Rig design, manufacturing and testing by SWS

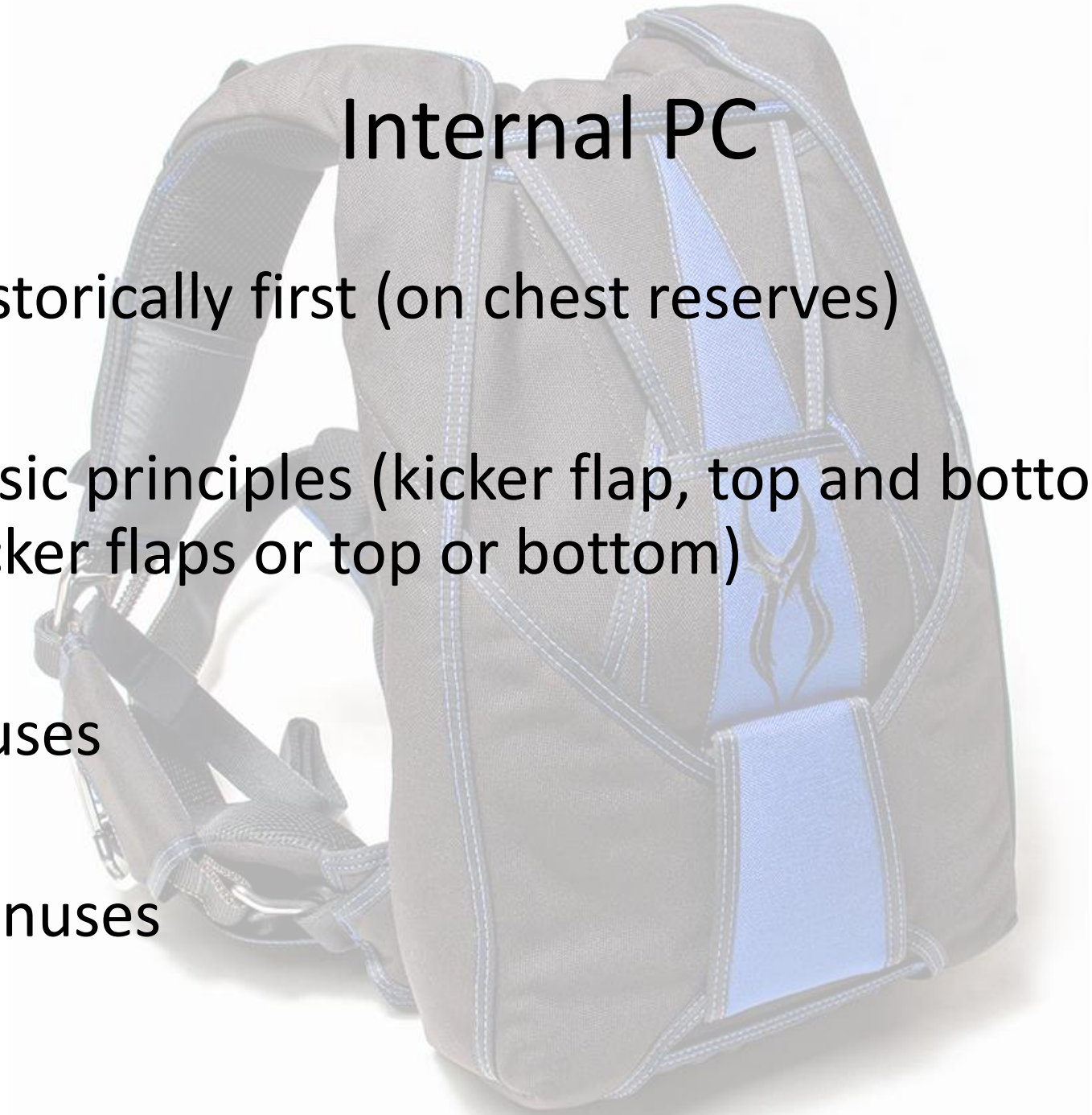
Decision process (comparison):

- **Reserve container type**
- **Reserve container pincover type**
- **Main container type**
- **Main container pincover type**
- **Riser covers type**
- **Additional futures (RSL\MARD)**
- **Harness construction**

Reserve container type

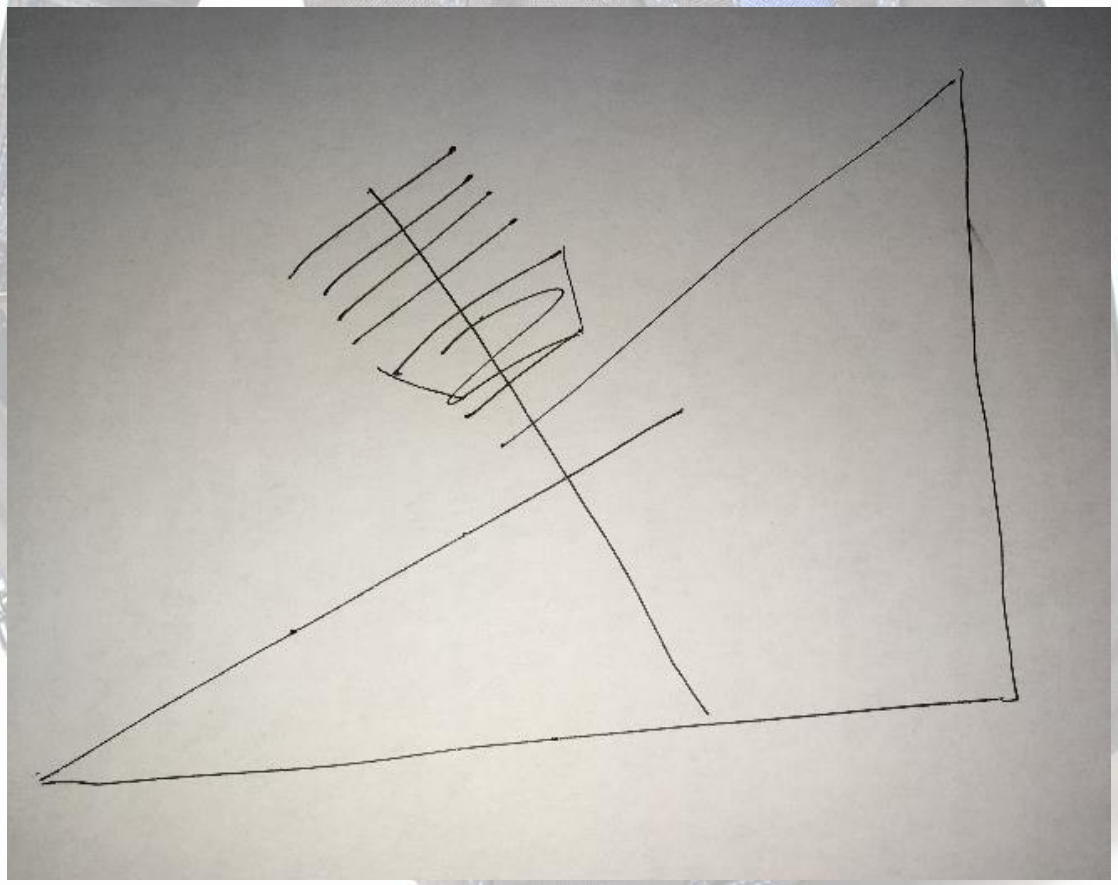
- Internal PC
- Exposed PC
- Semi-exposed PC

Internal PC



- Historically first (on chest reserves)
- Basic principles (kicker flap, top and bottom kicker flaps or top or bottom)
- Pluses
- Minuses

Basic principles (kicker flap, top and bottom kicker flaps or top or bottom)

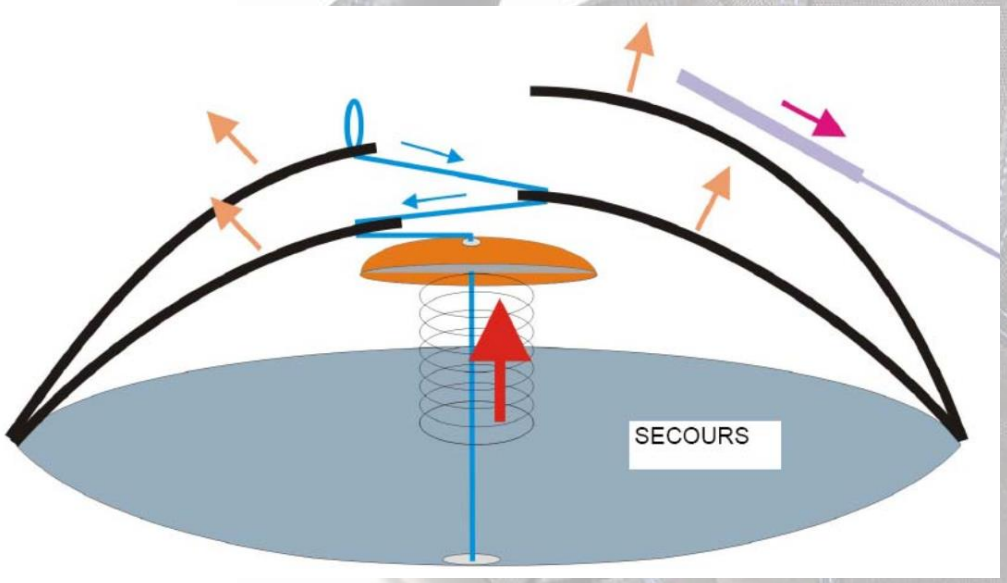


Pluses

- Esthetically clean
- Cover all errors in rigging

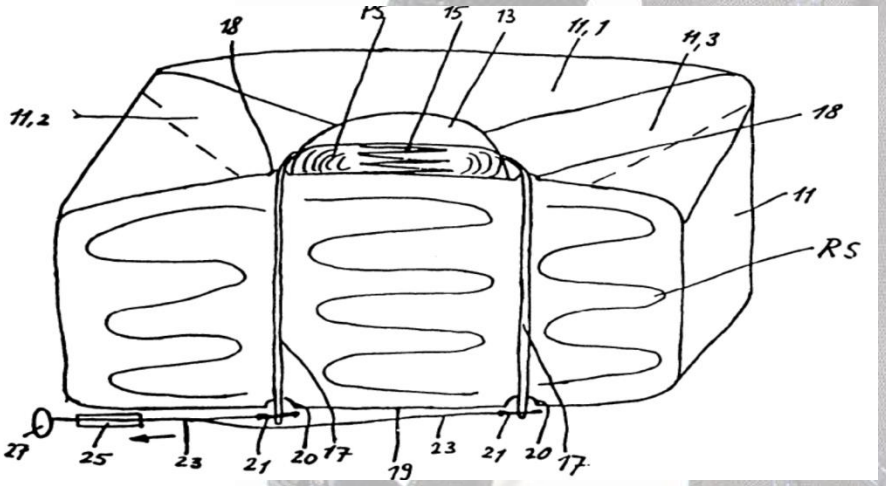
Minuses

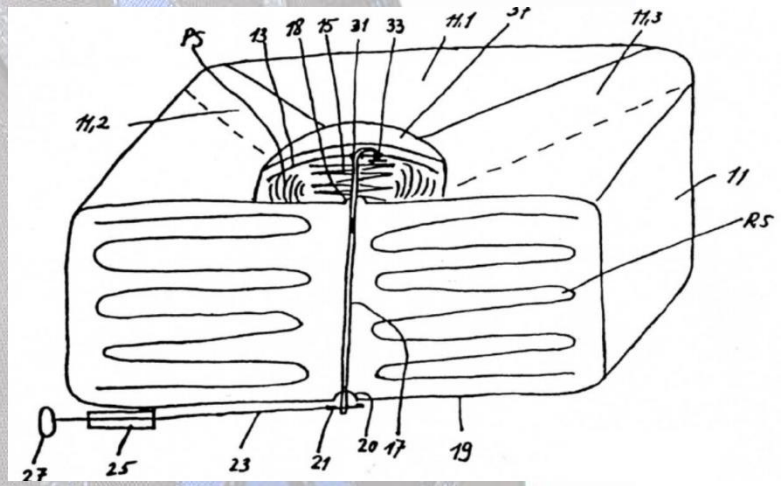
- Cover all errors in rigging
- Inherent problem:
    - stiffeners (weight and stiffness of PC cover flaps),
    - PC strength to counter that
    - AAD activation (unsure of activation OR rigging troubles)



Exposed PC

- 2 pins or 1 pin construction





- Pluses (clean PC start, weight, softness)

- Minuses (packing, snags, pull force, 2 pin cutter)

Semi-exposed PC

- Combination of 2

- Pluses (better PC start and less weight then in internal, easier packing then exposed)
- Minuses (demanding to rigging, rigging errors shows)

Reserve pincover flap

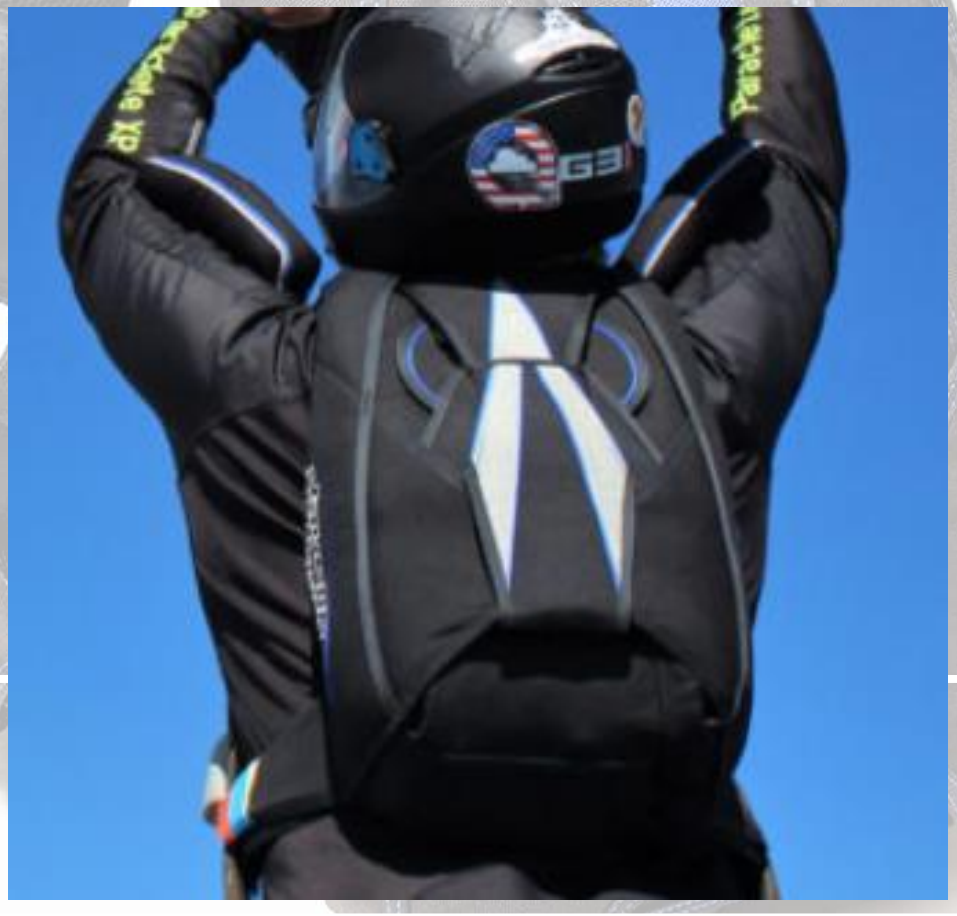
- Straight

- Folding

Main container type

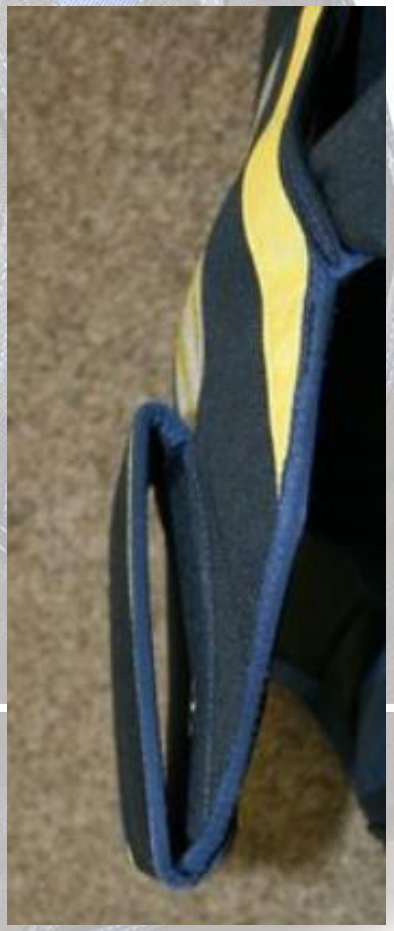
- **3 or 4 flaps**
- **Bridle protection**

Main pincover type (Top to bottom)



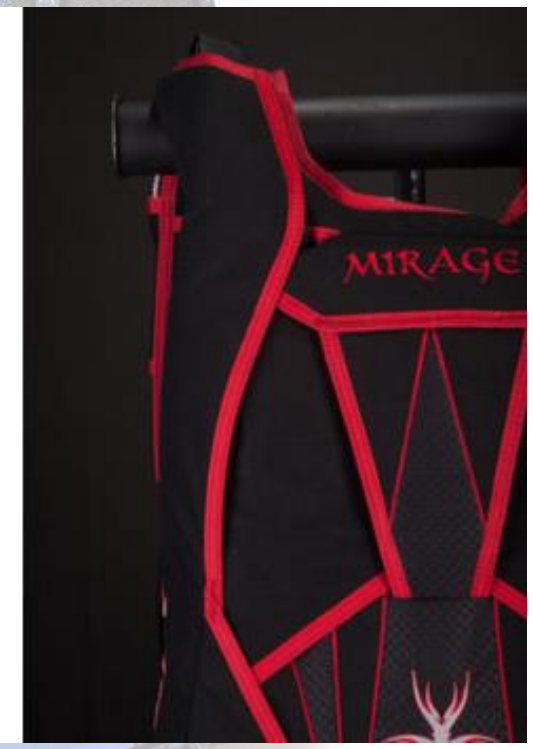
Main pincover type (Bottom up)

Main pincover type (Bottom up and fold)



Riser covers type:

- **Pockets on the back**



Riser covers type:

- **Pockets on the flap**

Riser covers type:

- **Magnetic**

Additional futures: RSL (left\right)

Additional futures:
MARD (SkyHook, LES, Trap, Boost, Mojo, RAX, DRD)

Harness construction:

- rings on the lateral junction

Harness construction:

- rings lower then lateral junction

Preparations:

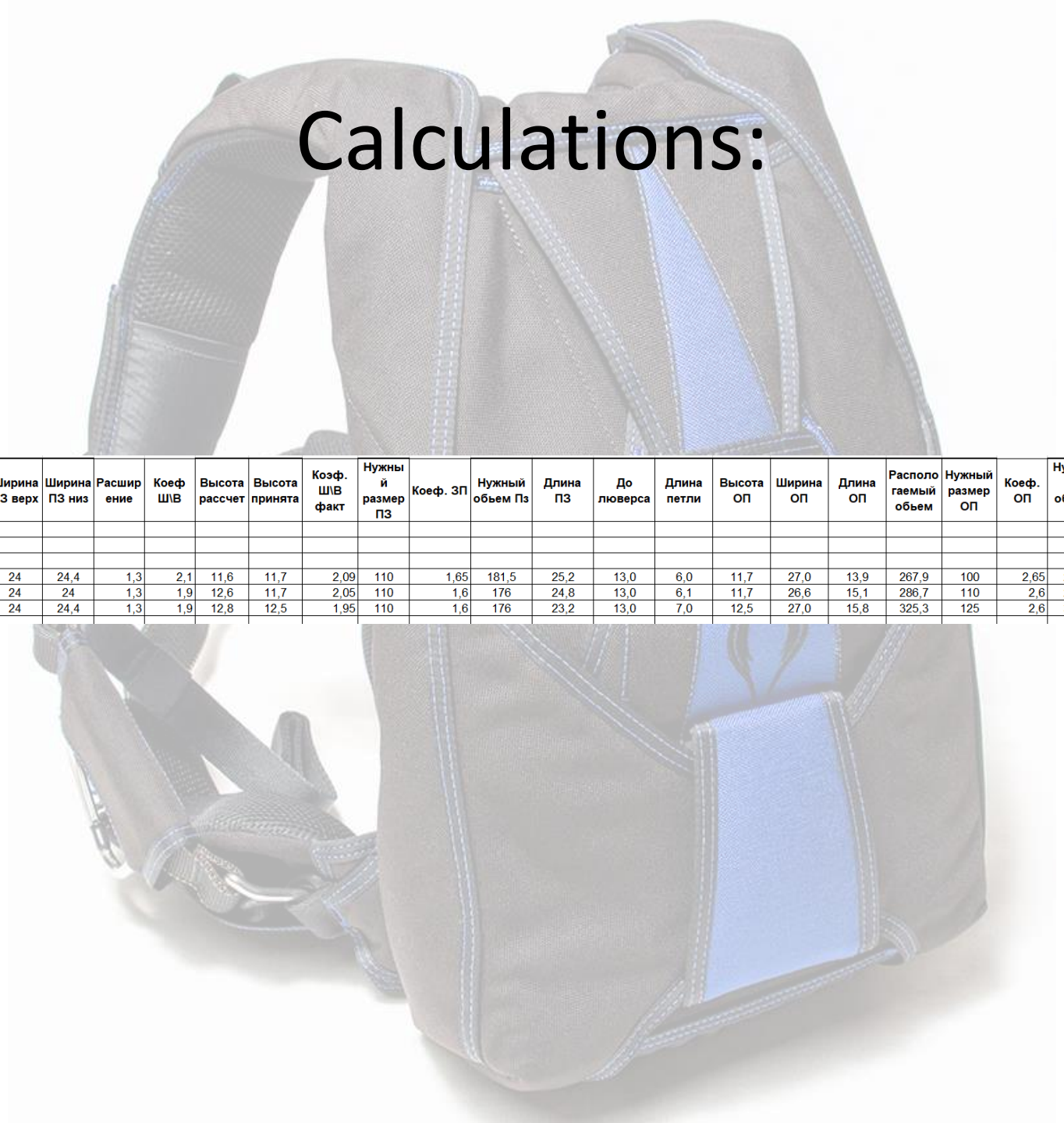
- packing volume calculations

Calculations:

ПЗ-ОП	Ширина ПЗ: вверх	Ширина ПЗ: низ	Размер втулки	Коэфф. ШВК	Количество рядов/ст.	Количество проходов	Коэфф. ШВК факт.	Мульный диаметр ПЗ	Коэфф. ЗП	Мульный объем Пв	Длина ПЗ	Дл. планировки	Длина линии	Количество ОП	Ширина ОП	Длина ОП	Расчетная полезный объем	Мульный диаметр ОП	Коэфф. ОП	Мульный объем ОП	Расчетная общая длина	Размер комфорт
ПЗ-1 109.000	24	24.4	1.3	2.1	11.6	11.7	2.08	110	1.68	581.6	28.2	13.6	6.8	11.7	27.0	13.8	367.8	100	2.68	268	38.1	1.68
ПЗ 109.110	24	24	1.3	1.8	12.6	11.7	2.08	110	1.6	576	24.8	13.6	6.1	11.7	26.8	16.1	389.7	110	2.6	286	38.8	1.82
ПЗ+1 109.208	24	24.4	1.3	1.8	12.8	13.8	1.88	110	1.6	576	23.2	13.6	7.0	12.8	27.0	16.8	358.3	120	2.6	308	38.0	1.64
ПЗ-1 208.110	24	24.4	1.3	1.8	12.8	13.2	2.02	120	1.6	2002	26.2	13.6	6.0	13.2	27.0	14.3	387.3	110	2.6	286	40.8	1.80
ПЗ 208.208	24	24.2	1.3	1.8	13.3	13.8	1.88	120	1.68	2006.28	28.1	13.6	6.7	13.8	27.8	16.2	332.8	120	2.68	321	40.3	1.68
ПЗ+1 208.140	24	24.4	1.3	1.8	13.4	13.8	1.88	120	1.6	2002	24.2	13.6	7.0	13.8	28.0	16.4	364.1	140	2.6	364	40.6	1.68
ПЗ+2 208.340	24	24	1.3	1.8	13.7	13.3	1.88	120	1.6	2002	23.4	13.6	7.4	13.3	28.6	16.6	417.7	140	2.6	436	41.4	1.68
ПЗ-1 340.208	24	28.6	1.3	2.1	13.2	13.1	1.88	140	1.6	2541	26.2	13.6	6.7	13.1	28.2	14.8	396.8	130	2.6	338	42.7	1.64
ПЗ 340.140	24	28.2	1.3	2.1	13.8	13.4	1.86	140	1.68	2531	26.0	13.6	7.0	13.4	28.8	16.8	371.9	140	2.68	371	41.8	1.68
ПЗ+1 340.340	24	28.6	1.3	2.1	13.7	13.6	1.86	140	1.6	2541	24.8	13.6	7.4	13.6	28.2	17.2	434.7	140	2.6	436	42.0	1.64
ПЗ+2 340.540	24	27	1.3	2.1	13.8	13.8	1.86	140	1.6	2541	24.3	13.6	7.7	13.8	28.6	16.8	468.4	140	2.6	468	43.1	1.68
ПЗ-1 380.340	26	27.8	1.3	1.8	14.6	14.2	1.86	140	1.6	2888	28.0	14.8	7.4	14.2	30.4	16.6	436.1	140	2.6	436	43.8	1.64
ПЗ 380.340	26	28.2	1.3	1.8	14.8	14.4	1.86	140	1.6	2888	27.4	14.8	7.6	14.4	30.8	17.2	468.0	140	2.6	468	44.7	1.68
ПЗ+1 380.000	26	28.6	1.3	1.8	15.1	14.7	1.88	140	1.6	2888	26.6	14.8	8.0	14.7	31.2	16.6	500.4	200	2.6	520	45.3	1.68
ПЗ 2000.000	27	28	1.3	1.8	15.3	14.8	2.00	200	1.6	3000	28.8	14.8	7.3	14.8	31.6	16.6	519.8	200	2.6	520	47.8	1.80
ЗП 2000.000	28	28	1.7	1.8	15.3	14.4	2.01	200	1.6	3000	28.4	14.8	7.3	14.4	30.4	16.4	523.7	200	2.6	520	46.8	1.68
ЗП 2000.208	28	28.8	1.7	1.8	15.7	14.3	1.88	200	1.6	3000	28.3	14.8	7.6	14.3	30.8	16.6	560.6	200	2.6	520	46.2	1.68
ЗП 2000.340	28	31	1.7	1.8	16.3	15.8	1.88	200	1.6	3000	30.3	14.8	7.6	15.8	34.4	16.6	603.8	200	2.6	520	49.8	1.68
ЗП 2700.270	28	32	1.7	1.8	16.8	16.3	1.84	270	1.6	4.05	31.3	14.8	7.7	16.3	35.4	16.1	716.3	270	2.6	716	51.4	1.68
ЗП 3000.000	28	32.8	1.7	1.8	17.3	17.3	1.80	300	1.6	4.80	31.8	14.8	7.8	17.3	36.2	16.8	783.1	300	2.6	780	52.4	1.68
С1 2000.000	28	30.8	2	1.8	16.2	16.7	1.84	230	1.780	412.439	30.0	14.8	8.1	16.7	34.8	16.6	688.4	230	2.6	598	48.6	1.62
С2 2750.270	28	32.4	2	1.8	17.1	17.6	1.84	270	1.68	464.79	30.8	14.8	8.3	17.6	36.4	16.1	760.8	270	2.68	784	50.8	1.67
С3 3000.000	28	33.6	2	1.8	17.7	18.3	1.84	300	1.78	550	32.4	14.8	8.2	18.3	37.6	16.4	858.3	300	2.68	858	52.8	1.67
3750.340	28	34	2	1.8	17.8	18.8		370	1.68	861.28	33.6	14.8	8.3	18.8	38.0	23.1	1044.1	330	3.3	1056	56.7	1.68
3750.370	28	38	2	1.8	18.4	20.0		370	1.68	861.28	33.0	14.8	10.0	20.0	38.0	23.4	1113.4	370	3	1110	60.4	1.62
3750.400	28	38	2	1.8	18.4	20.0		370	1.68	861.28	33.0	14.8	10.0	20.0	38.0	24.8	1278.8	400	3.3	1360	58.8	1.81

Размер	Спинка					Геометрия ПЗ										Геометрия ОП						Камера ОП			Камера ЗП						
	Шир.план2 верх	Длина: ЗП	Длина: ОП	Шир. план2 низ	Длина: низкая	Ширина ПЗ2 верх	Длина: ПЗ	Длина: для	Ширина ПЗ2 низ	Кольев ПЗ	Кора бинокляр.	Нож бинокляр.	Хлопушка бинокляр.	Ш2 нож. планир.	Нижн. планир.	Нижн. планир.	Хлопт	Шир. ЗП2	Длина: ЗП	Длина: ОП	Шир. ОП2	Длина: низкая	кольев ОП	Шир.план ОП	Длина: план ОП	Кол. план ОП	Шир2 план.	Длина: для	Длина: низкая	Шир2 план.	Форт план.	Кольев верх дет	Длина: низкая
ПЗ-1 109.000	13.6	28.4	14.1	13.7	38.6	13.0	28.2	13.0	13.2	11.7				7.6	16.1	11.2	7.6	13.2	28.2	13.6	13.6	17.7	11.7	27.6	14.4	13.2	16.0	16.6	16.7	16.2	13.3	13.7	28.2
ПЗ 109.110	13.6	28.0	16.2	13.8	40.2	13.0	24.8	13.0	13	11.7	8.8		8	7.6	14.8	11.0	8.3	13.2	24.8	16.1	13.2	16.2	11.8	27.1	16.6	13.2	16.0	15.8	16.3	16	13.3	13.7	28.8
ПЗ+1 109.208	13.6	23.6	16.8	13.7	38.4	13.0	23.2	13.0	13.2	13.8	8.8		8	7.6	13.7	11.2	8.7	13.2	23.2	16.8	13.8	16.4	12.0	27.8	16.2	13.0	16.0	15.8	14.7	16.2	13.1	13.8	24.2
ПЗ-1 208.110	13.8	28.4	14.8	13.7	40.8	13.0	26.2	13.0	13.2	13.2	8.8	8	8	7.8	16.3	11.2	7.8	13.2	26.2	14.3	13.8	16.4	12.0	27.8	14.8	13.7	16.0	15.8	15.7	16.2	13.8	13.2	27.2
ПЗ 208.208	13.8	28.2	16.4	14.1	40.7	13.0	28.1	13.0	13.6	13.8				7.8	16.6	11.6	8.4	13.2	28.1	16.2	13.8	16.8	12.0	28.3	16.7	13.4	16.0	15.8	16.6	16.6	13.8	13.8	28.1
ПЗ+1 208.140	13.8	24.4	16.8	14.2	41.0	13.0	24.2	13.0	13.7	13.0	8.0		8	7.8	14.8	11.7	8.0	13.2	24.2	16.4	14.0	20.1	13.0	28.8	16.8	13.8	16.0	15.8	16.7	16.7	13.7	14.0	28.2
ПЗ+2 208.340	13.8	23.8	16.2	14.8	41.8	13.0	23.4	13.0	13	13.3	8.0		8	7.8	14.3	12.0	8.8	13.2	23.4	16.6	14.3	21.2	13.2	29.1	16.8	13.8	16.0	15.8	16.8	17	14.0	14.3	24.4
ПЗ-1 340.208	13.8	28.2	14.7	14.3	41.1	13.0	28.2	13.0	13.8	13.1	8.8		8	7.8	16.2	11.8	8.8	13.2	28.2	14.8	14.1	18.3	13	28.7	16.8	13.6	16.0	15.8	17.2	16.8	13.8	14.1	27.2
ПЗ 340.140	13.8	28.2	16.8	14.8	42.2	13.0	28.0	13.0	13.7	13.4	8.8		8	7.8	16.2	12.1	8.7	13.2	28.0	16.8	14.4	20.2	13.0	28.3	16.3	13.8	16.0	15.8	17.0	17.1	14.1	14.4	27.8
ПЗ+1 340.340	13.8	28.0	17.4	14.8	43.4	13.0	24.8	13.0	13.7	13.6	8.8		8	7.8	16.2	12.3	8.8	13.2	24.8	17.2	14.6	21.1	13.0	28.7	17.7	14.1	16.0	15.8	16.8	17.3	14.3	14.6	28.6
ПЗ+2 340.540	13.8	24.8	16.8	15.0	43.8	13.0	24.3	13.0	13.8	13.8	8.8		8	7.8	14.8	12.8	9.3	13.2	24.3	16.8	14.8	20.8	13.0	28.1	16.3	14.3	16.0	15.8	16.8	17.8	14.8	14.8	28.3

Calculations:



	ПЗ-ОП	Ширина ПЗ верх	Ширина ПЗ низ	Расширение	Коеф Ш\В	Высота рассчет	Высота принята	Коэф. Ш\В факт	Нужный размер ПЗ	Коеф. ЗП	Нужный обьем Пз	Длина ПЗ	До люверса	Длина петли	Высота ОП	Ширина ОП	Длина ОП	Располагаемый обьем	Нужный размер ОП	Коеф. ОП	Нужный обьем ОП	Рассчет общая длина	Провер коэффф	
8																								
9																								
10																								
11																								
12	F2-1_110\100	24	24,4	1,3	2,1	11,6	11,7	2,09	110	1,65	181,5	25,2	13,0	6,0	11,7	27,0	13,9	267,9	100	2,65	265	39,1	1,45	Р
13	F2_110\110	24	24	1,3	1,9	12,6	11,7	2,05	110	1,6	176	24,8	13,0	6,1	11,7	26,6	15,1	286,7	110	2,6	286	39,9	1,50	У
14	F2+1_110\125	24	24,4	1,3	1,9	12,8	12,5	1,95	110	1,6	176	23,2	13,0	7,0	12,5	27,0	15,8	325,3	125	2,6	325	39,0	1,44	У
15																								

Drawing:

Wide range of sizes:

Rig size 26 (120 reserve, 160 main)

and size 62 (160 reserve, 120 main)

Production:

Different approaches to parachute testing:

- Government regulations: TSO, E\JTSO, QAC, ets.
  - TSO and AS8015\TS135 docs,
  - revisions,
  - tests (human factor and actuation force tests, environments tests, structural overload, functional tests, direct drop tests, MARD tests, breakaway tests, RoD, stability, ets).

4.3.6 STRUCTURAL OVERLOAD TESTS:

No material(s) or device(s) that attenuates shock loads and is not an integral part of the parachute assembly or component being certified may be used. Tests may be conducted for either a complete parachute assembly or separate components. There shall be no evidence of material, stitch, or functional failure that will affect airworthiness. For reusable items the same items shall be used for all 4.3.6 tests. Peak opening force shall be measured on all 4.3.6 tests. The parachute must be functionally open within the number of seconds calculated for 4.3.8 tests. Parachute assemblies shall be tested in accordance with the following schedule:

(a) Test weight = Maximum operating weight x 1.2
Test speed = Maximum pack opening speed x 1.2

Droptest:

- plane

  (size of the door, tail position, speed with open door)

Droptest:

- plane

  (size of the door, tail position, speed with open door)

Droptest:

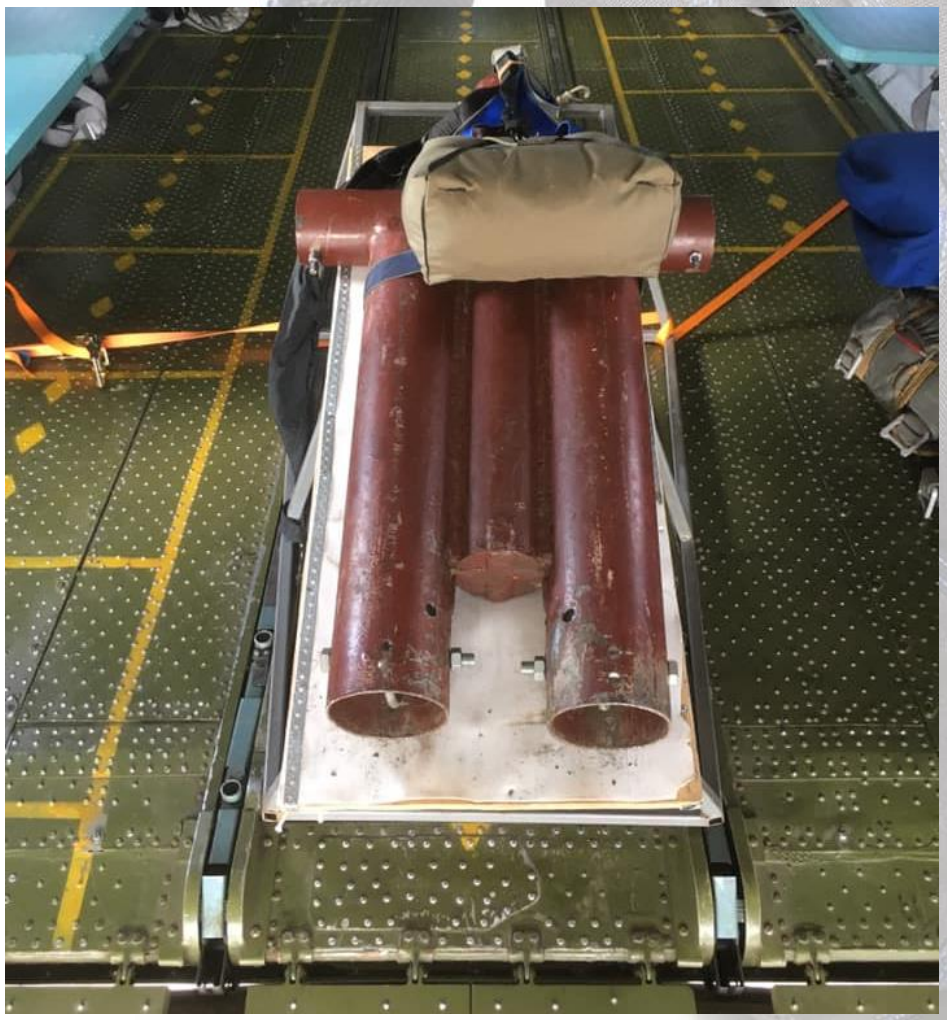
- plane

  (size of the door, tail position, speed with open door)

Droptest:

- plane

  (size of the door, tail position, speed with open door)



Droptest:

- plane

  (size of the door, tail position, speed with open door)

Droptest:

- dummy

  (soft (filled with sand\lead), rubber, metal, box)

Droptest:

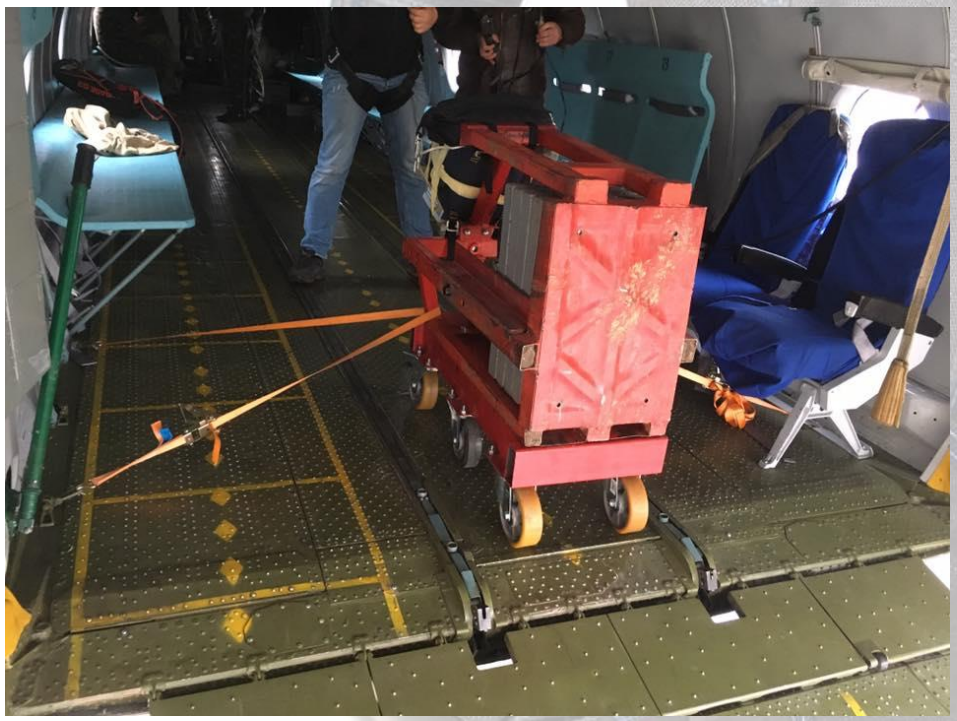
- dummy

  (soft (filled with sand\lead), rubber, metal, box)

Droptest:

- dummy

  (soft (filled with sand\lead), rubber, metal, box)



Droptest:

- dummy

  (soft (filled with sand\lead), rubber, metal, box)

Droptest:

- dummy

  (soft (filled with sand\lead), rubber, metal, box)

- dropteam

  (who do what, safety)

Droptest:

- support and retrieval team

  (offroad ability, easy loading, enough peoples)

Droptest:

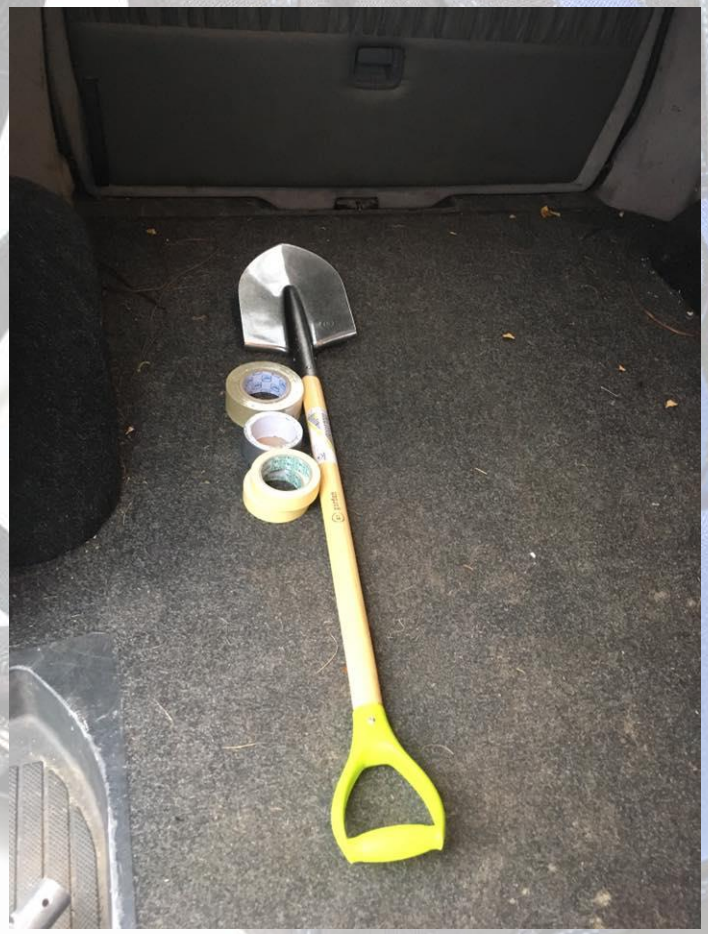
- support and retrieval team

  (offroad ability, easy loading, enough peoples)

Droptest:

- support and retrieval team

  (offroad ability, easy loading, enough peoples)



Droptest:

- support and retrieval team

  (offroad ability, easy loading, enough peoples)

Different approaches to parachute testing:

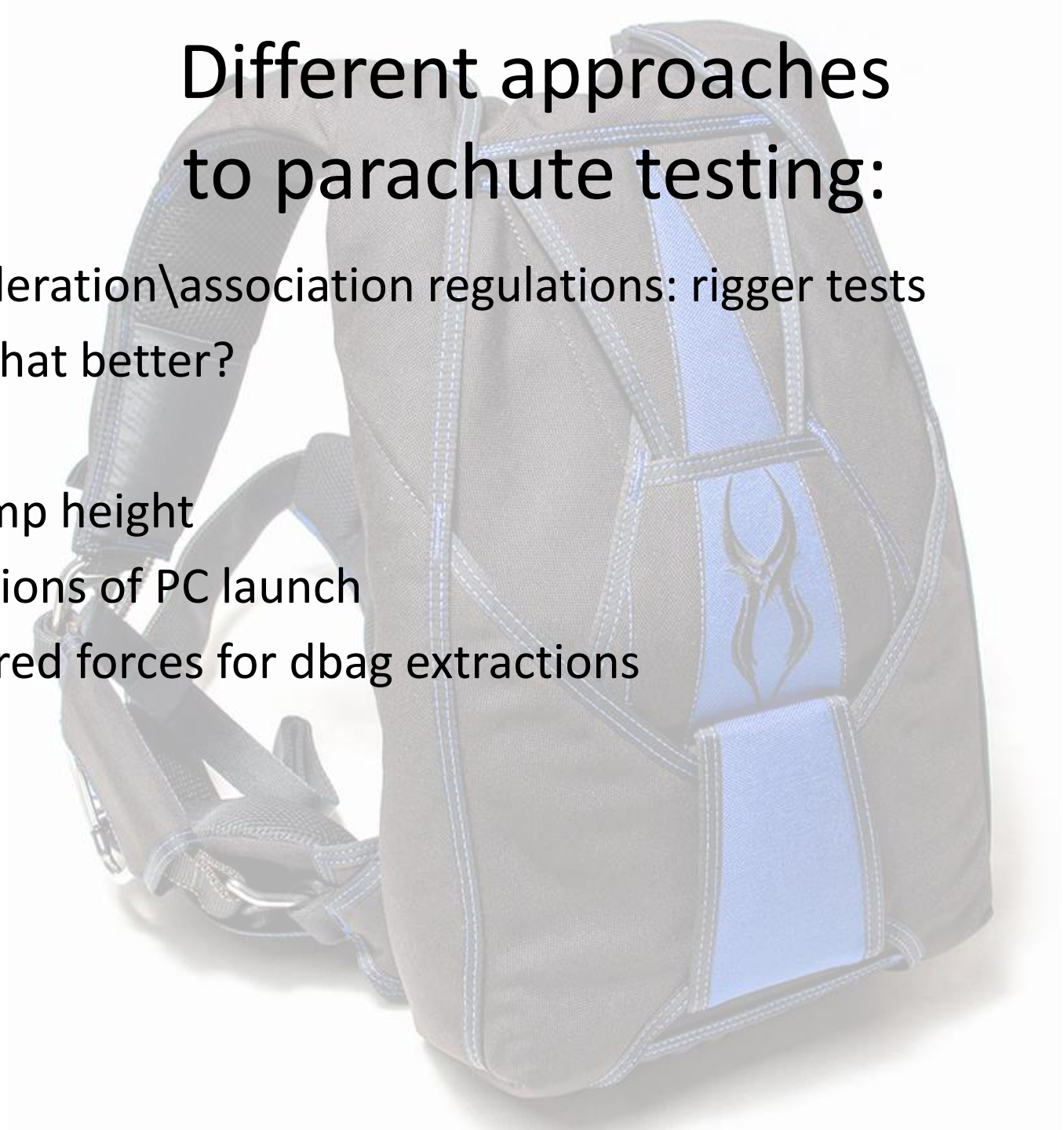
- Federation\association regulations: rigger tests

Why that better?

PC jump height

Directions of PC launch

Required forces for dbag extractions



Different approaches to parachute testing:

Tensile strength