FAI CIMP
Ballooning and Human Factors

Introduction
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**Balloon Pilot** since 24 years, born in Berlin, retired **Engineer. DFSV. Instructor, BFU (Accident Investigation), HP&L Work-Group, Examiner, Safety Administrator**, Trains the Trainers and the Instructors, ………….
Human Factors, Stresses in Ballooning

1. Technical details of balloons and its operational procedures and associated problems.

2. Physiological / psychological demands in Ballooning.

3. Accident causes in Balloon Operations.
All kinds of Balloons

Special Shapes!
Hot Air Balloon: Technical Details:

Ex.: Balloon, 4 People

+Balloon Volume: 3400m³ (Containment of ~100 Fuel-Trucks)

+About 28m (9 story building) high - Diameter 19m

+Envelope ~ 1300m² (> Sails of a big Sailing Ship)

+Envelope Weight: ~ 120kg (without advertisement)

+Upper Outlet about 5m Diameter
Upper outlet:

- can be opened or closed anytime
- to control the lift
- to be able to sink or to start climbing again.
Two independent burners:
(each ~ 4000 hp)

- Each burner is supported by two Gas Bottles (Propane), each 20-30 kg.

- Passenger compartment:
  - a Basket, with it´s high flexibility.
Combined Instruments:
- Altitude
- Vertical Velocity Indicator (VVI) and a
- Temperature Gauge (balloon temperature!)

An Aviation **Radio** is a minimal setup.
If needed a **Transponder** is used.
There are Baskets up to 30 People
Before Hot Air is used:
Filling starts with "Cold Air" by an inflator fan
Heating up the Air with the “Burner“.
Gas-Balloons with and without a net.
Balloon Specialities

• **Hold the Altitude** = Loss of Heat, Compensation through Heating Up!
  (Initiate the Burner for 3 sec, every 20 – 30 sec)

• No Wind to experience in the Balloon, as it travels with the speed of the wind.

• **Slow Reaction**: First effect after heating up after about ~ 8 sec

• Basically **NO G-Forces**, no ‘Air-Holes‘
The Balloon is the most sensible AC

- The **ONLY steering inputs** possible is by **changing the altitude**!
  Because: The wind has as a rule another direction in different altitudes.

- The only Steering Option is **taken away**, if **Updrafts and Thermals** are present.

- Therefore Ballooning **ONLY** takes place about
  - **2 ½ hours before SUNRISE**
  - respectivly **2 hours before SUNSET**

- The **Landing Place** is basically **not known**!
Masses of a Balloon:
Basket, Burners, Envelope, 4 Gas-Bottles, Equipment, 4 People ~750 Kg
3400 m³ Air ~ 3400 Kg

Masses on the Move > 4 t
Electrical Mast with 110 kV Wires.

The Balloon is not easy to decelerate! You land WITH the Wind-Speed!
Big Ballon – Big Car …..
Hot AIR-Balloon Operation:

Limitations:

- Temperatures in Balloon: 110°C – 130°C (individual makes)
- Wind Speed on Ground: < 12 kt / 20 km/h
- Masses (Minimum Weight required)

Other Ops Issues:

- **NO** Altitude Limitations and Restrictions!
- The Basket is always “below“ (**NO** Acrobatics!)
- There is **NO** “Front“ or “Rear“
- Basically **NO** SEATS, **NO** Safety Belts (only in exception)
- Practically **NO** technical Failures or Accidents.
Physiological / Psychological Demands

Ballooning

Physiological Aspects:

- A typical Hot Air-Balloon Ride
  - around 500m GND
  - seldom longer than 2 hours

- Not enough time for big physiological changes

- Pilot in a “Standing Position“ in Open Space

- NO Cabin: Heat / Cold, Noise of Burner, Exhaust Fumes / Residuals (but no wind!)
Gas-Ballooning lasts much longer!

In Competitions (up to 4 days) 2 Pilots ride in a 1,2 m² Basket with seating and sleeping options.
-Typical TIME Shedule in Summer- for Ballooning!-

21:30 SS after Landing
Balloon Logistics, Drive Back, short Landing Party, Documentation, Filling of Gas bottles

0:00 - go to Sleep!

3:30 Get Up, Weather Briefing and Considerations/ Decision, inform Crew and Passengers (Wake them Up!), Shower (or not), Breakfast (or not), Navigational-Preparation, Prepare TO-Field, Loading of Equipment, Trailer, get Crew and Passengers from home, Drive to the TO Place, Crew Briefing, Get Balloon ready for Ride

5:30 SR Take Off
-Only 3:30 h Sleep, (what about the Alcohol?)
-Max. 7h from Landing Party to next Take Off!
ALTITUDE:
It is possible to get up to very high altitudes.
-Oxygen is Required!

HEARING PROBLEMS:
-The Burner Noises are relatively loud!
-The Inflator fan for filling the Balloon with cold Air.
-HEARING PROTECTION required (No Headsets!)

VISION:
Only at low altitude ground-details can be seen.
For LANDING you have to see details (fences, wires)
Eye Glasses have to be perfect! –
The near vision has to be in the upper part,
-distant vision in lower part of the glasses!
Vision Problems. Looking Up or Down!
The view **upwards** is covered by the envelope. Riding in a PULK: Must be achieved by looking **downwards**, “actively running“!
No typical Aviation Problems:

**Pilot:**

NO optical illusions on runways,
NO Flicker-Vertigo,
NO Accelerations (G-Forces),
NO Vertigo

etc.

**Passengers:**

Seldom occurring

Fears, Altitude Fears (Acrophobia), Hyperventilation, Vertigo

Alcohol, Drugs, Smoking
Hard Physical Work after Landing!
Psychological Factors:
Permanent Decision Making

For Example:

**Searching for a Landing Site**: Vegetation, Obstacles, Fences, Electrical Wires, Orographia, Wind near ground, Animals / Horses / Birds (!), Sheds, Options for Transport, sudden direction changes, …..

**Psychological Pressures from the outside**: Expectations from Sponsors, Companies, paying Passengers, ….

**Selfinduced Pressure in Competitions / Flight**: when others start preparing for Take Off (Fan On-Syndrome).

**Economical Problems** if a Ride gets cancelled

**Peer Pressure**, unexpected critical **Weather Changes**

**Time Pressures**, i.e. Updrafts begin early!
Accidents in ballooning:

• Lack of Standard Operational Procedures (SOP)
• Lack of good Training Books!
• Chain of Failures lead to Accidents
• Most accident happen on landing, approach to land!
• There is no definite position for passengers in the basket during landing.
• Collision with equipment and people.

Fast Landings: -- Main Injuries: Leg and Feet-Fractures!
Reasons for Injuries

- Interaktion mit Pax: 32%
- Interaktion mit Gaszylinder: 15%
- Interaktion mit Ausrüstung: 8%
- Interaktion mit Korb: 6%
- Umknicken: 17%
- Haltung: 22%
Reasons for Injuries

- Upright Position: 22%
- Bent Joints: 17%
- Interaction with Basket: 6%
- Interaction with Gas Equipm.: 15%
- Interaction with other Equipm.: 8%
- Interaction with Passengers: 33%
Distribution Heavy Injuries of Passengers

- (2x) double as high as light green area
- 4 x as high as light green area
- 6-bis 8 x as high as light green area
Other Accidents:
Man over Board: often the pilot himself
Late identification of obstructed sites

Landing Accidents:
• bad single decision
• wrong decision chain
• deficient preparation
• any pressure
• pendulum after touch down
• fast landings are demanding /cannot be trained!
Other:

• Dealing with hot and cold parts
• Burning flame Propane 1200-1600°C
• Propane Fire
• Liquid Propane (-42°C) in free Atmosphere, or on skin
• Inadequate Emergency Procedures

(at least we cannot forget “our under-carriage“!)
Small Balloon -- Small Car.
Conclusion:

Only a few Accidents through technical defects!

>>> Human Factors!

No Accidents through Medical Problems.

Chain of failures:

- Wrong Decision-Making (WEATHER)
- Education, Training Deficits!
- Failing to respond in time,
- False Procedures!
- Deficient exercise!

etc.
Try to understand this better!
Comments?

Questions?