAFOIL 282	94/08	895	DACRON	273
NAA	PARAFOIL 282	89/02	888	DACRON	271
NAA	PARAFOIL 282	00/00	776	DACRON	285
NAA	PF-2000/240	09/00	745	DACRON	222
NAA	PF-2000/300		928	DACRON	273
NAA	TRICON 26	86/02	579	DACRON	26'
NATIONAL	AVENGER	84/04	457	DACRON	214
NATIONAL	MARAUDER	84/06	547	DACRON	253
NATIONAL	PHANTOM 145	87/03	343	DACRON	139
NATIONAL	PHANTOM 180	86/01	369	DACRON	176
NATIONAL	PHANTOM 22	85/04	274	DACRON	22'
NATIONAL	PHANTOM 24	87/03	386	DACRON	24'
NATIONAL	PHANTOM 24	85/04	332	DACRON	24'
NATIONAL	PHANTOM 26	87/04	435	DACRON	26'
NATIONAL	PHANTOM 26	84/11	384	DACRON	26'
NATIONAL	PHANTOM 28	85/01	472	DACRON	28'
NATIONAL	SCORPION	84/06	419	DACRON	178
NATIONAL	SPITFIRE	84/06	402	DACRON	176
NATIONAL	STINGRAY	84/04	324	DACRON	142
NATIONAL	VULCAN	00/00	561	DACRON	NA
NEW ENGLAND PARA	CHALLENGER 180	88/09	624	DACRON	196
NEW ENGLAND PARA	CHALLENGER 198	88/09	696	DACRON	214
NEW ENGLAND PARA	CHALLENGER 218	88/12	758	DACRON	232
NEW ENGLAND PARA	CHALLENGER 218	88/12	710	DACRON	236

NEW ENGLAND PARA	CHALLENGER 228	88/06	683	DACRON	247
NEW ENGLAND PARA	CHALLENGER 238	93/08	773	DACRON	253
NEW ENGLAND PARA	CHALLENGER 238	88/10	785	DACRON	254
NEW ENGLAND PARA	CHALLENGER 240-	89/01	602	DACRON	264
NEW ENGLAND PARA	CHALLENGER 259	88/06	823	DACRON	282
NEW ENGLAND PARA	CHALLENGER 282	86/07	780	DACRON	310
NEW ENGLAND PARA	CHALLENGER 305	88/10	984	DACRON	333
NEW ENGLAND PARA	CHALLENGER 328	87/07	974	DACRON	353
PARA AUSTRALIA	AIR FORCE 120	93/08	265	SPECTRA	122
PARA AUSTRALIA	AIR FORCE 140	94/05	287	SPECTRA	287
PARA AUSTRALIA	METEOR	85/08	492	DACRON	213
PARA AUSTRALIA	X-228	00/00	573	DACRON	217
PARA AUSTRALIA	X-300	83/03	723	DACRON	275
PARA DE FRANCE	BT-50	89/01	388	KEVLAR	NA
PARA DE FRANCE	BT-60	89/01	420	KEVLAR	NA
PARA DE FRANCE	MAGIC	89/01	535	DACRON	232
PARA DE FRANCE	MINIMAX 7	91/05	407	KEVLAR	174
PARA DE FRANCE	TECHNO 115	97/04	267	SPECTRA	N/A
PARA DE FRANCE	TECHNO 128	97/	267	SPECTRA	N/A
PARA DE FRANCE	TECHNO 155	95/06	314	SPECTRA	N/A
PARA DE FRANCE	TECHNO 155	10/99	287	SPECTRA 825	
PARA DE FRANCE	TECHNO 98	05/99	259	SPECTRA	96
PARA DE FRANCE	TRANSFAIR	90/08	292	DACRON	120
PARA FLITE	CIRRUS-R	87/03	503	DACRON	237
PARA FLITE	CIRRUS-R	85/02	443	DACRON	230
PARA FLITE	CRUISLITE	91/03	592	DACRON	222
PARA FLITE	CRUISLITE	86/10	569	DACRON	220
PARA FLITE	CRUISLITE	85/05	476	DACRON	220
PARA FLITE	CRUISLITE BETA	85/03	399	DACRON	175
PARA FLITE	CRUISLITE XL	90/03	684	DACRON	246
PARA FLITE	CRUISLITE XL	86/05	554	DACRON	241
PARA FLITE	DC-5	85/07	556	DACRON	282
PARA FLITE	EVOLUTION 140	90/11	474	SPECTRA	150
PARA FLITE	EVOLUTION 160	90/10	537	SPECTRA	166
PARA FLITE	EVOLUTION 160	89/10	505	DACRON	166
PARA FLITE	EVOLUTION 240	90/11	642	SPECTRA	236
PARA FLITE	EVOLUTION 240	90/03	707	SPECTRA	228
PARA FLITE	EVOLUTION S-160	91/04	600	SPECTRA	168
PARA FLITE	EVOLUTION S-200	91/12	796	SPECTRA	216
PARA FLITE	NIMBUS	87/01	626	DACRON	N/A
PARA FLITE	NIMBUS	84/05	537	DACRON	223
PARA FLITE	NIMBUS BETA	87/05	521	DACRON	191
PARA FLITE	NIMBUS BETA	85/05	454	DACRON	188
PARA FLITE	NIMBUS XL	85/06	623	DACRON	273
PARA FLITE	PURSUIT 230	92/02	735	DACRON	228
PARA FLITE	PURSUIT 230	85/04	608	DACRON	236
PARA FLITE	PURSUIT 230/RW	85/07	549	DACRON	232
PARA FLITE	ROBO 205	91/02	473	SPECTRA	205
PARA FLITE	ROBO-Z 165	92/09	410	SPECTRA	163
PARA FLITE	ROBO-Z 185	92/09	454	SPECTRA	181
PARA FLITE	ROBO-Z 185	00/00	500	SPECTRA	179
PARA FLITE	SAFETY FLYER	78/06	468	DACRON	152

PARA FLITE	SPORT 260	00/00	715	DACRON	242
PARA FLITE	STRATO CLOUD	85/06	569	DACRON	240
PARA FLITE	SUPER EVOLUTION	92/02	483	SPECTRA	148
PARA FLITE	SWIFT	87/06	413	DACRON	184
PARA FLITE	SWIFT	85/04	366	DACRON	177
PARA FLITE	SWIFT PLUS 145	91/06	330	SPECTRA	146
PARA FLITE	SWIFT PLUS 175	92/02	433	SPECTRA	177
PARA FLITE	SWIFT PLUS 175	88/10	410	DACRON	180
PARA FLITE	SWIFT PLUS 225	91/07	524	SPECTRA	231
PARA FLITE	SWIFT/MAIN	00/00	397	DACRON	199
PARA FLITE	TURBO-Z 125	94/06	341	SPECTRA	123
PARA FLITE	TURBO-Z 125	94/06	341	SPECTRA	123
PARA FLITE	TURBO-Z 145	93/08	375	SPECTRA	144
PARA FLITE	TURBO-Z 145	93/08	375	SPECTRA	375
PARA FLITE	TURBO-Z 185	93/11	485	SPECTRA	180
PARA FLITE	TURBO-Z 205	93/08	505	SPECTRA	203
PARA FLITE	TURBO-ZX 225	95/05	483	SPECTRA	
PARA FLITE	TURBO-ZX 285	96/10	628	SPECTRA	
PARA FLITE	XL-CLOUD	89/04	792	DACRON	279
PARA FLITE	XL-CLOUD	85/07	631	DACRON	277
PARA INNOVATORS	EAGLE	00/00	560	DACRON	253
PARA INNOVATORS	HAWK	00/00	435	DACRON	225
PARA INNOVATORS	R2-3	85/06	321	DACRON	23'
PARA INNOVATORS	R4-3	85/06	394	DACRON	26'
PARATEC	BALANCE 280	97/03	640	DACRON	283
PARATEC	BALANCE ZP	97/12	414	SPECTRA	174
PARATEC	SPEED 120	09/02	249	SPECTRA 825	117
PARATEC	SPEED 135		284	SPECTRA 825	129
PARATEC	SPEED 150		316	SPECTRA 825	145
PARATEC	SPEED 190	01/03	369	SPECTRA 825	184
PARATEC	SPEED2000 120R	97/11	287	SPECTRA	121
PARATEC	SPEED2000 220	97/04	478	SPECTRA	223
PERFORMANCE DESIGNS	EXCALIBUR 210	89/01	575	SPECTRA	NA
PERFORMANCE DESIGNS	LIGHTNING 113	98/03	429	DACRON	123
PERFORMANCE DESIGNS	LIGHTNING 126-Z	94/03	451	DACRON	134
PERFORMANCE DESIGNS	LIGHTNING 143	96/06	497	DACRON	155
PERFORMANCE DESIGNS	LIGHTNING 160-Z	93/03	534	DACRON	171
PERFORMANCE DESIGNS	LIGHTNING 176	93/01	497	DACRON	189
PERFORMANCE DESIGNS	LIGHTNING 193	95/06	532	DACRON	200
PERFORMANCE DESIGNS	LIGHTNING 193	94/01	534	DACRON	201
PERFORMANCE DESIGNS	LIGHTNING 193 F	94/06	510	DACRON	202
PERFORMANCE DESIGNS	LIGHTNING 218	92/11	610	DACRON	231
PERFORMANCE DESIGNS	LIGHTNING 235 F	94/06	600	DACRON	247
PERFORMANCE DESIGNS	LIGHTNING 235 PE	12/99	858	DACRON	249
PERFORMANCE DESIGNS	LIGHTNING 253	93/11	694	DACRON	271
PERFORMANCE DESIGNS	LIGHTNING 253	93/05	677	DACRON	270
PERFORMANCE DESIGNS	NAVIGATOR 200	98/05	652	DACRON	NA
PERFORMANCE DESIGNS	NAVIGATOR 220	98/10	705	DACRON	NA
PERFORMANCE DESIGNS	NAVIGATOR 220	03/06	784	DACRON	NA
PERFORMANCE DESIGNS	NAVIGATOR 240	98/04	744	DACRON	NA
PERFORMANCE DESIGNS	NAVIGATOR 260	98/02	756	DACRON	NA
PERFORMANCE DESIGNS	NAVIGATOR 280	98/10	815	DACRON	NA

PERFORMANCE DESIGNS	NAVIGATOR 280	02/04	820	DACRON	259
PERFORMANCE DESIGNS	NAVIGATOR 300	09/03	782	DACRON	312
PERFORMANCE DESIGNS	PD-106R	3/01	253	SPECTRA 725	111
PERFORMANCE DESIGNS	PD-113R	94/10	286	SPECTRA	123
PERFORMANCE DESIGNS	PD-126R	92/03	296	SPECTRA	137
PERFORMANCE DESIGNS	PD-143R	97/03	343	SPECTRA	151
PERFORMANCE DESIGNS	PD-143R	91/05	363	SPECTRA	150
PERFORMANCE DESIGNS	PD-143R	89/08	355	DACRON	154
PERFORMANCE DESIGNS	PD-143R	8/00	362	SPECTRA 725	149
PERFORMANCE DESIGNS	PD-143R	09/01	356	SPECTRA 825	148
PERFORMANCE DESIGNS	PD-150	90/11	382	SPECTRA	159
PERFORMANCE DESIGNS	PD-150	86/05	375	DACRON	139
PERFORMANCE DESIGNS	PD-160	93/04	375	SPECTRA	160
PERFORMANCE DESIGNS	PD-160R	94/03	388	SPECTRA	174
PERFORMANCE DESIGNS	PD-160R	92/03	372	SPECTRA	171
PERFORMANCE DESIGNS	PD-160R	90/08	359	DACRON	166
PERFORMANCE DESIGNS	PD-160R	10/00	419	SPECTRA 825	168
PERFORMANCE DESIGNS	PD-160R	01/02	378	SPECTRA 725	166
PERFORMANCE DESIGNS	PD-170	95/06	391	SPECTRA	182
PERFORMANCE DESIGNS	PD-170	87/05	432	DACRON	175
PERFORMANCE DESIGNS	PD-176R	91/01	447	SPECTRA	189
PERFORMANCE DESIGNS	PD-176R		414	SPECTRA 825	189
PERFORMANCE DESIGNS	PD-190	92/06	566	SPECTRA	195
PERFORMANCE DESIGNS	PD-190	93/02	448	SPECTRA	205
PERFORMANCE DESIGNS	PD-190	86/06	436	DACRON	179
PERFORMANCE DESIGNS	PD-193	93/04	439	SPECTRA	200
PERFORMANCE DESIGNS	PD-193	88/11	414	DACRON	191
PERFORMANCE DESIGNS	PD-193/CRW	92/02	582	DACRON	203
PERFORMANCE DESIGNS	PD-193/CRW	92/02	594	DACRON	200
PERFORMANCE DESIGNS	PD-193/CRW	91/10	610	DACRON	198
PERFORMANCE DESIGNS	PD-193R	92/10	471	SPECTRA	200
PERFORMANCE DESIGNS	PD-193R	90/12	470	DACRON	201
PERFORMANCE DESIGNS	PD-210	94/04	495	SPECTRA	223
PERFORMANCE DESIGNS	PD-210	93/10	583	DACRON	222
PERFORMANCE DESIGNS	PD-210	86/11	493	DACRON	212
PERFORMANCE DESIGNS	PD-218 ZP	90/02	616	DACRON	226
PERFORMANCE DESIGNS	PD218R	04/91	564	SPECTRA 825	231
PERFORMANCE DESIGNS	PD-218R	95/03	496	DACRON	235
PERFORMANCE DESIGNS	PD-218R	92/03	475	SPECTRA	232
PERFORMANCE DESIGNS	PD-218R	89/10	519	DACRON	230
PERFORMANCE DESIGNS	PD230	06/02	618	SPECTRA 825	
PERFORMANCE DESIGNS	PD-230	93/08	600	DACRON	244
PERFORMANCE DESIGNS	PD-230	92/09	516	SPECTRA	244
PERFORMANCE DESIGNS	PD-230	91/08	536	SPECTRA	244
PERFORMANCE DESIGNS	PD-230	86/11	589	DACRON	230
PERFORMANCE DESIGNS	PD-235	93/11	492	SPECTRA	242
PERFORMANCE DESIGNS	PD-235	96/03	700	SPECTRA	
PERFORMANCE DESIGNS	PD-235	94/10	575	DACRON	244
PERFORMANCE DESIGNS	PD-235	93/11	518	SPECTRA	241
PERFORMANCE DESIGNS	PD-235R	97/04	521	DACRON	245
PERFORMANCE DESIGNS	PD-253	91/04	573	DACRON	270
PERFORMANCE DESIGNS	PD-253	12/99	744	DACRON	263

PERFORMANCE DESIGNS	PD253R	01/02	639	DACRON	266
PERFORMANCE DESIGNS	PD-253R	95/01	551	SPECTRA	267
PERFORMANCE DESIGNS	PD-253R		642	DACRON	271
PERFORMANCE DESIGNS	PD-253R	90/10	597	DACRON	265
PERFORMANCE DESIGNS	PD-260	93/09	650	DACRON	277
PERFORMANCE DESIGNS	PD-260	92/09	570	SPECTRA	277
PERFORMANCE DESIGNS	PD-260	91/08	588	SPECTRA	277
PERFORMANCE DESIGNS	PD-260	86/11	627	DACRON	260
PERFORMANCE DESIGNS	PD-260	86/08	545	DACRON	257
PERFORMANCE DESIGNS	PD-280	97/05	798	SPECTRA	298
PERFORMANCE DESIGNS	PD-280	94/06	731	SPECTRA	298
PERFORMANCE DESIGNS	PD-281R	06/01	646	SPECTRA 825	297
PERFORMANCE DESIGNS	PD-281R		681	DACRON	297
PERFORMANCE DESIGNS	PD-300		718	DACRON	300
PERFORMANCE DESIGNS	PD-300	87/07	677	DACRON	300
PERFORMANCE DESIGNS	PD-300	92/03	703	DACRON	317
PERFORMANCE DESIGNS	PD-340	89/07	880	DACRON	333
PERFORMANCE DESIGNS	SABRE 107	92/10	306	SPECTRA	115
PERFORMANCE DESIGNS	SABRE 107	91/02	287	SPECTRA	113
PERFORMANCE DESIGNS	SABRE 120	90/10	328	SPECTRA	127
PERFORMANCE DESIGNS	SABRE 135	91/10	363	SPECTRA	143
PERFORMANCE DESIGNS	SABRE 150	97/03	413	SPECTRA	157
PERFORMANCE DESIGNS	SABRE 150	92/08	398	SPECTRA	159
PERFORMANCE DESIGNS	SABRE 170	93/02	451	SPECTRA	179
PERFORMANCE DESIGNS	SABRE 170	91/10	445	SPECTRA	174
PERFORMANCE DESIGNS	SABRE 170	90/05	397	SPECTRA	171
PERFORMANCE DESIGNS	SABRE 190	94/05	567	DACRON	197
PERFORMANCE DESIGNS	SABRE 190	91/08	500	SPECTRA	199
PERFORMANCE DESIGNS	SABRE 190	90/06	509	SPECTRA	195
PERFORMANCE DESIGNS	SABRE 2 135	09/01	422	SPECTRA 825	
PERFORMANCE DESIGNS	SABRE 210	92/09	527	SPECTRA	218
PERFORMANCE DESIGNS	SABRE 210	91/01	562	SPECTRA	214
PERFORMANCE DESIGNS	SABRE 2-190	08/02	541	SPECTRA 825	
PERFORMANCE DESIGNS	SABRE 230	91/01	592	SPECTRA	239
PERFORMANCE DESIGNS	SABRE 97	93/02	267	SPECTRA	103
PERFORMANCE DESIGNS	SABRE 97	92/03	279	SPECTRA	103
PERFORMANCE DESIGNS	SILHOUETTE 150	97/05	398	SPECTRA	N/A
PERFORMANCE DESIGNS	SILHOUETTE 190	97/05	483	SPECTRA	N/A
PERFORMANCE DESIGNS	SILHOUETTE 230	97/05	588	SPECTRA	NONE
PERFORMANCE DESIGNS	SILHOUETTE 230	05/97	588	DACRON	N/A
PERFORMANCE DESIGNS	SPECTRE 107	97/05	296	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 120	97/05	321	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 135	97/05	354	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 150	97/05	370	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 170	97/05	416	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 170	97/07	455	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 170	97/04	424	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 190	97/05	475	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 190	97/04	467	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 210	97/05	515	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 230	97/05	532	SPECTRA	N/A
PERFORMANCE DESIGNS	SPECTRE 97	97/05	281	SPECTRA	N/A

PERFORMANCE DESIGNS	STILETTO 107	94/04	306	SPECTRA	N/A
PERFORMANCE DESIGNS	STILETTO 120		322	SPECTRA	
PERFORMANCE DESIGNS	STILETTO 135	93/07	327	SPECTRA	N/A
PERFORMANCE DESIGNS	STILETTO 150	11/00	422	SPECTRA 525	
PERFORMANCE DESIGNS	STILETTO 150	11/00	422	SPECTRA 825	
PERFORMANCE DESIGNS	VELOCITY 120	09/04	408	VECTRAN	
PERFORMANCE DESIGNS	VELOCITY 79	99/01	280	SPECTRA	NA
PERFORMANCE DESIGNS	VELOCITY 84	99/01	306	SPECTRA	NA
PERFORMANCE DESIGNS	VELOCITY 90	99/01	325	SPECTRA	NA
PERFORMANCE DESIGNS	VELOCITY 96	99/01	340	SPECTRA	NA
PERFORMANCE DESIGNS	VENGENCE 107	99/12	354	SPECTRA 825	
PERFORMANCE DESIGNS	VENGENCE 120	99/12	388	SPECTRA 825	
PERFORMANCE DESIGNS	VENGENCE 135	00/01	428	SPECTRA 825	
PERFORMANCE DESIGNS	VENGENCE 150	00/01	472	SPECTRA 825	
PERFORMANCE DESIGNS	VENGENCE 170	00/01	522	SPECTRA 825	
PERFORMANCE DESIGNS	VENGENCE 89	99/12	312	SPECTRA 825	
PERFORMANCE DESIGNS	VENGENCE 97	99/12	329	SPECTRA 825	
PIONEER	K-20	81/04	321	DACRON	20'
PIONEER	K-22	84/12	376	DACRON	22'
PIONEER	K-26	84/12	426	DACRON	26'
PIONEER	MERLIN	81/03	475	DACRON	206
PIONEER	TC-9		773	DACRON	332
PISA	CONQUEST 190	92/06	544	SPECTRA	188
PISA	HORNET 190	08/00	487	SPECTRA 825	
PISA	INVADER 370	85/06	358	DACRON	24'
PISA	INVADER 420	85/06	400	DACRON	26'
PISA	REFLEX 145	90/09	405	KEVLAR	NA
PISA	SKYMASTER 290	08/02	766	DACRON	
PISA	TEMPO 120	93/07	267	SPECTRA	120
PISA	TEMPO 150	93/10	294	SPECTRA	144
PISA	TEMPO 170	97/12	404	SPECTRA	180
PISA	TEMPO 170	97/02	395	SPECTRA	180
PISA	TEMPO 170	93/01	429	SPECTRA	181
PISA	TEMPO 170	93/10	345	SPECTRA	181
PISA	TEMPO 210	95/08	475	SPECTRA	206
PISA	TEMPO 210	94/07	404	SPECTRA	404
PISA	TEMPO 210	08/96	506	SPECTRA 825	
PISA	TEMPO 250	96/01	503	SPECTRA	
PRECISION	218-DASH M	12/99	553	DACRON	210
PRECISION	249-M(a)		570	SPECTRA 825	244
PRECISION	EXTREME 110	98/06/XX	347	SPECTRA	110
PRECISION	FALCON 150	91/08	350	SPECTRA	152
PRECISION	FALCON 175	90/11	422	DACRON	179
PRECISION	FALCON 175	87/05	455	DACRON	179
PRECISION	FALCON 195	91/02	464	SPECTRA	200
PRECISION	FALCON 195	87/05	508	DACRON	198
PRECISION	FALCON 215	91/04	465	DACRON	NA
PRECISION	FALCON 215	87/05	564	DACRON	218
PRECISION	FALCON 235	91/03	516	DACRON	NA
PRECISION	FALCON 235	90/10	566	DACRON	240
PRECISION	FALCON 265	90/10	627	DACRON	274
PRECISION	INTERCEPTOR 200	91/05	524	DACRON	214

PRECISION	INTERCEPTOR 225	89/09	623	DACRON	240
PRECISION	INTERCEPTOR 250	90/03	683	DACRON	276
PRECISION	MONARCH 120	92/09	347	SPECTRA	123
PRECISION	MONARCH 120	94/08	359	SPECTRA	124
PRECISION	MONARCH 135	92/09	379	SPECTRA	140
PRECISION	MONARCH 155	92/01	420	SPECTRA	160
PRECISION	MONARCH 155	91/08	395	SPECTRA	163
PRECISION	MONARCH 175	91/05	440	SPECTRA	183
PRECISION	MONARCH 195	94/07	492	SPECTRA	201
PRECISION	MR-120	94/08	287	SPECTRA	
PRECISION	MR-120	92/07	268	SPECTRA	114
PRECISION	MR-135	92/09	308	SPECTRA	134
PRECISION	MR-150	94/10	353	SPECTRA	149
PRECISION	MR-150	93/12	349	SPECTRA	150
PRECISION	MR-150	93/10	327	SPECTRA	150
PRECISION	MR-150	92/09	324	SPECTRA	150
PRECISION	MR-150	89/08	375	DACRON	148
PRECISION	P124-212a	97/04	439	SPECTRA	269
PRECISION	P124-246a	97/07	493	SPECTRA	
PRECISION	POLARIS	85/06	465	DACRON	223
PRECISION	RAVEN 1	87/05	391	DACRON	172
PRECISION	RAVEN 1	87/04	401	KEVLAR	172
PRECISION	RAVEN 1	84/11	361	DACRON	169
PRECISION	RAVEN 109M	97/01	274	SPECTRA	106
PRECISION	RAVEN 1F	93/01	375	SPECTRA	178
PRECISION	RAVEN 2	93/01	429	SPECTRA	209
PRECISION	RAVEN 2	87/04	457	DACRON	203
PRECISION	RAVEN 2	86/10	474	DACRON	203
PRECISION	RAVEN 2	85/05	400	DACRON	199
PRECISION	RAVEN 2E	91/04	484	DACRON	
PRECISION	RAVEN 2F	93/02	419	SPECTRA	213
PRECISION	RAVEN 2S	91/04	467	DACRON	211
PRECISION	RAVEN 3	93/01	484	SPECTRA	2485
PRECISION	RAVEN 3	87/03	515	DACRON	241
PRECISION	RAVEN 3	86/10	512	DACRON	242
PRECISION	RAVEN 3	85/05	478	DACRON	232
PRECISION	RAVEN 3G	94/11	557	DACRON	247
PRECISION	RAVEN 4	86/12	570	DACRON	266
PRECISION	RAVEN 4	85/03	506	DACRON	NA
PRECISION	R-MAX 138(a)	8/03	333	SPECTRA 825	145
PRECISION	SUPER RAVEN 249	97/02	474	SPECTRA	474
PRECISION	XAOS 68	08/02	337	UNKNOWN	
QUANTUM / RI	GEN-X 150	97/06	395	SPECTRA	153
STRONG	26' LOPO	86/05	487	DACRON	26'
STRONG	26' LOPO LT	86/02	426	DACRON	26'
STRONG	26' SEMI LT	86/05	443	DACRON	26'
STRONG	HOBBIT-M	84/06	357	DACRON	165
STRONG	HOBBIT-R	85/01	314	DACRON	162
STRONG	MIGHTY MACK	86/00	719	KEVLAR	250
STRONG	MIGHTY MAK-M	87/01	788	DACRON	360
STRONG	MIGHTY MAK-R	85/05	710	DACRON	360
STRONG	SPIRIT	82/08	496	DACRON	211

STRONG	STRONG ZPO 190	92/12	455	SPECTRA	188
STRONG	WIZARD	87/01	634	DACRON	278
STRONG	ZPO 190	92/12	455	SPECTRA	188
SURPLUS	24' T-10A	64/04	661	UNKNOWN	24'
SURPLUS	26' NVY CON	76/02	573	UNKNOWN	26'
SURPLUS	28' C-9	78/06	815	UNKNOWN	28'
WINCHESTER	SPACE 130	02/01	392	SPECTRA 825	
WINCHESTER	VIPER 120	97/02	341	SPECTRA	N/A
WINCHESTER	VIPER 135	97/02	382	SPECTRA	N/A