



PMA Standard

Periodical Inspection of Paragliders

PMA standard specifying uniform instructions and criteria to assess the airworthiness of a used paraglider

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1 Preface

This standard was developed by the experts of the Paragliding Manufacturers Association (PMA) in cooperation with independent experts; it is not a norm.

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The English version of this document shall be used as reference in case of differences between translations.

This standard can evolve according to new data and new design of paragliders. Please refer to the latest version of this document.

1.1 Scope of application

This standard specifies uniform instructions and criteria to assess the airworthiness of a used paraglider.

Manufacturers can specify different inspection test details and periodical intervals. In this case, the manufacturer's manual supersedes the PMA's recommendations.

1.2 Start of application

The date of application of this standard is December 2024.

1.3 Document history

The document versioning scheme is as follows: V Year.Month.Editorial

- Year.Month: Major changes, e.g., regarding inspection criteria and/or procedures
- Editorial: Only editorial change between versions

Date	Version	Changes / comments
25/07/2023	V 2023.07.0	Working group approved DRAFT / Research Paper
10/12/2023	V 2023.07.1	Added introduction and feedback forms
Jul-Dec 2024	V 2024.07.1	Work-in-progress: Review based on feedback
09/12/2024	V 2024.12.1	First official release

Table 1: Document history

Document Type: PMA Standard
 Version: V 2024.12.1

2 Definitions

For the purpose of this standard, the following terms shall apply:

Paraglider

Ultralight glider without a rigid basic structure which is launched and landed by foot and in which the pilot (and, if applicable, a passenger) is suspended in a harness (or harnesses) connected to the wing. Also called glider.

Canopy

The wing part of the paraglider which is actually creating lift. Everything except the lines and the risers. Also called wing or sail.

Profile / airfoil

The cross-sectional shape of the wing.

Leading edge

The foremost edge of the profile, and therefore the part which first meets the oncoming air in normal flight.

Trailing edge

The rearmost edge of the profile, where the external airflow exits the airfoil in normal flight.

Planform

Shape of the canopy laid flat on the ground viewed from the top.

Chord

An imaginary straight line joining the leading edge and the trailing edge of an airfoil.

Span

An imaginary line joining one wingtip to the opposite wing tip.

Chordwise

Directed, moving, or placed along the chord of a canopy.

Spanwise

Directed, moving, or placed along the span of a canopy.

Top sail

Fabric area of the canopy between the leading edge and the trailing edge of the glider, attached to the top of the profile. Also called upper sail or upper surface.

Lower sail

Fabric area of the canopy between the leading edge and the trailing edge of the glider, attached to the bottom of the profile. Also called lower surface.

Ribs

Internal panel ensuring the profile shape of the canopy, connecting the upper with the lower sail.

Diagonals and straps

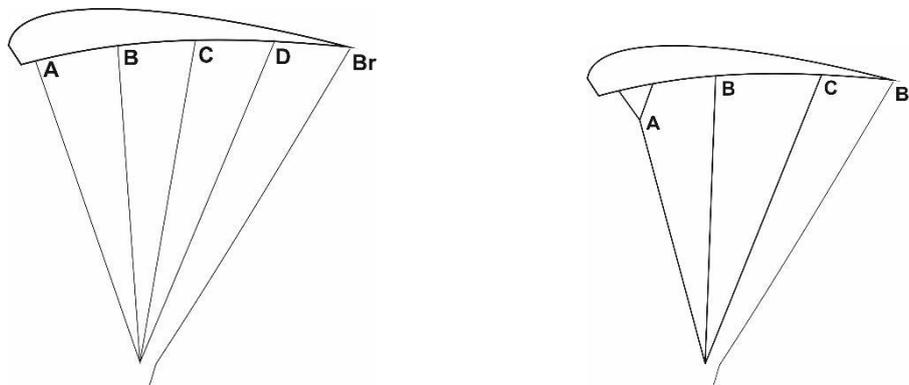
Internal panels spanning from one rib to another.

Line attachment points

Loops attached to the canopy. Each loop is connected to a suspension line.

Suspension lines

Strings linking the risers to the sail, also simply called lines. Lines are labeled according to the linkage order on the lower sail, from leading edge to trailing edge starting at the letter A. Brake / steering lines often have separate labeling systems, e. g.: K, Br, or Brake.



*Figure 1: Example representation of suspension lines in chord direction
4 liner (left), 3 liner (right)*

Main lines

Lines which are attached directly to the riser connectors.

Middle lines

Lines which are neither attached to the riser connectors nor directly to the line attachment points of the paraglider.

Upper lines

Lines which are attached directly to the line attachment points of the paraglider.

Brake lines / steering lines

A complete line system ending at the two primary control handles.

Line group

All lines that are connected to a main line belong to one line group. Line groups are numbered starting from 1 at the middle of the span.

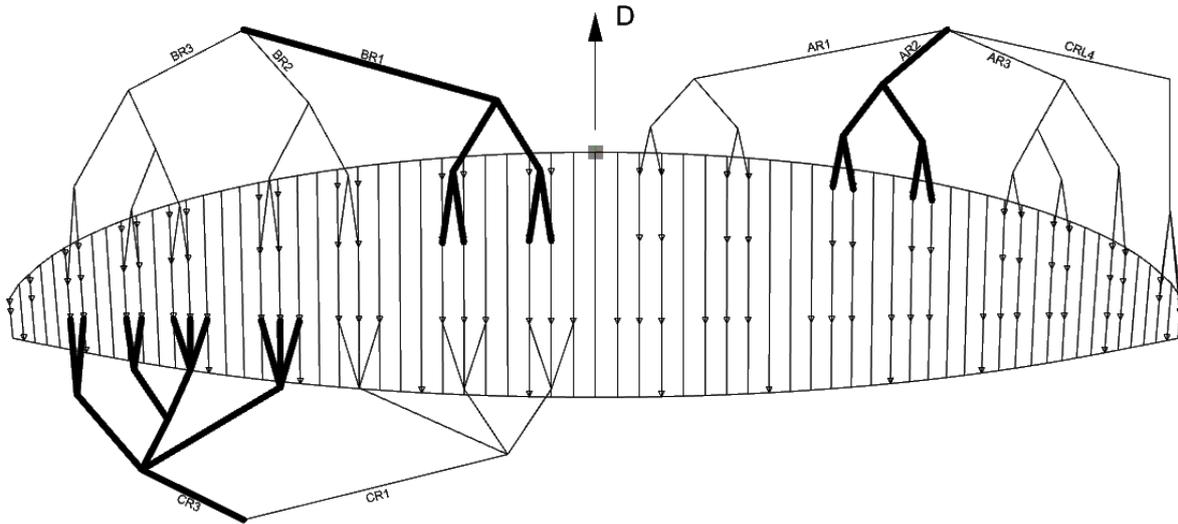


Figure 2: Illustration of line groups

D: Direction of flight

Thick lines: Examples of line groups and labels: BR1, AR2, CR3

Line level

The vertical position of a line inside a line group. The main lines are counted first, i. e. level 1.

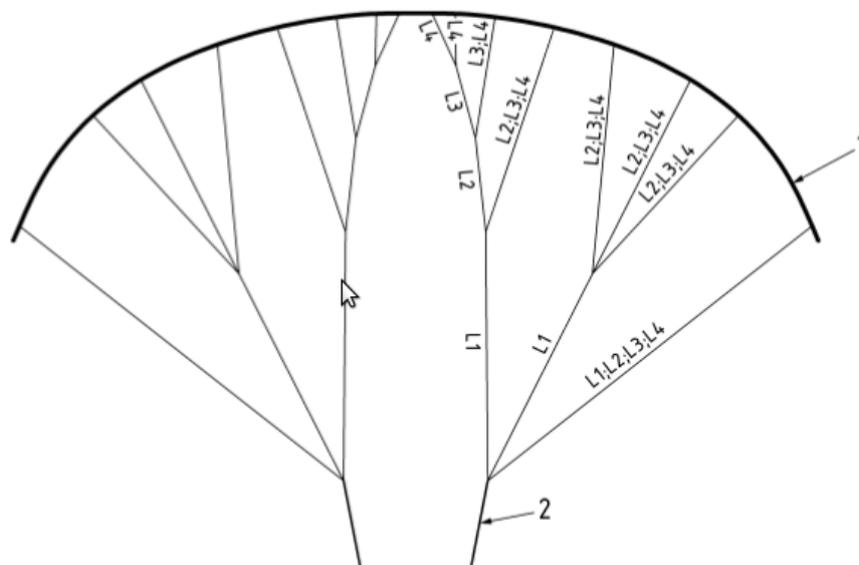


Figure 3: Illustration of a glider with four line levels

- 1: Wing
- 2: Risers
- L1: Level 1
- L2: Level 2
- L3: Level 3
- L4: Level 4

Total line length

The distance between the sail at the line attachment point and the internal side of the riser loop connected to the harness when the lines are under tension. Note: In case of risers equipped with trimmers, their reference position for total line length measurements must be set as specified by the manufacturer.

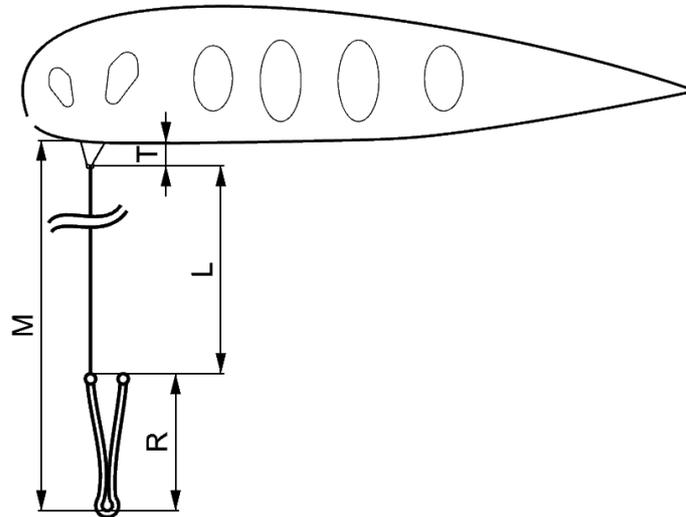


Figure 4: Total line length

R: Risers

L: Lines

T: Line attachment points

M: Total line length

For the brake line, the total line length bottom reference point is the top side of the handle knot, and the top reference point is the sail including any attachment system.

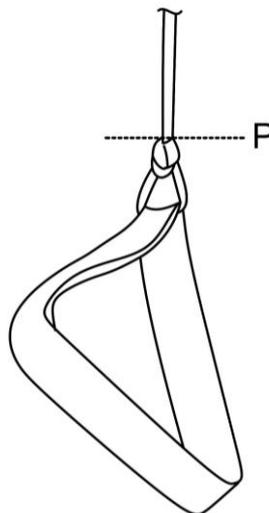
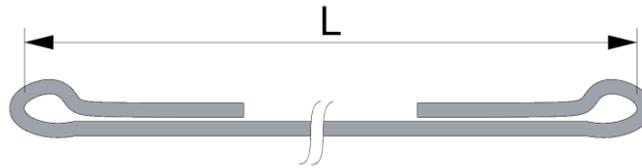


Figure 5: Reference point for brake line measurement

P: Reference point

Line sewn length

The distance between the internal side of the two loops of a line.



*Figure 6: Illustration of both ends of a line
L: line sewn length*

Riser

Textile element between the main lines and the suspension point on the harness (via a connecting element).

Connecting elements

Metal or textile parts used to link different parts of the paraglider.

Inspection

Evaluation of a paraglider's airworthiness.

Inspection test

List of instructions and criteria to evaluate a specific inspection.

Inspection company

A company executing inspections and issuing inspection reports.

Minor damage

Any deterioration of a part of the glider which has no influence on its safety.

Major damage

Any deterioration of a part of a glider that impairs its safety.

Porosity

Air permeability.

Right / left side

Right and left as seen from the pilot point of view while flying.

Bottom

In direction of gravity while flying.

Ripstop fibers

Fabric reinforcement to prevent ripping and tearing of the fabric.

3 Inspection intervals

By default, the maximum time interval allowed between inspections is 3 years of lifetime or 150 hours of flight, whichever comes first.

Starting date for the inspection intervals is (if available, in order of priority):

1. Date of check flight done by a manufacturer authorized person
2. Date of purchase
3. Date of manufacturing

4 Prerequisites and conditions

4.1 Inspection prerequisites

The following requirements are mandatory prior to beginning the inspection:

- Glider information
 - Manufacturer and model
 - Model size
 - Serial number
 - Manufacturer conformity check date
- Manufacturer documents (latest version)
 - Manual
 - Line plan
 - Inspection instructions and intervals
- Check if any safety notice has been issued regarding the material for inspection

It is preferable to also collect previous inspection reports.

Measurement instruments shall be calibrated and an internal check shall be executed at least every twelve months; the maintenance shall be done according to the instruments' manufacturers.

4.2 Test conditions

All inspection tests shall be conducted in the following conditions:

- Ambient temperature between 5°C and 35°C
- Ambient humidity between 30% and 80%
- Dry and clean surfaces

4.3 Inspection company requirements

The inspection company shall:

- Have a company status, which specifies the activity of paragliding inspection.
- Keep a record of the internal checks and calibrations of the instruments.

5 Instructions and criteria for inspection tests

5.1 Visual inspection

Accessories

- None

Instructions

- Perform a visual inspection of all parts of the paraglider:
 - identification stickers
 - top sail
 - lower sail
 - internal structure
 - line attachment points
 - lines
 - risers
 - connecting elements

Criteria to pass the test

- No major damages visible.

Note

- Minor damages shall be noted in the inspection report.

5.2 Fabric porosity inspection

Unit

- Liters per square meter per minute (l/m²/min)
- Measured under 20 mbar (200 mm of water pressure)

Accessories

- Air permeability measuring device

Instructions

- Divide the planform of the glider in four parts spanwise; each part will be a porosity zone.
- In each porosity zone, select a place without any visible damages or creases.
 - It is recommended, not to measure at the center cell(s) of the glider.
- Measure the permeability of the top sail of the glider in each porosity zone.
 - At least one measurement in each porosity zone is mandatory.
 - Multiple measurements in each porosity zone are possible.
- Each measurement position shall be between 5% and 30% of the local chord starting from the leading edge.
- The airflow direction during the measurement shall be from the inside of the canopy to the outside.
- The minimum distance along the spanwise axis between 2 measurement points shall be at least 4 cells.

Criteria to pass the test

- The average of the measurements in each porosity zone shows a porosity less than 540 l/m²/min.

Note

- Due to the difficult comparison between different types of fabrics It is not recommended to report the porosity value in the final report.
- It is recommended to rate the result using the table below.

Measurement	Rating
More than 540 l/m ² /min	Fail
Between 540 l/m ² /min and 360 l/m ² /min	Acceptable
Less than 360 l/m ² /min	Good

Table 2: Rating fabric porosity

Note

- Use the manual of your device to convert measurements to l/m²/min under 20 mbar.
- For reference, the JDC MK1/MK2 manual gives this formula to convert from a result in seconds at 10 mbar to a result in l/m²/min under 20 mbar:
 - porosity = 5400 / time_in_seconds
 - Therefore, 10 seconds correspond to 540 l/m²/min and 15 seconds correspond to 360 l/m²/min.

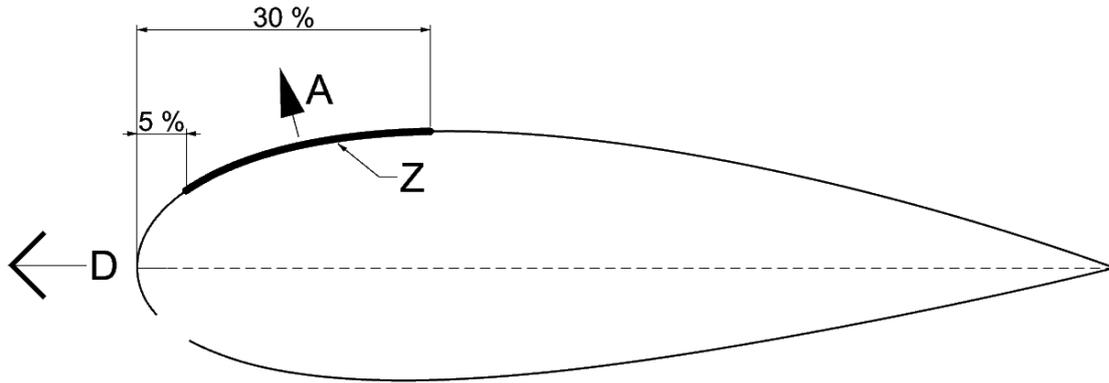


Figure 7: Parosity zone, side view
D: Flight direction
Z: Zone to check the porosity
A: Direction of airflow during the test

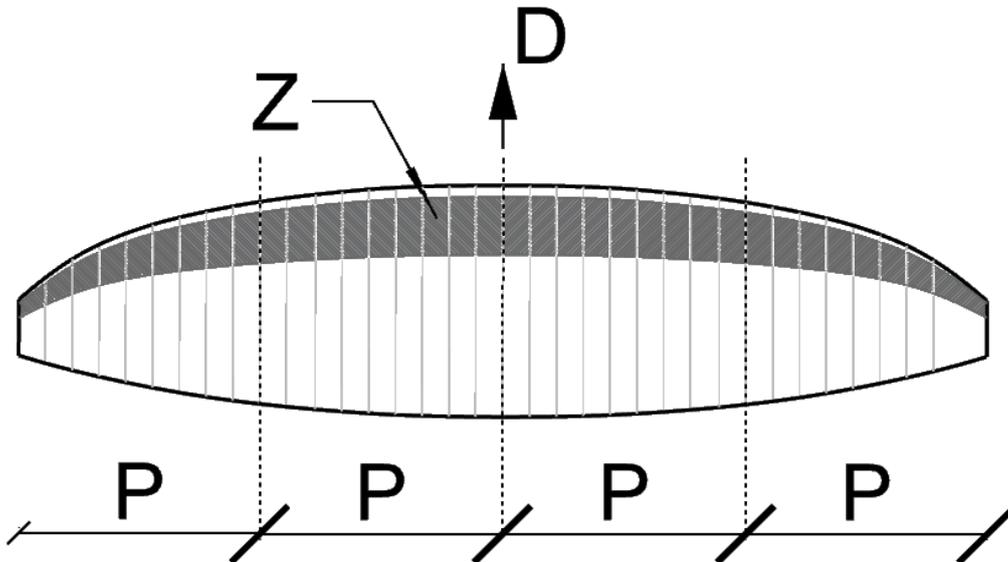


Figure 8: Parosity zone, top view
D: Flight direction
Z: Zone to check the porosity
P: Spanwise parts

5.3 Fabric tear strength inspection

Unit

- Decanewton (daN)

Accessories

- Strength gauge (mechanical or electronic; e.g., bettsometer)
- Needle attached to a support (anchor needle)
- Needle’s diameter between 1.1 mm and 1.4 mm

Instructions: Tear strength of top sail

- Select a part on the glider located on the upper surface at between 5% and 50% of the local chord.
- Put the anchor needle in the middle of one upper panel without damaging the ripstop fibers.
- Place the second needle with the strength gauge between 5 cm and 6 cm (tested distance) from the first needle at 45° from the ripstop direction without damaging the ripstop fibers.
- Pull the strength gauge up to the highest value of the criteria below; release the tension when this value is reached or when breaking of ripstop fibers occurs.

Instructions: Tear strength of ribs

- Attach an A line of line group 1 to an anchor point.
- On a rib connected to this line, select an area above the line attachment point.
- Place the needle with the strength gauge at least 10 cm (tested distance) from the line attachment point and outside of any reinforcement without damaging the ripstop fibers.
- Pull the strength gauge up to the highest value of the criteria below; release the tension when this value is reached or when breaking of ripstop fibers occurs.

Criteria to pass the tests

- The ripstop fibers of the fabric shall not break before the minimum value of 0.6 daN is reached.
- The following table shall be used to rate the result of this test:

If a break of ripstop fibers occurs with a force of ...	Rating
... less than 0.6 daN	Fail
... between 0.6 daN and 0.7 daN	Acceptable
... more than 0.7 daN	Good

Table 3: Test criteria fabric tear strength inspection

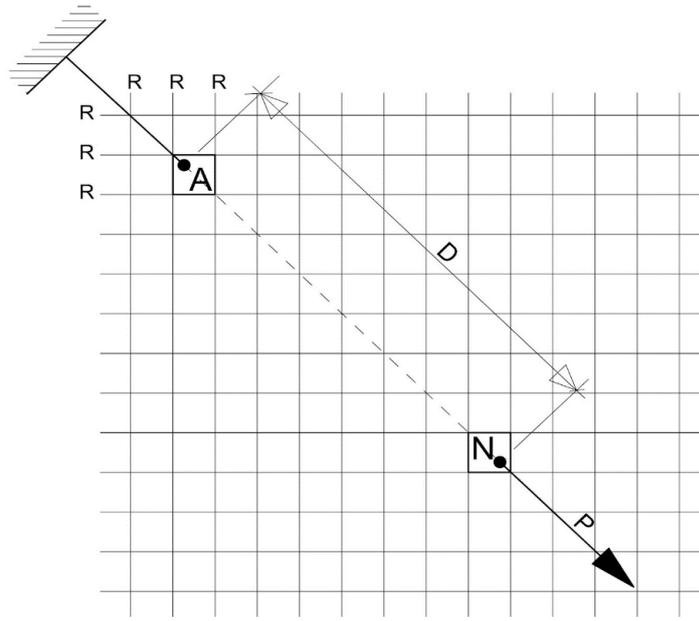


Figure 9: Tear strength of top sail

R: Ripstop fibers

N: Measuring tool needle

P: Pulling force

A: Anchor needle

D: Tested distance

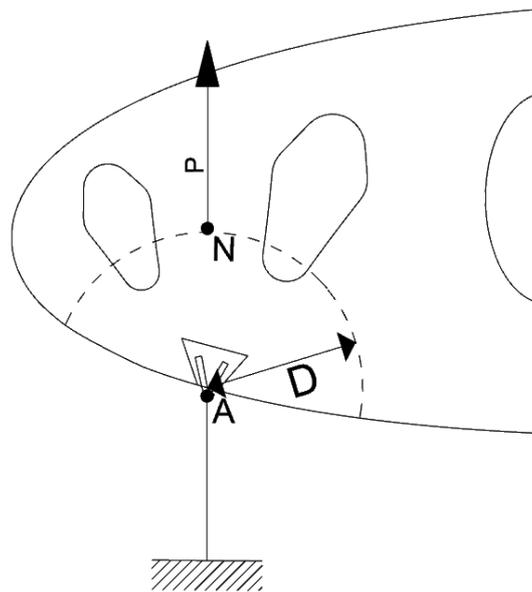


Figure 10: Tear strength of ribs

N: Measuring tool needle

P: Pulling force

A: Line attachment point

D: Tested distance

5.4 Line strength inspection

Unit

- Decanewton (daN)

Accessories

- A pulling device satisfying the following criteria:
 - The device must be long enough to break the line with only 2 points of contact – without any modifications on the line.
 - The line shall be attached on both ends with a metallic round section with a diameter between 3 mm and 4.5 mm.
 - The pulling movement of the device shall be smooth.
 - The pulling speed of the device shall be between 0.5 m/min and 1 m/min.
- An electronic sensor with an electronic strain gauge and a sampling rate of at least 100 Hz (100 measurements per seconds).

Instructions

- Extract at least one line of each line level from the paraglider which is part of the oldest set of lines that has not been replaced by previous inspections.
- This standard recommends to prefer:
 - Front lines (A and B) over rear lines (C and D).
 - Lines closer to the center of the canopy over lines closer to the side edge of the canopy.
- Break the line with the pulling device.
- Measure and record the breaking strength of the line.

Criteria to pass the test

- Each breaking strength value must be higher or equal to the `minimum_strength_value` determined by:
 - $minimum_strength_value = value_new * source_coeff * line_coeff$
- With
 - `value_new`: The breaking strength value of a new line provided by either the paraglider manufacturer or the line supplier.
 - `source_coeff`: A coefficient depending on the source of `value_new`, to be chosen from the table below:

Source of <code>value_new</code>	<code>source_coeff</code>
Paraglider manufacturer	1.00
Line supplier	1.05

Table 4: Coefficients for source of breaking strength value of a new line

- `line_coeff`: A coefficient depending on the line core material, to be chosen from the table below:

Line core material	<code>line_coeff</code>
Aramid / Technora / Vectran	0.45
Dyneema	0.65

Table 5: Coefficients for line core materials

- Note: Due to design choices, a paraglider manufacturer may provide a specific `minimum_strength_value` which may be higher or lower than the `minimum_strength_value` as determined via the above formula.

Post test

- The broken line shall be replaced by a new line respecting the original material, construction and stitching details.
- The new line length shall be adapted to have minimal influence on the glider's flight behavior.

5.5 Line geometry inspection

An example can be found in Appendix A.

Unit

- Millimeter (mm)

Accessories

- Distance meter with a precision of +/- 1.5 mm, capable of measuring up to 10 m
- If a laser measurement tool is used, the target shall not be bigger than 150 mm radius around the anchor point.
- An instrument to apply a constant tension of 5 daN (+/- 15%)

Instructions

- For each attachment point, measure the total line length (as defined in Figure 4) – measure both sides of the wing.
- For each attachment point, compute the difference Δ , defined as
 - $\Delta = \text{measured_length} + \text{correction_offset} - \text{reference_length}$where
 - measured_length is the measured total line length,
 - correction_offset is a unique correction offset value that can be applied to all measurements (same value for all measurements), brake lines included,
 - reference_length is the total line length given in the glider's manual.
- Compare the difference Δ to the test criteria.
- Apply necessary modifications on the lines or risers to fit the criteria.

Criteria to pass the test

- The correction offset value shall be less than +/- 1.5% of the maximum total line length given in the glider's manual.
- For each total line length (except for the brake lines) the difference Δ shall be within the range [-12 mm, +12 mm].
- For each brake line's total line length, the difference Δ shall be within the range [0 mm, +50 mm].

Line length modification option

- Line lengths should be adjusted with length modification options selected from the list in appendix B.
- Other modifications not described in appendix B or by the manufacturer are not recommended.

6 Documents and reports

6.1 Inspection report

6.1.1 Inspection report document

If all the prerequisite information (section 4.1) is collected, and the inspection company has executed, evaluated and recorded all inspection tests, an inspection report can be issued.

The inspection company must be able to authenticate an issued report.

This report shall be labeled clearly as an inspection report.

6.1.2 Inspection report requirements

At least the following elements shall be included in the inspection report issued to the owner of the paraglider and shall be archived by the inspection company:

- Date of the inspection
- Serial number of the glider
- Glider model and size
- Glider color
- Inspection details (list of inspection tests done during the inspection)
- Individual results/values of all the tests
- References to the broken lines
- References to the instrument used for the inspection
- Details of any modification done to the glider
- Details of any minor damage noticed
- Time span until next recommended inspection (in years of lifetime and hours of flight, refer to glider's manual); depending on the state of the glider - especially if some tests are rated "Acceptable" - the inspection company may reduce the interval to the next recommended periodical inspection.
- Inspection company references
- Signature of the inspection company's legal representative
- Reference to the PMA standard (and version) used for the inspection

The units for the reported values shall be the same as the ones used in this standard.

In addition, the following elements shall be internally archived by the inspection company:

- Inspector's name

If the inspection does not include all the following inspection tests

- Visual inspection
- Fabric porosity inspection
- Fabric tear strength inspection
- Line strength inspection
- Line geometry inspection

it shall be written clearly in the inspection report: “Warning, this inspection is a partial inspection and cannot fully validate the airworthiness of the glider.”

6.2 Data exchange

In order to have a better interaction between manufacturers and inspection companies, the standard proposes at least the following data exchange and standards.

Data exchange between the manufacturer and the inspection company should be in a computable format. As a supplement to this standard, the PMA proposed “PMA Periodical Inspection Data Format” can be found on the PMA website.

6.2.1 Paraglider manufacturer to inspection company

For each model / size:

- Manufacturer
- Model
- Size
- Periodical inspection details
 - Inspection interval
 - Inspection test details (if different from this standard)
- Weight range (kg)
- Line plan with line references
- Lines details
 - Material references
 - Sewn length
 - Colors
 - Construction details
 - Breaking strength value of the new line (value_new, source paraglider manufacturer), or as a fallback the minimum_strength_value
- Total line length for each attachment point according to the reference points of this standard – including trimmer position (if applicable)

The units for the reported values shall be the same as the ones used in this standard.

6.2.2 Inspection company to paraglider manufacturer

For each inspected glider:

- Manufacturer
- Model
- Size
- Serial number
- Date of the inspection
- Version of this standard used for the inspection
- Details of the visual inspection
- Fabric porosity inspection
 - Porosity values
 - Position of the measurements (panel number, upper/lower surface, approximate chord position)
 - Porosimeter unit (if not in l/m²/s under 20 mbar)
- Fabric tear strength inspection
 - Results
 - Position of the measurements (panel number, upper/lower surface, approximate chord position)
- Line strength inspection
 - Line strength values
 - References of the tested lines
- Line geometry inspection
 - Total line length values measured
- List of the modifications done on the glider

The units for the reported values shall be the same as the ones used in this standard.

7 Appendices

7.1 Appendix A: Line geometry inspection

This appendix provides an example for the line geometry inspection laid out in section 5.5. All line length data are in millimeters.

For this example, the following example glider is considered:

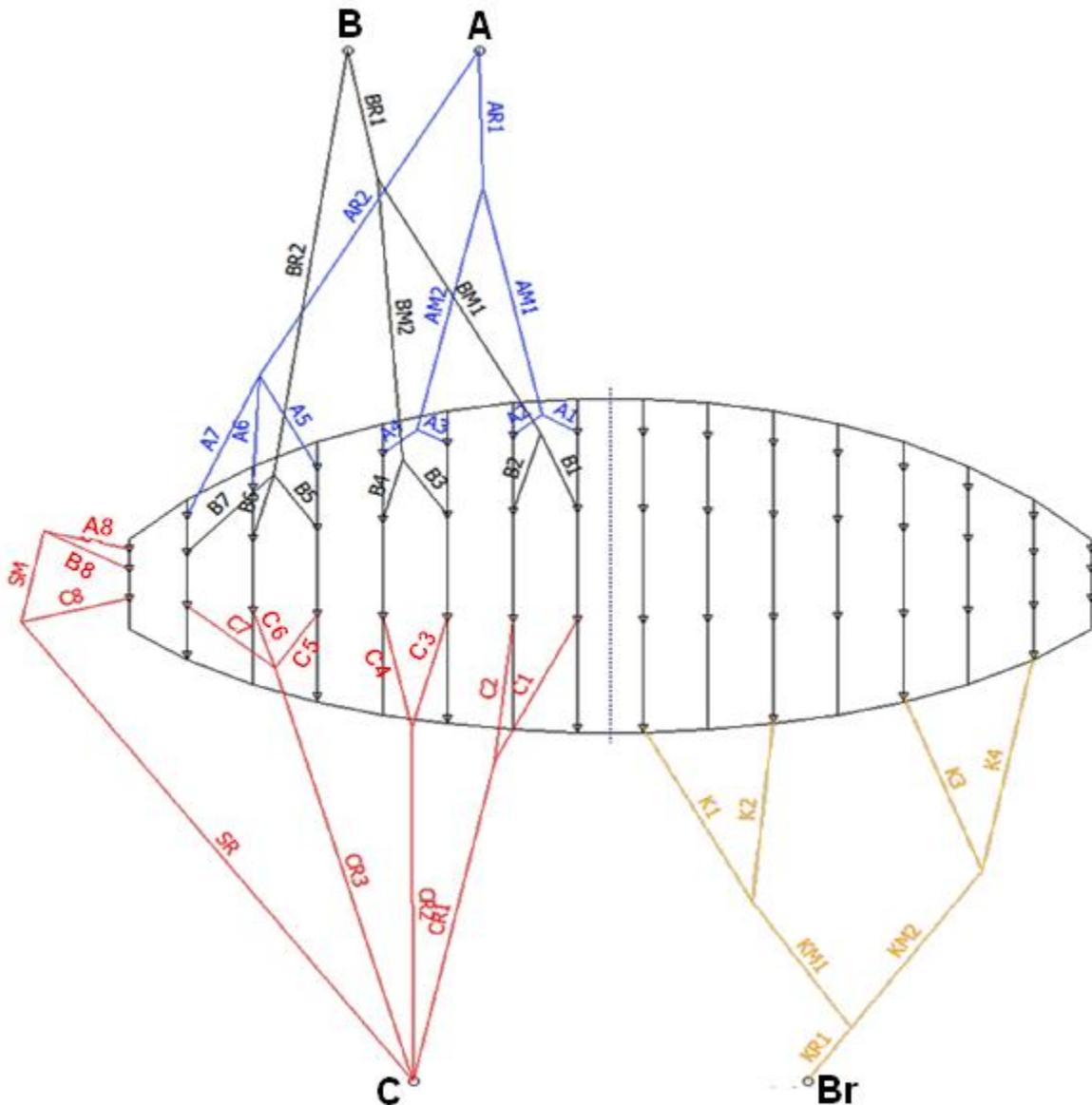


Figure 11: Example glider for example of line geometry inspection

For this example, the following line lengths data are considered:

Measured data (mm): measured_length					Reference values (mm): reference_length				
	A	B	C	K		A	B	C	K
1	6026	5954	5959	6930	1	6048	5985	6002	7002
2	5945	5871	5932	6573	2	5970	5907	5964	6638
3	5900	5838	5884	6290	3	5925	5870	5919	6360
4	5912	5857	5837	6060	4	5938	5892	5871	6128
5	5784	5716	5782		5	5804	5751	5826	
6	5625	5605	5654		6	5655	5637	5696	
7	5707	5555	5600		7	5735	5587	5642	
8	5274	5265	5288		8	5301	5297	5323	

Table 6: Line lengths measured and line lengths references from the glider’s manual

Unadjusted difference between measured data (mm) and reference values (mm): measured_length – reference_length				
	A	B	C	K
1	-22	-31	-43	-72
2	-25	-36	-32	-65
3	-25	-32	-35	-70
4	-26	-35	-34	-68
5	-20	-35	-44	
6	-30	-32	-42	
7	-28	-32	-42	
8	-27	-32	-35	

Table 7: Differences between line lengths measured and line lengths references from the glider’s manual

For this example, the following offset calculations can be conducted:

- A correction offset value of up to +/- 1.5 % of the maximum total line length can be chosen
- The maximum total line length in the manual is 7002 mm
- The correction offset value shall therefore be between -105 mm and +105 mm
- For the example, the correction offset value is chosen to be correction_offset = +38 mm

Difference Δ as defined in the instructions with correction_offset = -38 mm $\Delta = \text{measured_length} + \text{correction_offset} - \text{reference_length}$				
	A	B	C	K
1	16	7	-5	-34
2	13	2	6	-27
3	13	6	3	-32
4	12	3	4	-30
5	18	3	-6	
6	8	6	-4	
7	10	6	-4	
8	11	6	3	

Table 8: Difference Δ after application of correction offset value

For this example, the following can be concluded:

- A1, A2, A3, A5 are not within the range [-12 mm, +12 mm]
- K1, K2, K3, K4 are not within the range [0 mm, + 50 mm]
- Therefore, these lines need some adjustments

7.2 Appendix B: Line length modification options

Line lengths should be adjusted with length modification options selected from the list in this appendix. Other modifications not described in this appendix or by the manufacturer are not recommended. This list of modifications also applies to lines used in or as risers.



Figure 12: No adjustment



Figure 13: One loop



Figure 14: Lark's foot (lark's head)



Figure 15: Turns around



Figure 16: Lark's foot + loop

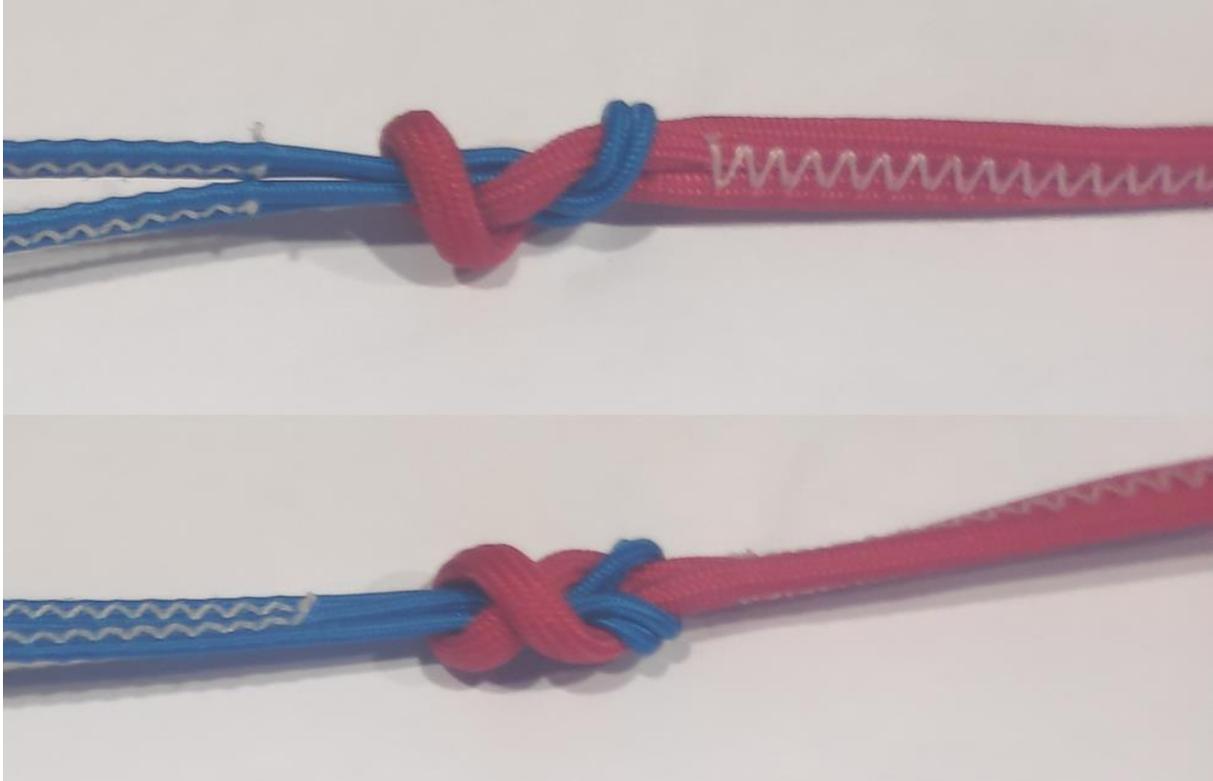


Figure 17: Cascade on lowers