Tethered flight

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This Appendix describes the approach and limitations for the performance of tethered flights with Schroeder fire balloons hot air balloons and the corresponding equipment.

1. General information

The information of this Appendix replace the specification from the Theo Schroeder fire balloons flight manual in case of discrepancies for tethered operation as described in the following paragraphs.

2. Limitation

The tethering equipment must be original Schroeder fire balloons equipment and this Appendix is only applicable to complete Schroeder hot air balloon systems. That means that envelope, basket, burner and burner frame must comply with Schroeder specimen and the balloon equipment must be combined as prescribed.

The described procedure must be adhered; inadmissible deviations can cause severe damages or injuries.

- All parts must be airworthy and visually checked before each first flight.
- Maximum envelope volume is 7000 m^3 (ca. 247.000 ft^3)
- Maximum wind speed for tethered flights:
  Envelopes with volumes below 7000 m^3: $v_W \leq 8$ knots, measured in the basket
  Envelopes with a volume of 7000 m^3: $v_W \leq 5$ knots, measured in the basket
- Maximum ascending speed: $v_S \leq 1$ m/s (ca. 200 ft/min)
- Maximum height from ground to bottom of basket: $h \leq 30$ m (ca.100 ft)
- The takeoff mass must not exceed 75% of the maximum weight (MTOW) specified in the data matrix of the Schroeder fire balloons flight manual (See also Example in Paragraph 11)
- Karabiners must only be used lengthwise during tethered flights.
- Only figure of eight knots must be used for tying the tethering ropes to the anchor. All knots not used for the actual tethering must be unknotted!

3. Tethering equipment

The equipment for tethered flights consists of the following parts:

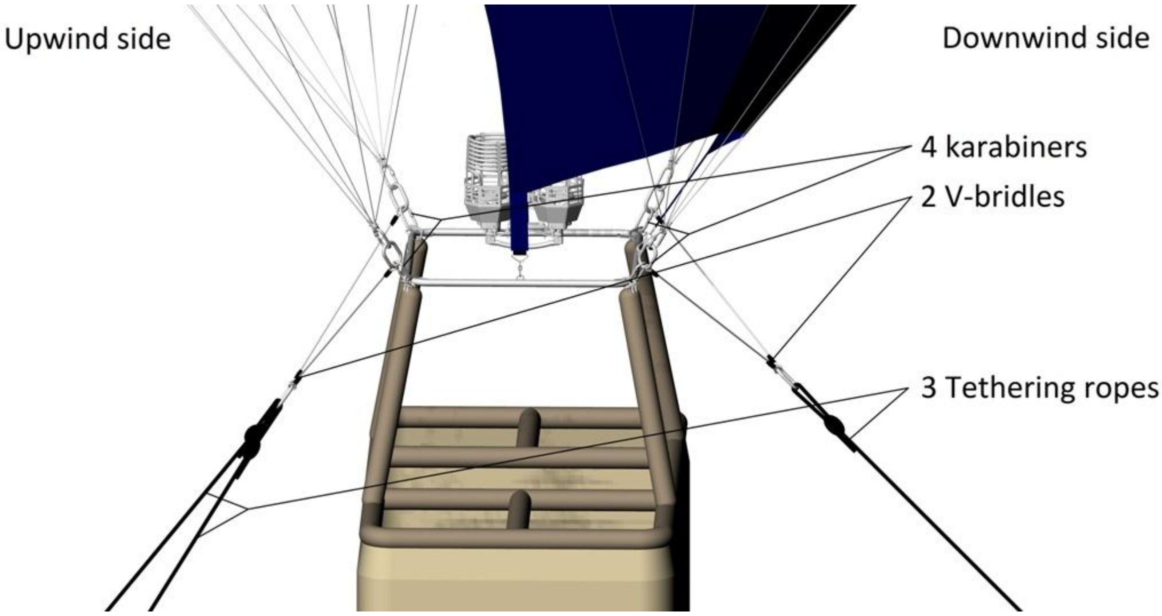
- 2 V-bridles with forged rings on every of the three ends
- 4 additional 4000 daN screw lock karabiners
- 3 tethering ropes of 50 m length (164 ft)
- 3 scoop extensions

The parts are shown in picture 1.

Optional:

- Pulling damper to reduce the load peaks
- Weak link with bypass

Only genuine Schroeder fire balloons equipment must be used.



Picture 1: Parts for the tethering system

4. Tethering site

The tethering site must be relatively even with plenty of space to hot inflate the balloon and spread out the tethering ropes.

The distance to tall, downwind obstacles must be high enough to be able to make a safe free flight in case of failure of the tethering equipment. Distances to lager or dangerous obstacles as power lines, wind wheels, buildings, masts etc. in all other directions should also be kept high to assure that a safe free flight and landing can be ensured in case of turning winds and failure of the tethering system.

The distance to obstructions is to choose as if there was a regular start at maximum wind speed to be performed on the site.

Furthermore must be taken care that all spectators and flight guests can´t be endangered in any way by the tethering system of the ascending or descending balloon or the balloon itself. Proper barriers must be installed to keep the all present persons away as far as necessary from the tethering site.

5. Ground anchor points

Each of the three tethering ropes must withstand a drag force as high as the MTOM of the actual balloon plus 800 kg.

6. Preliminary arrangements

Before getting started the latest local weather forecast and the actual weather conditions must be requested and checked for suitability. A hand held anemometer can be used for example. With an oncoming storm, thunderstorm, cold front, high gustiness or switching wind directions and conditions, all tethered flights must be cancelled. Only steady and stable weather conditions should be chosen. Rain during tethered flight has a destructive effect to the fabric and should be avoided.

The tethering equipment must be subject to a visual inspection for defects and damages after specific occurrences and before every installation prior to the start. Damaged equipment must be replaced before inflating the balloon.

7. Emergency procedures

If a failure to the tethering system during flight should occur, parts of the envelope fail or damages appear, a safe landing must be initiated immediately. The envelope is to deflate as quickly as possible to minimize further damages. Damaged parts must be replaced by original spare parts.

A prompt and safe landing must be conducted if there is a sudden change of wind direction. After the landing the weather conditions must be checked again. If the weather condition allows further tethered starts, the site must be reevaluated for tethered flights with the actual direction of the wind. If the site allows further tethering operation with the new wind conditions, the tethering system with the ground anchor points must be adjusted to the new situation. For the adjustment, the envelope needs to be deflated in the downwind direction.

If the balloon releases from the tethering, a safe landing on another landing site is to be pursued. For this it is important to have enough gas reserves on board.

8. Tethered operation

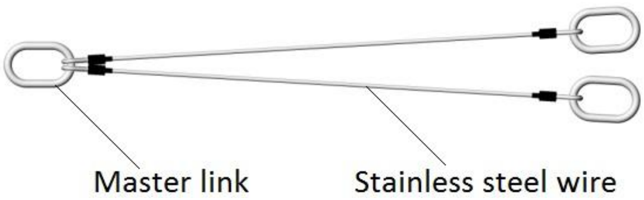
In order to get a stable tethering system for tethered flights, a flat “tripod” is the best arrangement for the tethering ropes.

The quick release of the basket must **not** be used to attach tethering ropes for tethered flights.

The direction and the speed of the wind must be observed and measured in the basket at all times during tethered flight.

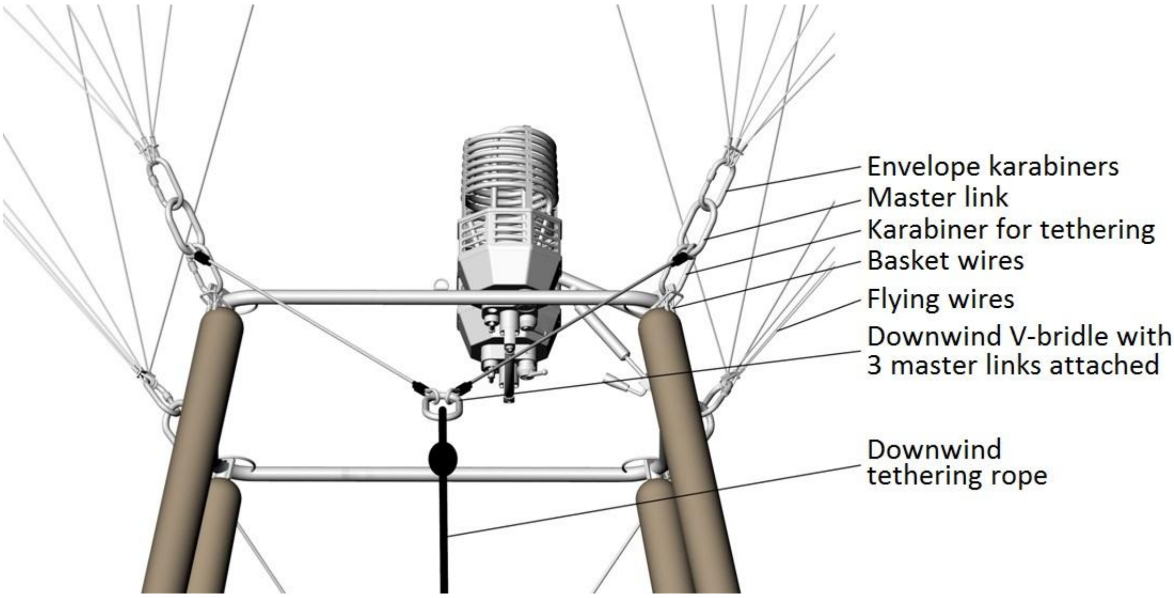
<u>Setup:</u>

The tethering ropes are attached to the two V-bridles which are integrated in the suspension system of the balloon.



Picture 2: V-bridle

Each V-bridle consists of 3 zinc coated master links, 2 stainless steel wires and 2 zinc coated 4000 daN karabiners. On the loose ends of the wires there is a master link attached by a thimble. The other wire ends are brought together to the third master link where they are connected to the V-formed bridle also by a thimble (picture 2).



Picture 3: Downwind assembly

To this master link there are two 50 m long ropes attached for tethering on the upwind side and the second V-bridle is equipped with one tethering rope on the downwind side.

The two V-bridles are fitted between the burner frame and the envelope. One V-bridle must be installed in the upwind and one in the downwind direction. The two master links on the upper end of the V-bridle are connected to the left and right handed envelope karabiners on the burner frame. The four ancillary karabiners to the tethering equipment are used to connect the envelope to the master links of the two V-bridles.

Upwindside:

The two tethering ropes must be tautened in the direction of the anchor points and then tied to the anchor. The ropes should be tied with the same lengths between the anchor point and the balloon. The angle between the two on the ground lying tethering ropes should be approximately 90°. The direction of the wind must be the angle bisecting line.

Downwind side:

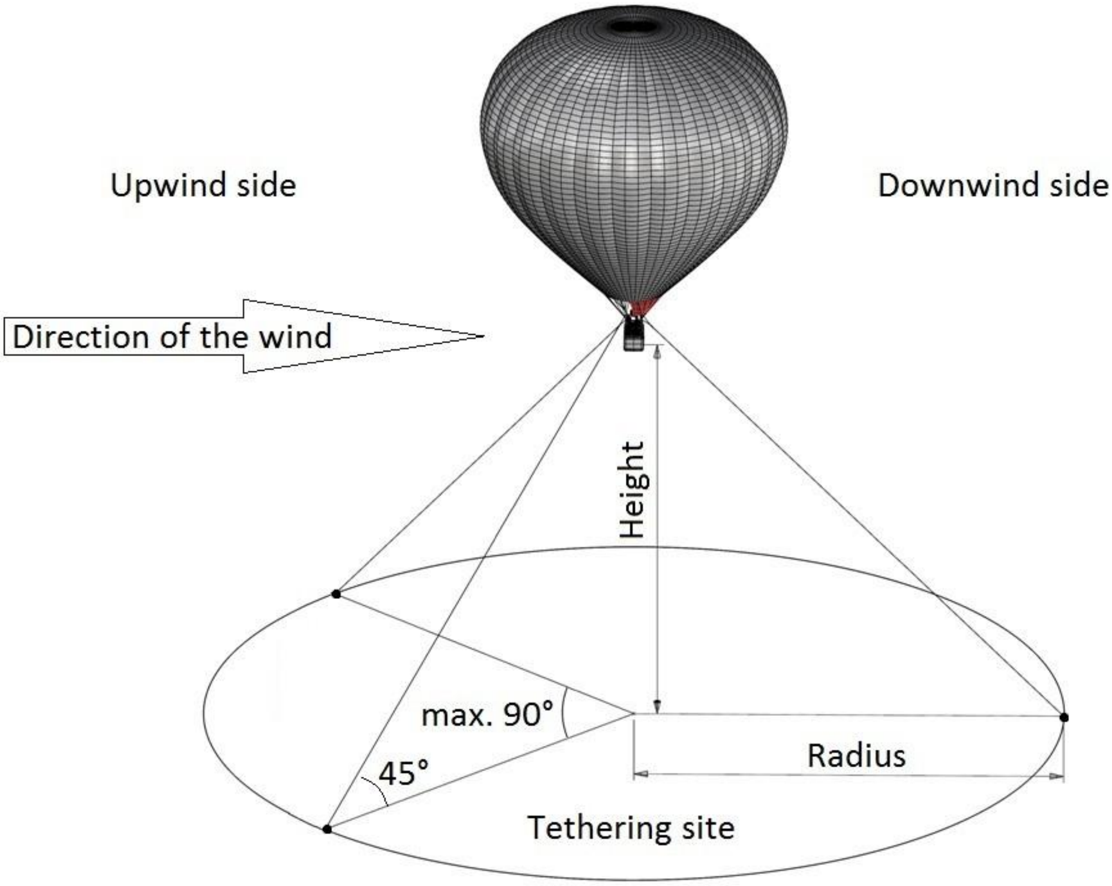
There is only one tethering rope on the downwind side attached to the tip of the V-bridle. The downwind tethering rope must be laid out in the direction of the wind. It can be tied to a movable anchor point in order to possibly vary the height of the balloon.

The envelope can now be pulled out the sack for inflation.

<u>Start:</u>

The Takeoff mass of the balloon, related to the height of the tethering site and the outer temperature must not exceed 75% of the maximum weight (MTOM) of the corresponding envelope size specified in the Schroeder fire balloons flight manual data matrix.

The rate of climb must not be faster than 1 m/s (200 ft/min). The ropes must be observed during the ascent. The balloon must be maneuvered into the upper position very slowly in order to prevent shocks to the tethering system and the balloon. The final position is reached when the ropes almost describe a straight line. The balloon must be held in a floating manner until the landing procedure is initialized. The envelope temperature in the final position must not be increased in order to keep the loads to the tethering system and the balloon as low as possible. There should not be anybody near the tethering system during flight.



Picture 4: Tethering the balloon

9. Maintenance and tendance

The equipment must be visually checked after the last flight in order to identify damaged material. Wet or moist equipment must be dried immediately after use. Dirt can be rinsed or wiped off using clear water. The Equipment must be stored dry and must be protected by excessive heat and sunlight.

10. Additional equipment

A weak link with a bypass can be installed to the tip of the upwind V-bridle. This weak link shows the pilot by failure early enough that there is an imminent load to be expected that might damage the balloon and the equipment. The pilot can initiate the landing procedure before overstressing the equipment.
Furthermore pulling dampers can be installed to the upwind tethering ropes in order to decrease load peaks.

11. Example

Envelope size:	4250 m³;
Temperature:	15°C;
Height of the site:	0 m (MSL)
Empty weight of the balloon:	350 kg
Maximum takeoff mass$_{4250m^3}$:	1340 kg (MTOM)

For tethered flight there is a takeoff mass limit of 75% of the maximum takeoff mass usable for the balloon, as described in Paragraph 2. The data matrix of the flight manual shows for a 4250 m³ envelope a maximum mass of 1340 kg. The allowed 75% of the Maximum takeoff mass for tethered flights can be calculated as follows:

$MTOM_{Tethered\ flight}$ = MTOM * 75% = 1340 kg * 75% = 1005 kg

The 1005 kg as the maximum takeoff mass for tethered flights with 4250 m³ envelopes must not be exceeded.
Furthermore the tethered flight must comply with the limitations of the envelope. A load calculation for the balloon with the actual condition, temperature and height must be conducted.
The load chart of the Schroeder fire balloons flight manual shows a takeoff mass of 1185 kg for the above described conditions (T=15°C; h=MSL). Due to the 75% MTOM limitation for tethered flights this laod capacity of 1185 kg cannot be used. The 1185 kg exceed the 1005 kg. 1005 kg would be the takeoff mass (TOM) for this case. The empty mass of the balloon must be subtracted from this takeoff mass in order to gain the useable payload.

$Payload_{Tethering} = TOM_{Tethering} - m_{empty\ balloon}$ = 1005 kg – 350 kg = 655 kg

The payload for this tethering start adds up to 655 kg.

This payload can be used for the pilot, gas cylinders, passengers and further equipment like the tethering equipment which varies depending on the chosen options.

For this example empty mass, starting height and temperature are chosen close to the real values. These values must be exchanged by the actual values of the tethering operation.