MANUAL

OF

THEORETICAL KNOWLEDGE

&

SAFETY TOPICS

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SUMMARY

WARNING

The safe and sound practice of aerobatics must take into account a number of considerations I.E.:

- Aircraft type (fit for purpose)
- Pilot's skills and knowledge
- Personal fitness (age, health, physical activity, goals)
- Meteorology ceiling, visibility, wind, turbulence, adverse weather.
- Environment: Topography, aerobatic box (overhead or offset, noise abatement issues)
- Type of training (Training camps or random sessions)
- Etc. …

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Adapt briefings, air exercises, execution of manoeuvres
every time when changing aircraft

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Special care should be exercised when changing from a wooden wing to a rigid carbon one; Aircraft controls behaviours, roll rates, stall, spin and gyroscopic manoeuvres characteristics may differ.

THEORETICAL KNOWLEDGE

To be read & understood, before starting aerobatic training & adapted whenever changing aircraft.

A) THE AIRCRAFT

1. STUDY YOUR POH

- Get familiar with the fuel system and tanks transfers, use of wing tanks limitations, fuel capacity and consumption at allowed aerobatic settings.
- Understand the specifics and equipment of an aerobatic certified aircraft.
- Know the maintenance programme of your aircraft (See paragraph C) 2. page 7)
- Exercise extra care during the "pre-flight" inspection: Make sure fuel caps in place and securely locked; Aileron spades or balancing counterweights (if applicable) firmly attached.
- Accurately check flight controls and their attachment points, condition of a/c skin surface.
- Carefully inspect for alteration, wear, cracks, inspect control cables, canopy condition including its hinge attachments.
- Check and figure out the trim indicator lever position and its correspondent deflection on the elevator tab.
- Verify no loose objects inside the cabin (FOD) and that the luggage compartment is empty.
- **Warning** > Check controls free movement not impaired by surfaces locks, pilot/passenger harness straps, cushions, headset cables.
- Mooring of a/c (aircraft) (when not hangered); Brakes, control surfaces locks, canopy cover, pitot and static ports covers, wheel chocks.
- Always drain (all drain points) and check fuel for contamination using a fuel cup to check for water and other contaminants, this, **before moving the aircraft prior to first flight of the day.**

2. FLIGHT EQUIPMENT > Wear a Nomex flying suit (**recommended**), appropriate shoes, gloves, glasses or helmet, hear protection.

3. SETTLING ON BOARD AND RIGGING:

There are additional precautions to consider when boarding and accessing the cabin in an aerobatic a/c:

- How to step on the wing and inside the cabin, where to hang on while sitting.
- Harness: Main and safety straps, correct tightening, (waist/ shoulders), use of ratchet.
- Rigging of passenger or when flying solo securing passenger harness.

- Adjustment and securing of seat(s) and rudder pedals or rudder cables.
- Pilot and passenger briefing: **no loose objects**, pockets empty and closed, cockpit clean (canopy, cabin floor) carrying of throw up bags within reach.
- Brief emergency a/c evacuation both on the ground and in flight.

4. MANDATORY PARACHUTE :

   Wearing and tightening, emergency deployment, speed limitations, life span, periodical servicing, protection from heat and sunrays.

- Study of aircraft parachute (if available) procedure and it's envelope.

5. UNDERSTANDING OF THE AIRCRAFT FLIGHT ENVELOPE AND ITS LIMITATIONS; VA, VNE, VD, Gust loads, relation between speed/ bank angles and pitch rate and G-Loads, specific MTOW and mass & balance limitations in "A" aerobatic category.

- Be aware of the consequences of exceeding aircraft limitations: Structural (cracks, delamination) not always visible, premature wear; Likely consequences on airworthiness restrictions or grounding. Beware of compression and/or torsional loads in case of hard landings on landing gear struts, bearing surfaces (longerons, engine mounts, steel trusses, silent blocks).
- Understand "Flutter" and its consequences, how to get away from it if it's still possible.
- Manage your engine: Beware of risks of excessive RPM's & temperatures, propeller over speeds (especially for fixed prop pitch).

B) PILOTAGE:

1. STUDY OF SECURITY CARDS (See p_16).

2. STUDY OF EMERGENCY PROCEDURES

- Emergency landing using elevator trim (in case of jammed elevator).
- In flight engine restart (know your altitude loss) using starter or with propeller wind milling (in case of unsuccessful electric starter procedure).
- In flight smoke or fire, or on the ground.
- Procedures for emergency evacuation both on the ground and in flight.
- How to deal and report accidental flight envelope overruns and engine over speeds both on the ground and in flight.

3. STUDY OF PHYSIOLOGICAL EFFECTS ON THE HUMAN BODY

Positive, negative, lateral accelerations (G-Loads), extreme pitch and bank angles are responsible for:

- Spatial disorientation
- Nausea (necessity to carry appropriate bags within reach)
- "Black" or "Grey out"
- Loss Of Consciousness due to G's: G-LOC
- Cervical issues… (compression/distension of spine and vertebrae switching from negative to positive G-loads)
  - Prevention and early detection are fundamental (contraction of abdominal muscles, holding breath during manoeuvres, no sharp head movement).
  - Release of stick pressure will alleviate the symptoms.
- Due to several causes like sharp head movements (but not exclusively), big angles between the spine and the head, lot of negative G's (but not only negative), hard training leading to fatigue, dehydration, vertigo or balance issues could appear for some pilots. Interrupt aerobatics immediately while avoiding any G's and more than a few degrees of banking, this is a stressful and dangerous situation. Check for medical documentation of this topic.
- It is of primary concern to maintain consciousness and situational awareness and to remain well strapped in order to keep aircraft under control at all times, so > **this paragraph 3 is VITAL**
- Review those sport activities which are beneficial for aerobatics vs those potentially harmful
- Benefits of maintaining proper physical and psychological fitness, and check the list of medicines, some allowed other banned, and see World Anti-Doping Agency (WADA) documentation.

C) AEROBATICS

1. STUDY OF REGULATION

- Aerobatic box (permanent, temporary).
- Aerobatic box availability during training.

2. MAINTENANCE RELATED ISSUES

- Reporting over G's/ hard landings / over speeds.

3. OPERATING INSIDE THE "AEROBATIC BOX" /AREA

- Lower and upper height limits.
- Maximum distance from the "BOX centre".
- Radio frequency needed (if any).

4. GROUND COACHING REQUIREMENTS (INSTRUCTOR/ COACH)

- Check for appropriate skills, expertise, knowledge, experience, vocabulary, suggestions, instructions.
- For solo flights, the instructor will decide of the programme for this specific flight, and make sure pilot is able to master all emergency situations while not only training for "basic" simulated emergency landings but also during manoeuvres like stall turn and spin (in "flight emergency" > safety exercise: instructor cuts the throttle at the pivot point of stall turn to simulate engine loss, this also during a spin to instil proper recovery reactions).
- In case of black out or G-LOC, several studies show hearing is the first sense which reappear when regaining awareness, so it's fundamental the instructor or coach keep talking to the pilot even if he doesn't react.

5.DANGER OF "CONTEST SPIRIT" AND EMULATION

Pay close attention to your decision-making process and respect of safe altitude, weigh the risks of flying too sharp or "Showing off" when low while your training level is weak, even if you have the temptation after seeing very well-trained pilots doing so.

Don't emulate recklessness, recklessness can be misinterpreted as superior pilot skills while it is no more than bad judgement, recklessness is incompatible with safety.

REMINDER:

This 7 PRIORITIES order must be kept in mind from the beginning of the syllabus to the end:

1/ To fly the correct manoeuvres in the correct order (I.E. > NO zero !).
2/ Be as accurate as possible.
3/ Put the manoeuvres in the correct ground position in the box left/right balance and depth from the judges.
4/ Become slowly sharper on your inputs on elevator and ailerons especially at the stops.
5/ Concentrate the manoeuvres close to the centre of the box.

6/ Manage the head, cross or tail wind, and integrate the perspective I.E. fly high when far and lower when closer, as well as all the slight corrections of positive or negative tendencies or shallow or steep 45° according to the wind. Check and integrate the lateral translation during snaps and get used to the small trajectories "cheating" to move into the box to relocate whenever needed. Learn and use the tricks to keep the flight perspective in place.

7/ While using this philosophy during his progression, the pilot will be able to manage increasing workloads..., which is the main quality of the top-level pilots.

Aerobatics, and especially competition air shows require
extensive sound decision making attitude and good judgement processes.

6. BE AWARE OF DEGRADED PERFORMANCE DUE TO:

- Temperature.
- Density altitude.
- Moisture.
- Turbulences.

7. CLOUDS / HAZE > WHAT TO DO ? SEPARATION FROM CLOUDS.

Bad visibility affecting the horizon with adverse effects on orientation during manoeuvres.

8. ENERGY SPEED AND ALTITUDE MANAGEMENT:

> Altitude is of primary concern

- Practice your manoeuvres with a good safety margin well within the flight envelope limits, know your personal limitations.

9. NEW MANOEUVRES:

> Do not practice without proper qualified assistance

! Even "easy" manoeuvres can play dirty tricks !

TRANNING SYLLABUS

LIST OF ITEMS

Aerobatic Preliminaries

To be studied & rehearsed & adapted to the aerobatic aircraft in use

_ITEM -0PF:

Refresher of aerodynamics… Reviewing of theoretical principles:

- Forces coming into play; straight and level, climbing, descending, turning; Engine torques, effects of controls, (induced roll, adverse yaw and coordination); Stalling symmetric and asymmetric; Stall in the turn, symmetric and asymmetric; Spin upright and inverted, including flat spins, cross over spins, spirals.
- Lift at different configurations; Crosswind landings with tailwheel aircrafts.
- Risk of asymmetrical flight loss of control during base to final turn often with crosswinds compensating drift with either not enough bank or turning too late adding more rudder in the direction to align with runway centreline.

_ITEM -1PF IN FLIGHT:

Tailwheel training (When applicable)

_ITEM -2PF:

Effects of controls: elevator, ailerons, rudder (upright and inverted). Adverse yaw, induced roll.

_ITEM -3PF:

Engine torque and propeller flow effects; Straight and level, in slow flight, in climb 45° and in a vertical.

_ITEM -4PF:

Trimming.

_ITEM -5PF:

- Pitch attitude, upright and inverted at various speeds.
- Acquisition of horizon and attitudes references from engine cowling, canopy arch and/or reference marks set on windshield (KEY POINT 1).
- Engine settings at different pitch attitudes.

_ITEM _6PF:

Increase/decrease of efficiency & increase/decrease of controls pressure forces

- With respects to speed.
- With and without power.

_ITEM -7PF:

Slow flight upright and inverted.

_ITEM -8PF:

- Flight symmetry at various speeds.
- Slips and skids.

_ITEM -9PF:

Spirals.

_ITEM -10PF:

Stall (straight and level) upright and inverted > Angle of attack, lift, drag, stalls, spins

- At minimum speed: *symmetric, *asymmetric.
- Under load (Dynamic): *symmetric, *asymmetric.

_ITEM -11PF:

Slipping and skidding turns and stalls.

_ITEM -12PF:

- Relation between pace and speed.
- Pressure forces on controls at different AOA.

_ITEM -13PF:

- Aircraft positioning on lines (trajectories).
- Elevator centring (neutralizing) to stabilise a/c.

_ITEM -14PF:

Axis and speed acquisition at various speeds, parameters with respects to combination of speeds/altitudes/power settings; Check cabin prior to aerobatics and exert vigilance with constant airspace and radio communications monitoring for conflicting traffic.

_ITEM -15PF:

Simulated forced landings from anywhere and at any time in the box or on the axis.

_ITEM -16PF:

Lazy 8, barrel rolls, unusual attitude extrication including spiral.

NOTA BENE:

- ***Each flight** involves a pre-flight briefing covering the mission, followed by in flight demonstrations with a quick reminder of the KEY POINTS, trials by the student under instructor supervision and critique, then trials by the student with no instructor comment, and an after flight debrief.*
- ***Each briefing** involves theory, demonstration of the manoeuvre with a model, explanation of most common errors, as well as some useful tricks known by the instructor, and on top the safety part with a reminder of all KEY POINTS.*

  Reminder of prominent safety issues (altitude, speeds, G-Loads etc. ...).
- ***All aspects related to manoeuvres involving inverted flight** could be brought about at the beginning of the training at instructor's discretion.*

POSITIVE AEROBATICS

ITEMS LIST

Instructor has to verify and confirm that "A" category weights, mass & balance calculations to be within limits prior to each flight, and to brief student on flight envelope limitations with respects to the manoeuvre(s) involved, as well as to remind to fly with a gentle precise touch control.
The need of more vigorous piloting can be exercised during snaps to impart a crisp AOA (make sure to remain within the envelope) and at manoeuvres stops which have to be sharp without wobble.

_ITEM - 1PA:

Effect of controls in inverted flight, half roll to inverted, and half roll back to upright.

_ITEM – 2PA:

Slow roll L & R.

_ITEM - 3PA:

Loop.

_ITEM - 4PA:

Upright spin L & R.

_ITEM - 5PA:

Hammerhead (stall turn).

_ITEM - 6PA:

Half cuban 8.

_ITEM - 7PA:

Reverse half cuban.

_ITEM - 8PA:

Inverted turns L & R.

_ITEM - 9PA:

Flick (snap) roll L & R.

_ITEM -10PA:

Immelmann (beware of inadvertent flick risk "at the top" during a botched Immelmann).

_ITEM -11PA:

Various spin entries (Standard / inadvertent; after hammerhead pivot, or during a "step" while reaching the top of it at very slow speed trying to fly straight and level, or while flicking with wrong technique).

_ITEM -12PA:

"Aerobatic" positive spins L & R > 1 turn; $1t^{1/4}$; $1t^{1/2}$; $1t^{3/4}$; 2 turns

- Check differing exit techniques, BEWARE these can differ from POH.

_ITEM -13PA:

Hesitation 4 points roll > use of rudder.

_ITEM -14PA:

Flat upright spin > adverse and dangerous effects from engine RPM's and ailerons incorrect positions.

_ITEM -15PA:

- Nose down, positive spin.
- Spin transitioning into a spiral.

_ITEM -16PA:

- Roll inverted entry.
- Roll inverted exit.
- Roll sequencing L & R.

_ITEM -17PA:

Inverted spin L & R.

NOTA BENE

- *After reaching a satisfactory proficiency level, start a sequence of manoeuvres alternating both right and left rolls and flicks, constantly monitoring minimum safe altitude and training area/aerobatic box volume parameters.*
- *Instructor must insist on strict compliance to flight envelope limitations, constant monitoring of entry and exit speeds, engine RPM's, G-Loads and judging criteria.*

INVERTED AEROBATICS

ITEMS LIST

Instructor has to verify and confirm that "A" category weights, mass & balance calculations to be within limits prior to each flight, and to brief student on flight envelope limitations with respects to the manoeuvre(s) involved, as well as to remind the student to fly with a gentle precise touch control.

_ITEM - 1iA:

2; 4; 8 hesitation rolls L & R.

_ITEM - 2iA:

"Competition" positive flicks on different lines L & R.

_ITEM - 3iA:

Avalanche.

_ITEM - 4iA::

Vertical rolls (upline) L & R.

_ITEM - 5iA:

Stall turn "Hammerhead" negative exit.

_ITEM - 6iA:

Half inverted loop starting from the top (pushover).

_ITEM - 7iA:

Inverted loop

_ITEM - 8iA:

Pulled/pushed humpty bump.

_ITEM - 9iA:

Inverted half cuban 8.

_ITEM -10iA:

Inverted reverse cuban 8.

_ITEM -11iA:

Downline vertical rolls L & R (after hammerhead) pulled/pushed exits.

_ITEM -12iA:

Hammerhead started from inverted.

_ITEM -13iA:

Rolling turns (inside & outside) L & R.

_ITEM -14iA:

Negative flick L & R.

_ITEM -15iA:

Tailslides: positive & negative (if within a/c capabilities).

_ITEM -16iA:

- "Aerobatic" inverted spin L & R.
- Cross over spins: positive spin from inverted, negative spin from upright (NO longer FAI approved).

_ITEM -17iA:

Inverted flat spin (if within a/c capabilities).

NOTA BENE

- *After reaching a satisfactory proficiency level, start a sequence of manoeuvres alternating both right and left rolls and snaps (flicks), constantly monitoring minimum safe altitude and training area/aerobatic box volume parameters*
- *Instructor must stress on strict compliance to flight envelope limitations, monitoring entry and exit speeds, engine RPM's,* G-Loads *and judging* criteria.

IMPORTANT SAFETY ISSUES

3 points should always be kept in mind
all along the pilot progression and career.

- 2 refer to "KEY POINTS" safety gates and the last one refers to the safe code of conduct in case of any deviation from these 2 KEY POINTS during a manoeuvre.

HISTORY OF THOSE 3 POINTS:

There have been cases in aerobatic/air-show accidents where either pilot didn't remember those KEY POINTS or may be failed to check them or while checked them failed to abort the manoeuvre when at risk, and/or being over stressed/mentally impaired (MENTAL FREEZING ATTITUDE) to name a few.

Aerobatics and air-shows involve some elements of risk, common to all high-performance motor sports. Stick adherence to those 2 KEY POINTS, and energy gates parameters will reduce drastically those risks at the origin of several accidents.

TWO KEY POINTS

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THE FREEZING MENTAL ATTITUDE

KEY POINT 1

STRAIGHT AND LEVEL MANOEUVRES

- **Position of the horizon** in relation to engine cowlings, canopy arch (in inverted flight, Cap10), adhesive stripes (pitch references) on windshield:

There is a safety risk involved whenever these references fall below the horizon at rather high speed, while the slower the speed will be, the higher those references must be above the horizon (higher AOA means higher attitude).

The most important is:

1 ___ > To visualize and make good use of these references.

2 ___ > To take immediate corrective action.

3 ___ > Measures or recover without delay whenever any deviation from the intended path is detected.

KEY POINT 2

VERTICAL LINES

- **Constant monitoring** of speeds/heights parameters at the top in order to decide whether it is safe to complete or abort the manoeuvre.

For higher performances aircrafts, these KEY POINTS must be checked also while passing the vertical up and down attitudes

- "Energy" states available at the top are correlated to heights/speeds/power/elevator forces parameters set at the start of manoeuvres (at the bottom).

Every pilot/competitor operating a high-performance aircraft in a confined area (aerobatic box) is responsible to know and respect these parameters and constantly monitor them during the flight.

- **If those KEY POINTS are not met, then the pilot must immediately abort the manoeuvre applying the proper rehearsed emergency procedures !**

THE FREEZING MENTAL ATTITUDE

Decision making process when outside the above "key points parameters": Pay attention of the risk of "FREEZING MENTAL ATTITUDE" severely handicapping pilot's performance and judgement.

A common reaction during high stress scenarios in highly dynamic situations affecting aerobatic pilots are the risk involved with completing the manoeuvre with "KEY POINTS" outside safety margins.
Pressure to complete the manoeuvre (like following strictly judging criterias) may override common sense

- **It is vital to abort !**

Likewise, the instructor or coach must not only brief the pilot on the risks involved but also call for an immediate interruption in case of any deviations whenever he is either flying with or monitoring the flight.

The level of stress will be higher, further compromising judgement the closer the pilot is to the ground; And the risks of an accident raise exponentially

- **It is vital to avoid this "FREEZING MENTAL ATTITUDE" !**

To make a short résumé:

- Know the KEY POINTS and unfailingly observe them, for each manoeuvre and for each aircraft type you fly.
- Do not deviate from them - exceed or fail to reach - (according to the context) being vigilant upstream.
- Be able to instantly recognize any deviations.
- Know the safety procedure to abort the manoeuvre and use it in an emergency.
- Maintain constant awareness accounting for risks such as mental impairment, overload **and stress** due to lack of experience, low level of competence, low altitude, air shows, competitions.

In the next paragraphs, every time you read this:

KEY POINTS: .....

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- *Make sure you fill the dotted lines below with your aerobatic instructor so as a reminder to keep a constant attention to this vital safety aspect, this applies to the Aerobatic FI's as well.*

LIST OF COMMON ERRORS

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THEIR CONSEQUENCES

Please note that you can find several inflight demonstrations of common errors (from basic manoeuvres to unlimited and freestyle manoeuvres) in the "sub videos" of Academy of Aerobatics Apps (www.facebook.com/academyofaerobatics and/or http://academy-of-aerobatics.com/)

A) POSITIVE AEROBATICS

Closely monitor airspace prior to engage in any every manoeuvre or series of manoeuvres Pay also attention to the risk of grey/black out/ G-LOC in case of uncontrolled speed increase to the **risk of grey/black out/ G-LOC**, increase of elevator or other controls pressure forces, overspeed and G's overload.

SPIRAL:

- Likelihood of substantial and rapid **altitude loss**, with possible **overspeed**, exceeding G-Loads and RPM's and increase of elevator or other **controls pressure forces.**

ROLLING TO INVERTED / FROM INVERTED TO UPRIGHT:

- Expect altitude loss **if inverted attitude too shallow** due to wrong nose attitude acquisition and/or insufficient forward stick pressure.
- Pay close attention not to exceed VA during ailerons full deflections.

KEY POINTS: .....

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SLOW ROLL L & R

- Warnings for rolling to inverted apply.
- **Spatial disorientation** if fast roll rate or bad horizon/visibility.

KEY POINTS: .....

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INSIDE OR POSITIVE LOOP

- G-Loads overstress possible at the beginning/end of manoeuvre under load (turbulence impact and entering own shear path during pull-out).
- Potential **symmetrical and asymmetrical** stalling in case of high pitch rate, whatever the speed and nose attitude.
- Exceeding RPM /overspeed likely and altitude loss **if not sustained in pitch** at recovery.

KEY POINTS: .....

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POSITIVE SPIN:

- Incorrect pitch attitude control and altitude control at the start.
- Insufficient monitoring of **airspace beneath**, collision risk involving other traffic. a/c response insufficient or simply unavailable for collision avoidance prior or during the manoeuvre.
- **Weight and balance** outside limits with risk of delayed or impossible recovery.
- Unclear determination of **spin direction** of rotation due to disorientation.
- Inability to determine **flight controls position** during the spin itself and/or during the recovery
- Urge to modify flight controls positions **due to impatience** with unexpected consequences at recovery.
- **Wrong unconscious** ailerons inputs flattening the spin, inappropriate pitch inputs leading to excessive nose down attitude or spiral.
- Failure to throttle back to idle, aggravating spin behaviour, risk of flat spin.
- **Secondary spin** in opposite direction when at recovery opposite rudder is held, at pull-out.
- Undetected transition into a spiral can happen if elevator and rudder are not held firmly against their full stops.
- Inability to count **number of turns** leading to increased height loss.
- Engine quitting if idle set at **too low RPM > Abort and immediately apply "engine off" recovery procedure.**

KEY POINTS: .....

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HAMMERHEAD / STALL TURN

- Pull up at entry/exit under load: same warnings for LOOP apply.
- Absence of altitude check during the pivot.
- **Flat positive spin** entry if after the pivot with stick positioned aft (by mistake), full rudder and opposite aileron still in place (aggravated with full power).

- **Negative spin** entry after the pivot with too much forward stick, full rudder and opposite aileron still in place.
- **Tail slide** if wing on pivot side too high during ascending line.

KEY POINTS: .....

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HALF CUBAN 8

- Pull at completion of manoeuvre: (warnings for LOOP apply).
- Inappropriate and unsterilized 45° down line, with **unsustain nose attitude**, generating increase of G-Loads, overspeed and altitude loss.

KEY POINTS: .....

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REVERSE HALF CUBAN 8

- **Setting and holding a proper 45°** climb attitude as well as appropriate entry speed is important before starting the half roll to inverted.
- **Too high a speed** either at entry or on the top of the figure will lead to dangerous speeds, G-Loads and RPM values in the descending part of the manoeuvre.
- Substantial altitude loss.
- Risk of **negative stall** when too much forward stick applied to keep the ascending line after the half roll.

KEY POINTS: .....

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INVERTED TURN

- Altitude loss and inverted spiral are likely to occur **if proper inverted attitude** is not maintained during the whole turn; Increased banking requires **to increase pushing** to compensate for loss of lift, just like in an upright turn.
- If nose is getting lower than horizon > **Immediately apply emergency recovery procedure** and mind the grey/black out/ G-LOC after the rotation during the pull.

KEY POINTS: .....

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POSITIVE FLICK

- Monitoring **safe entry speed** is essential.
- Altitude loss, spin or spiral if aft stick pressure is **kept at full deflection**.
- **Risk of tumble** if too much forward stick is applied while unloading.
- Since the flick rate is high with several G-Loads involved, spatial disorientation is possible leading to difficult accurate stop.

KEY POINTS: .....

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ROLL OVER THE TOP OR IMMELMANN

- **Stalling** at the top of the half loop whenever too much aft stick is kept while speed too low before the half roll.
- **Possible flick** during or after half roll over the top with aileron and rudder in the same direction, combined with aft stick to maintain trajectory at low speed at completion of manoeuvre.
- Possible spin entry if flick is not stopped immediately.
- In case the pilot will use right rudder (to counteract the adverse yaw) and left aileron, risk of **negative snap** (or spin) especially if the nose is too low and if the pilot pushes a lot on the stick to get the nose higher while still upside down.

KEY POINTS: .....

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POSITIVE SPIN (AEROBATIC SPIN)

- All warnings for POSITIVE SPINS apply.

+ For 1 turn:
  - **Possible inverted spin/flick** entry if at recovery the stick is abruptly pushed forward with opposite rudder and (possibly in spin aileron if the pilot finishes his spin with ailerons).
+ For $1t^{1/4}$:
  - Possible **confusion in yaw** may occur as brisk opposite short rudder action is required followed by a brisk rudder action in the same direction as at the start.

- Asymmetry at exit before or during the pull if the ball is not centred progressively and early on the down line.
- Engine quitting during manoeuvre > **Abort and apply immediately "engine off" recovery procedure.**

KEY POINTS: .....

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4 POINT ROLLS

- Warnings for normal ROLL apply.
- **Monitor VA.**
- **Major altitude loss can occur if nose allowed to descend** at first knife edge STOP leading to low nose at second hesitation STOP when inverted, and possibly even lower during the third hesitation point at knife edge.

KEY POINTS: .....

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UPRIGHT FLAT SPIN

- All warnings for POSITIVE SPINS apply.
- + **Comply with recovery procedures specific to a/c type and model** > I.E.: **Throttle back is required on certain a/c** to get out of spin.
- **Spatial disorientation and FREEZING** at the controls can occur after few turns.
- **Excessive altitude loss** likely due to number of turns and time necessary for recovery.
- During the flat spin increased inertia moments **may delay recovery, be patient**; Resist any rush to modify initial control inputs (provided in compliance with a/c flight manual) keep controls in appropriate position **long enough to reach the desired effects**.
- **Secondary spin** possible whenever the stick is in avertedly kept aft with rudder in opposite direction at recovery.
- If engine at idle: Engine may quit if set at too low RPM's > **Abort and apply immediately "engine off" recovery procedure.**
- **Increased speeds and loads** likely if spin transition into spiral.

KEY POINTS: .....

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ROLL FROM INVERTED, SEQUENCE OF ROLLS:

- All warnings for ROLLS apply.
- Disorientation.
- **Altitude loss if nose allowed to drop** at the start, with possible RPM and speed increase.

KEY POINTS: .....

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INVERTED SPIN:

- Pay attention and **double check harness, including inverted safety belt**, properly fastened and tightened.
- Search for the best spot for **outside reference/best ground vertical view**.
- Make sure to check altitude and pitch attitude at start.
- Passenger presence (tandem) can block side visual.
- Look forward (cowling).
- Look diagonally far aft raising your head as far as it will go.
- Insufficient monitoring of **airspace beneath**, collision risk involving other traffic. a/c response insufficient or simply unavailable for collision avoidance prior or during the manoeuvre.
- **Weight and balance** outside limits with risk of delayed or impossible recovery.
- Unclear determination of **spin direction** of rotation due to disorientation.
- Inability to determine **flight controls position** during the spin itself and/or during the recovery.
- Urge to modify flight controls positions **due to impatience** with unexpected consequences at recovery.
- **Wrong u**nconscious ailerons inputs flattening the spin, inappropriate pitch inputs leading to excessive nose down attitude or spiral.
- Failure to **throttle back to idle**, aggravating spin behaviour, risk of flat spin.
- **Secondary spin** in opposite direction when at recovery opposite rudder is held, at pull-out.
- Undetected transition into a spiral can happen if elevator and rudder are not held firmly against their full stops.
- Inability **to count number of turns** leading to increased height loss.
- Engine quitting if idle set at too low RPM > **Abort and immediately apply "engine off" recovery procedure.**
- **Risk of grey/black out /G-LOC** at the recovery (pull), ease stick pressure and contract abdominal muscles.

KEY POINTS: .....

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NOTA BENE :

↳ *For concatenation of manoeuvres*
Refer to individual warnings

B) INVERTED AEROBATICS

Accurately check for **free airspace** before starting.
Pay also attention to the **risk of grey/black out /G-LOC** when pulling at recovery after a manoeuvre or a series of manoeuvres involving transitions from negative G's to positive.

POSITIVE FLICKS AT DIFFERENT LINES (COMPETITION):

- Previous warnings apply; **Spatial disorientation** likely if flick is too brutal and/or sustained.
- Stop rotation with opposite rudder.
- For ½; 1½; 1¼ use fast opposite rudder for the stop and immediately rudder in the same direction as for the entry.
- Be aware **speed increase** during descending flicks.
- **Transition into a "ruade" negative tumble** if stick brought too much forward during the manoeuvre on certain a/c.
- Transition into a "ruade" if at the stop of half positive snap the stick is pushed too sharply and too far forward.

KEY POINTS: .....

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AVALANCHE:

- Same warnings as for LOOP apply.

+ Same warning as for flicks, I.E. > Possible spin entry or spiral.

KEY POINTS: .....

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VERTICAL UPLINE ROTATIONS:

- Loop section: see LOOP - Monitor VA at the beginning of rotations.

KEY POINTS: .....

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STALL TURN (HAMMERHEAD) WITH INVERTED RECOVERY:

- Verify lap straps harnesses are properly **tightened** including safety one.
- Monitor free airspace, check **speed prior to push, beware of stall** at recovery if stick brought brutally forward at push.

- **Overspeed, over G and RPM** (fixed pitch prop) can occur if push at the bottom not timed properly.

+ *NB: Review your a/c flight envelope, bear in mind the* ***relation between speed and G increase.***

- **Major altitude loss** when compared to positive exit due to increased radius at the push (since likely less negative G's compared to positive G's during a positive exit).
- Keep a **safety margin** in terms of **G-Loads** to account for possible shear turbulence at recovery.
- Expect **increased efforts in pitch** as well as increase G-Loads for the same position of flight controls due to IAS increase.

KEY POINTS: .....

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PUSH OVER THE TOP:

- STALL TURN WITH INVERTED EXIT WARNING apply.
- **Risk of increased IAS, G-Loads,** RPM's if first quarter loop is incorrectly timed/executed.
- **Expect increased altitude and energy** loss likely even if manoeuvre is properly executed.

KEY POINTS: .....

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OUTSIDE (UPWARD) LOOP STARTING FROM INVERTED:

- Same warnings as for two previous manoeuvres apply.
- Exercise proper **airspace monitoring** at all times.
- Be aware of G-Loads increasing at the start of push, then diminishing passing 60°. Then increasing again while nose going below the horizon, and same apply for stick forces.
- Account for **substantial height and energy loss**.

KEY POINTS: .....

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INVERTED PULLED HUMPTY BUMP:

- Same warnings as for VERTICAL ROLLS apply.
- **Risk of stall / gentle low energy flick** at the top, if elevator pulled too briskly.

+ Botched tailslide (hold stick firmly, risk of damage to elevator and or rudder).

KEY POINTS: .....

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INVERTED PUSHED HUMPTY BUMP

- Same warnings as for VERTICAL ROLLS apply.
- During a vertical roll, at the push over the top full deflection of rudder may be required to counter gyroscopic forces thus preventing nose veering **and rolling**.
- Incorrect timing at the top may provoke a tailslide (be ready to hold stick and rudder firmly to avoid elevator/rudder damage).

KEY POINTS: .....

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INVERTED HALF CUBAN 8:

- Unless the 45° inverted downline is properly executed and maintained, expect **possible pitch increase** leading to overspeed, increase of RPM's (fixed pitch prop) and G-Loads and stick forces.
- Expect important altitude loss.

KEY POINTS: .....

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INVERTED REVERSE HALF CUBAN 8:

- If the 45°inverted upline is too shallow or allowed to flatten during and/or after half rotation in roll, or hastened half rotation, or too much speed at manoeuvre entry, **risk of overspeed on top prior to pushover**, speed, RPM (fixed pitch prop) and G-Loads increase, as well as increase of stick forces.
- Always keep in mind be ready to abort the manoeuvre at the top.
- Account for **substantial altitude loss**.

KEY POINTS: .....

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DOWNLINE VERTICAL ROLLS AFTER STALL TURN/HAMMERHEAD WITH POSITIVE OR NEGATIVE EXIT:

- Beware of speed increase **and height loss**.
- Account for **overspeed, increased RPM's** (fixed pitch prop) **and G-Loads**, as well as increased elevator pressure forces.

KEY POINTS: .....

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HAMMERHEAD/STALL TURN STARTED FROM INVERTED:

- **Tailslide at the top (lack of energy) hold stick/rudder firmly to avoid damage**.
- Position the wing on the pivot side slightly low at the start of the push in order to raise it with opposite rudder during the vertical inverted climb.
- Full excursion of rudder will be available in the direction of the pivot at the top easing the rotation to downline.

KEY POINTS: .....

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INSIDE ROLLING TURNS:

- **Stall or flick (positive or negative)** if nose attitude kept to high above the horizon combined with too much stick (and rudder) deflection.

KEY POINTS: .....

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OUTSIDE ROLLING TURNS

- **Altitude loss, overspeed, increased G-Loads and RPM's** (fixed pitch prop).
- **Spiral.**

KEY POINTS: .....

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OUTSIDE SNAPS/ FLICKS:

- **Check harness.**
- Keep an eye on proper **entry speed.**
- Risk of **negative spin, negative spiral, altitude loss, spatial disorientation.**

KEY POINTS: .....

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TAILSLIDE (PUSHED/PULLED ENTRY OR EXIT):

- Make sure it's approved for your a/c.
- Beware of damage to elevator/rudder during the slide, if not **held firmly**, it may slam against the stops or hit other controls (depending on tail plane surfaces designs).

- Monitor altitude loss, dependent on the time in the line.
- **Engine may quit if idle set at too low RPM > Abort and apply immediately "engine off" recovery procedure.**

KEY POINTS: .....

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INVERTED SPIN (COMPETITION)

- Same warnings as for STANDARD INVERTED SPIN apply.

+ For 1 turn:
  - Risk of **positive flick** if at the stop the stick is pulled back too briskly.
+ For $1t^{1/4}$:
  - Possible **positive flick** if at the stop the stick is pulled back too briskly.
  - **Risk of asymmetrical pull.**
  - **Possible grey/black out /G-LOC during the positive recovery.**

- **Engine may quit if idle set at too low RPM > Abort and apply immediately "engine off" recovery procedure.**

KEY POINTS: .....

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INVERTED FLAT SPIN:

- Check a/c FM **if approved** manoeuvre.
- Same warnings as for negative spin apply.
- **Substantial altitude loss.**
- Possible **spatial disorientation**.
- **Inertia may delay exit** after many turns, hold controls in **proper position and wait.**
- **Risk of grey/black out / G-LOC** during the exit positive recovery.
- If done idle: **Engine may quit if idle set at tow low RPM > Abort and apply immediately "engine off" recovery procedure.**

KEY POINTS: .....

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NOTA BENE:

- *For all other manoeuvres or combination of manoeuvres: P-loops, 45° pushed or pulled humpty, double humpty bumps, refer to warnings as indicated for the manoeuvres they originate from. Verify proper* ***entry speeds*** *whenever a* ***flick is involved.***
- *For hesitation loops (square, diamond, and so on) monitor* ***G-Loads.***
- ***For the downward loops with hesitations at bottom: mind the possible snap on 3rd or 4th hesitation.***

KEY POINTS: .....

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ADDITIONAL REFERENCES

To remain connected on those topics

- https://www.facebook.com/academyofaerobatics

- http://www.academy-of-aerobatics.com/

  "Academy of Aerobatics" (AoA) is a video application that gathers video briefings to help you explore the world of aerobatics.

  From the very beginning up to freestyle manoeuvres, this app will make YOU a better and safer pilot.

And

- https://www.facebook.com/aerosafetyfirst

- http://www.aero-safetyfirst.com/

  "Aero Safety First" is a video application featuring video demonstrations with subtitles.

  You will get mentally immersed in the various scenarios involved, just like you would do in a simulator session when you rehearse your skills.

  You will be able to grasp the manoeuvres like being in the cockpit with all the visual cues and motion inputs, with the extended benefit of replaying the scenarios as many times as you feel...

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