A - Spin Ballast

1 General

The powered sailplane ASK 21 Mi only spins with in-flight C.G. positions of r = 400 mm (15.75 in) or behind. This supplement describes the use of spin ballast in order to practice spins with two pilots.

This enables the ASK 21 Mi to be used for spin instructions, as a measure against the fact, that uncontrolled flight attitudes (departures, spins etc) account for a large part of serious accidents.

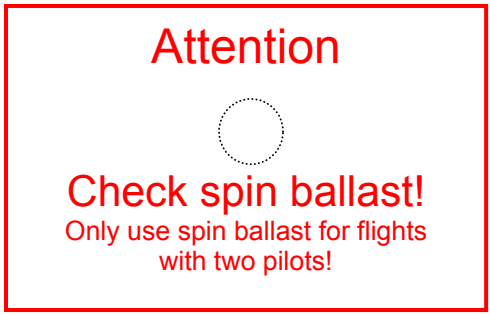
2 Limitations

The installation of spin ballast does not change the limitations of the ASK 21 Mi, this applies particularly to the C.G. range. A spin ballast table, which is calculated individually for each serial number, only serves the purpose to adjust a certain C.G. position.

Without valid spin ballast-table (Flight Manual page 9.A.8 respectively 9.B.12), spin ballast at the tail may not be used. The validity period is specified on each spin ballast-table. A valid spin ballast table can be obtained from the manufacturer (procedure, refer to Maintenance Manual page 13.A.3)

Spinning with spin ballast is only allowed in dual flight. When spin ballast is attached, aerobatics are prohibited (except spinning). Intentional spinning is permitted only with the propeller retracted.

A red placard is affixed in the cockpit within the pilot's view:



A M8-screw must be mounted through the placard from the backside of the instrument table. When the spin ballast is removed, the placard must be covered using the nut and washer that otherwise hold the spin ballast. It must be done such that the nut and washer cover the text of the above placard.

3 Emergency Procedures

No changes become necessary for the emergency procedures.

For your own safety, the decision height for a bail out should be determined before start. It should be agreed upon, who makes the decision, and what the instruction to bail out is.

If, for whatever reason, the glider has not yet finished the spin after one turn, the following questions have to be checked:

- Is *full* rudder applied against the spin? Is back pressure upon the stick released, and aileron neutral?
- Is the glider really in a spin – and not in a spiral dive?

If both questions can be answered with „Yes“, the glider should still be given the chance, to recover from the spin (Patience!). The altitude loss in a spin is 45m to 80m (150ft to 250ft) per turn. After further three turns it probably makes sense to restart the recovery procedure.

4 Normal Procedures

During each pre-flight check it is necessary to verify that no spin ballast or only the intended spin ballast is attached.

Pre Take-off Check:

1. Tail dolly removed ?
2. Parachute fastened correctly ?
3. Automatic parachute rip-chord connected?
4. Safety harness tight (particularly lap belt) ?
5. Controls easy to operate ?
6. Airbrakes retracted and locked ?
7. Trim set in take-off position ?
8. Spin Ballast - Placard ?
9. Altimeter adjusted ?
10. Radio operational and transmission tested ?
11. Check wind direction !
12. Both canopies closed and locked ?
13. Action for aborted take-off in mind ?

Spin Characteristics

The ASK 21 spins in upright flight as well as in inverted flight.

WARNING: *Intentional spins are only permitted in upright flight.*

The ASK 21 spins fast, steeply, and combined with a pitch oscillation. The oscillation of the spin causes a variance in pitch attitude that can range from extremely steep to nearly flat. Thereby the nose can pitch up almost to the horizon and the cockpit noise can calm down nearly completely. The pilot may not be used to such flat phases from other gliders of plastic design. The oscillation is more pronounced with increased loading. Nevertheless, it is possible in all phases to recover from a spin within one additional turn. But there are some important points to be regarded.

WARNING: *The following important points have to be regarded during recovery (see Flight Manual page 13):*

- *Deliberately apply opposite rudder **up to the stop**, and keep it at the stop until the rotation ends.*
- *Short pause (approx. ½ turn) after applying rudder and before releasing the stick.*
- *As long as rotation has not stopped, only give in to the pressure of the stick. Do **not** push the stick.*

Disregarding these points can delay or even prevent recovery.

WARNING: *During recovery from stalls in the presence of wing drop, or from departures and spins, application of forward stick prior to opposite rudder can delay recovery up to three additional turn.*

In order to obtain a reproducible result independently of the setting of the elevator trim, look out to bring the stick into neutral position, i.e. to the middle elevator course. In no case, the stick may be pushed to full nose down position.

Familiarize yourself with the spin characteristics

WARNING: *The combination of varying cockpit noise levels, varying pitch attitudes, and varying rotation rates and airspeed indications can cause disorientation to those unfamiliar with spinning this aircraft. If this occurs, positive application of recovery controls should be initiated immediately to minimize any effects of disorientation.*

We strongly recommend even experienced gliding instructors to familiarize them with spinning the double seated ASK 21 (Mi). This may happen through a fellow instructor already experienced in spin training on the ASK 21. When the spin ballast attachment is new in the gliding club, there might be opportunities through the national gliding associations or in training courses for the continuing education of instructors. Apart from that, there are also flight schools offering spin training with the ASK 21. A list of such schools can be requested from Alexander Schleicher, or looked for on their web site.

Condition of the aircraft

The condition of the glider must be identical to the condition during the last valid weighing. This condition is documented in the equipment list, on which the weighing report refers.

When the batteries in the wing root were installed during weighing, they must also be installed during flight.

CAUTION: *Control surface gaps have to be treated according to Maintenance Instruction C.*

Disregarding this item can delay spin recovery or may even prevent recovery.

The spanwise gaps of ailerons and elevator must be *air-tight*. According to Maintenance Instruction C this is achieved with a teflon sealing/slip tape under the mylar fairing strips. Mylar fairing strips without sealing tape beneath are not sufficient!

At the gap of the rudder a zig-zag-tape is placed at the forward edge of the mylar fairing strip (a combined zig-zag-fairing tape is also possible, Maintenance Instruction C).

Usage of the Spin Ballast Table

Before every flight with spin ballast the pilots must be weighed with the equipment worn in flight (clothes, parachute …). According to the effective spin ballast table page 9.A.8, spin ballast has to be attached. The mass of the pilot in the front seat defines the respective line of the table; the mass of the pilot in the rear seat defines the respective column. At the intersection, the number of ballast plates is noted (each 1 kg = 2.2 lbs), which have to be attached.

Every other trim ballast and (loose) equipment in the cockpit has to be removed. The use of this table ensures a permissible in-flight c.g.-position, even if the cockpit load falls below the minimum cockpit load specified in the Weight and Balance Form. When one or more ballast plates are to be attached to the tail, a C.G. of approx. 406 mm (16 inch) results for the flight. In the range of low cockpit load, the table indicates, that no spin ballast is necessary. Then the in-flight-C.G. is located between 406 mm and 469 mm (16 inch and 18.47 inch).

Up to a maximum of 12 spin ballast plates are permissible. The plates have to be distributed evenly to the left and right side of the fin and must be fixed with the provided screw.

CAUTION: The washer and nut screwed on the cockpit placard (see above) **must** be used. After removal of the spin ballast the washer and the nut must be fixed again on the placard.

Higher masses in the cockpit and on the tail influence the rotational speed of the spin and the amplitude of the superimposed pitch oscillation. With higher masses, the average pitch attitude is approx. –40° and the pitch amplitude is about ±30°.

In all spins, the altitude loss is approximately 60 m (200 ft) per turn with a variance of 45 m (150 ft) minimum to 80 m (250 ft) maximum.

Spin Entry Procedure

As specified in Section 4.5.9.

An aileron impulse against spin direction in due time can support spin entry.

CAUTION: *We recommend to enter spins in a generously safe altitude.*

For example it may be recommendable to enter the spin not below 1000m (3280 ft) AGL, when you intend to spin one turn and then recover. If you want to spin three turns and then recover, do not enter the spin below 1300 m (4270 ft) AGL

When determining your minimum altitude for entering a spin, always bear in mind, that the student not recover correctly at first go, or other imponderability may happen. For example, recovery may be postponed by three additional turns during a wing drop or spin, when forward stick was applied before opposite rudder.

WARNING: *If a spiral dive sets in, opposite rudder, opposite aileron, and relaxed back stick pressure must be used immediately to prevent overstressing the structure.*

If cockpit noise due to outside airflow continues to increase to the point that conversation between crewmembers is difficult, or if the airspeed indicator is increasing through 110 km/h (60 kts), the aircraft is no longer spinning but is likely in a spiral.

NOTE: *We recommend **not** to use the airbrakes during recovery to reduce the airspeed, since the tolerable load factor with extended airbrakes is only +3,5g / -0g.*

Spin Recovery

According to the standard procedure, as specified in Section 3.5.

5 Performance

The aerodynamic drag caused by the spin ballast plates impairs the glide performance of the ASK 21 Mi slightly.

Performance in powered flight will not change significantly.

Because of the aft C.G. position the aircraft naturally will respond more strongly to elevator deflections.

6 Weight and Balance

With every new weighing of the aircraft, an updated spin ballast-table must be requested from the manufacturer, and filed after this page. (Page 9.A.8 Spin Ballast, Details see Section 13.A in the Maintenance Manual).

The inspector must remove the old table after filling in the Mass and Balance Form in Section 6. Having requested and received the new table the owner / operator may insert this page himself without the necessity of an inspector.

Instead of this page the spin ballast table
can be inserted if applicable.

9.A.8 Spin Ballast

Appendix to A - Spin Ballast
Excerpt of the USAF Manual

The US Air Force flight tested the ASK 21 with spin ballast in 1989. Their results already went into this Manual. In the report of the USAF there is also a recommendation for the Flight Manual. This text is too detailed for the average student pilot. As an offer to the flight instructor, it is attached below. Since it is older, there are some deviations from the current concept (e.g. concept of spin ballast table).

Some definitions are given at the end of the text. Remarks and omissions made by AS are indicated by square brackets [].

Schleicher ASK-21 (TG-9) Stall and Spin Evaluation

Doyle B. Janzen, Charles J. Precourt

July 1989,
Air Force Flight Test Center Edwards Air Force Base

This text may supply useful information for the pilot.
It is not part of the approved flight manual.

[..] The following discussion is the recommended writeup for SectionVI (Flight Characteristics) of the flight manual. The information is also appropriate for the manufacturer's flight manual. [..]

Departure and Spin Susceptibility

Entry Techniques

The simplest spin entry is accomplished from wings level with the pitch attitude held constant at 10 degrees nose high until stall, while smoothly applying full rudder and full aft stick. Proper timing of aileron inputs prior to stall can generate additional yaw (adverse yaw due to aileron) to assist spin entry. This is particularly true at more forward cg when rudder and elevator alone fail to produce spin entry.

Spin entry is sensitive to entry conditions. If the entry attitude is too nose high, it results in a spiral dive. If the entry attitude is too shallow, it results in a steep-banked sideslip. The spiral or sideslip occur more frequently as the cg is moved forward. Spin entry is unlikely with the in-flight cg forward of 12.4 inches [315 mm]. In this case, entry attempts result in spirals or sideslips regardless of control input techniques.

Mass Properties Effects

Spin entry success is also sensitive to inertia loading. The ASK 21 aircraft has the unique feature of tail ballasting, meaning that it can be loaded at both ends of the fuselage. Although the tail weights were designed to control cg, they greatly effect the inertia terms that govern aircraft response to flight maneuvers. Since the tail weights significantly increase the inertia of the longitudinal axis of the aircraft, any initial yaw rotation results in more angular momentum than without tail weights. This greater momentum results in, achievable spins at cg's further forward than the low inertia case.

Flight testing has produced spins at cg's as far forward as 12.9 inches [328 mm]. With minimum inertia loadings (solo, lightweight pilot without tail ballast), incipient spins can be achieved at cg's aft of 13.0 inches [330 mm] and sustained spins aft of 15.0 inches [381 mm]. With higher inertia loadings (two pilots and tail ballast), incipient spins can occur aft of 12.5 inches [318 mm] and sustained spins aft of only 13.5 inches [343 mm]. Therefore, the tail weights cause the target cg where spins can be expected to move progressively more forward as pilot weights increase.

[..] In reference to test results [..], the best cg for spin training is 16.0 inches [406 mm]. [..] The maximum number of tail weights permitted is [12]. If pilot weights call for more than [12] tail weights [..], use [12] tail weights which will result in a cg slightly ahead of 16.0 inches [406 mm]. Due to the higher inertia of this case, the aircraft will still spin easily for training.

No Rudder Spin Entry

Spin entry without using rudder input can occur under certain conditions. A wing drop at stall can generate sufficient yaw to cause the rudder to float to the prospin position. Wing drop can occur due to adverse yaw from uncoordinated aileron inputs near stall or turbulence. In this case, if recovery is not initiated by applying rudder opposite the wing drop and then breaking the stall with forward stick, a spin can develop.

[..] If proper coordination is not exercised near stall, a departure or spin may occur with only stick inputs.

Spin Characteristics

Spin Modes

The ASK 21 has two spin modes, one upright and one inverted. Both are classified as fast, steep, and oscillatory, However, the oscillation of the spin causes a variance in pitch attitude that can range from extremely steep to nearly flat. The average attitude value is classified as steep. The spin modes may also appear smooth instead of oscillatory if they are only examined for three turns or less. This is because the period and frequency of the pitch oscillation vary as a function of cg and inertia loading. Variations from one oscillation per turn to one oscillation every three turns can be seen, depending on loading.

Spin-Parameters

The pitch attitude during ASK 21 upright spins averages 40 to 50 degrees nose low. The steep phase of the oscillation is as much as 70 degrees nose low and the flat phase as high as the horizon. In no case does the flat phase tend toward an unrecoverable situation. On some occasions, the spin attitude is steep enough that the AOA is momentarily less than stall, resulting in recovery as the aircraft pitches down out of the spin.

The oscillation occurs more frequently as the cg is moved aft, while increases in inertia loading result in a larger amplitude of the oscillation. For example, at a forward cg, the oscillation is seen every third turn. At the aft cg limit, the oscillation occurs every ¾ to 1 turn. At low inertia values, the pitch attitude oscillates typically ±15 degrees about 50 degrees nose low, while at high inertia the oscillation is ±30 degrees about 40 degrees nose low.

The rotation rate of the spin is as fast as 140 degrees per second, or one turn every 2.5 seconds. This rate occurs at the steep phase of a spin oscillation. During the flat phase, the rotation rate is as slow as 90 degrees per second or one turn every 4.5 seconds. The average rotation rate is fastest at forward cg 's and high inertias, where oscillations occur least frequently. Toward the aft cg limit, where oscillations to flat attitudes are more frequent, the average rotation rate is slowest.

In all spins, the altitude loss is approximately 200 feet [60 m] per turn with a variance of 150 feet [46 m] minimum to 250 feet [79 m] maximum. This indicates that in spite of the oscillatory nature of the spin mode, the descent rate remains relatively constant.

Airspeed indications during the spin oscillate along with pitch attitude. In most cases, airspeed oscillates between 30 and 40 KIAS [56 and 74 km/h] During larger oscillations in pitch attitude, higher sideslip angles are present and airspeed erroneously reads zero or less (pointer unwinds [backwards]).

Since airspeed indications can be unreliable during spins, particular attention is necessary to recognize the transition to a spiral. If cockpit noise due to outside airflow continues to increase to the point that conversation between crewmembers is difficult, or if the airspeed indicator is increasing through 60 KIAS [110 km/h], the aircraft is no longer spinning but is likely in a spiral. Opposite rudder[, opposite aileron,] and relaxed back stick pressure should be used immediately to avoid potential overspeed or overstress situations associated with high-speed spirals. Spoilers should be used as necessary to control airspeeds during all spin or spiral dive recoveries. [Remark: AS does not recommend the use of airbrakes during recoveries. Extracting the airbrakes has an unfavourable influence on the lift distribution, and the tolerable load factor reduces to +3,5g / -0g, see Flight Manual Section II.5].

[..]

Cockpit noise also varies during sustained spin oscillations. During steep phases of the spin, cockpit noise from outside airflow is loudest, while during flat phases, the cockpit is very quiet.

WARNING: *The combination of varying cockpit noise levels, varying pitch attitudes, and varying rotation rates and airspeed indications can cause disorientation to those unfamiliar with spinning this aircraft. If this occurs, positive application of recovery controls should be initiated immediately to minimize any effects of disorientation.*

Control forces during spins are light. There is a tendency for the ailerons to float into the direction of the spin, accompanied by 5 to 10 pounds [2,3 to 4,5 daN] of lateral force on the control stick. At the higher spin rates, the elevator and rudder forces at full prospin deflection drop to zero.

Control Effects

Flight Manual Recovery

When opposite rudder is initiated at a slow point or flat phase of the spin, the rotation stops in ¼ to ½ turn and the aircraft recovers. In the majority of cases, even at higher rotation rates, opposite rudder recovers the aircraft in ½ to ¾ of a turn from the point of input. However, with cg's of 14 to 16 inches [355 to 406 mm] and at higher inertias, recovery can take up to 1½ additional turns to recover once opposite rudder is applied. It is imperative that a slight pause occur between application of opposite rudder and forward stick or even greater delay in recovery can occur.

[Due to this statement the flight manual had been changed, adding the rule to obey a short pause between applying full rudder and relieving stick back pressure.]

A recovery of 1½ turns may take up to 5 seconds, which may seem excessively long to an inexperienced pilot. The flight manual procedure has a 100 percent success rate if given sufficient time to work.

Aileron Effect

For the ASK 21, ailerons against the spin produce a noticeable bank angle away from the spin turn direction as well as a nose down pitch rate. This sometimes results in recovery as the yaw rate decreases through inertial coupling and the nose pitches down leaving the aircraft in a steep sideslip to terminate the spin. In other cases, the aircraft remains in the spin with a bank angle away from the spin direction. Therefore, ailerons against the spin are not a reliable contributor to spin recovery.

Ailerons with the spin increase rotation rate but this effect is masked by the oscillatory characteristics of the spin. In the majority of cases, ailerons into the spin achieve a slightly higher rotation rate and a more sustainable spin. The results of testing isolated aileron inputs indicate neutral aileron is the best position for recovery.

Elevator Effects

In some case, application of forward stick with no rudder input will result in a continued spin. During either the incipient phase of the spin or at the start of a nose up oscillation, full forward stick can produce up to three more turns before recovery.

WARNING: *During recovery from stalls in the presence of wing drop, or from departures and spins, application of forward stick prior to opposite rudder can delay recovery up to three additional turn.*

Hands Off

In the majority of cases, when the controls are released during a spin, the stick moves laterally in the direction of the spin. The stick usually reaches full aileron deflection and then starts forward toward neutral. The aircraft pitch attitude steepens and then the rudders return to neutral. At this point, the aircraft self-recovers in a steep attitude.

If the controls are released just after the pitch attitude has cycled nose low and the rotation rate is high, the stick moves abruptly into the direction of the spin and remains at full aft/full aileron deflection. Rudders also remain at full deflection, or nearly so, and the spin continues indefinitely until the pilot forces the controls to the recovery position. This is most prevalent in the 14- to 16-inch cg range [355 to 406 mm] with higher inertia loadings. Since airloads on the controls can occasionally cause them to "lock out" in a prospin position, releasing the controls is not a viable option for departure or spin recovery. The spin recovery procedure must be used to ensure successful recovery.

Inverted Spins

Flight testing has verified that the ASK 21 has an inverted spin mode. Testing has been conducted between 15.8 inches cg [401 mm] and the aft cg limit.

WARNING: *Intentional inverted spins are prohibited.*

Susceptibility

[..] Inverted spins become less likely to occur at cg's forward of 15.8 [401mm] inches since control positions become more critical. Overall, the ASK-21 is extremely resistant to inverted spins since only sustained inverted stalls result in spins, regardless of cg. Although testing indicates increased resistance forward of 15.8 inches cg [401 mm], this does not imply inverted spins at more forward cg's are impossible.

Characteristics

The inverted departure and spin entry are essentially a mirror image of the upright case. The nose falls to approximately 60 degrees nose low and then hesitates. Cockpit g forces build up to –2g and the nose then oscillates back up to 40 degrees nose low. The spin develops in approximately 180 degrees of rotation and is oscillatory just as the upright spin. Altitude loss is 200 to 300 feet per turn [61 to 91 m] and rotation rate is one turn every 3 to 2½ seconds. At the cg's tested, the inverted spin oscillations occur every ¾ to 1 turn. Once the spin is developed, gforces oscillate between –1 and –1.5g. Airspeed oscillates near 40 KIAS [75 km/h] and remains stalled throughout. Cockpit g forces are uncomfortable but other spin characteristics are very comparable to the upright case.

Inverted spin recovery is immediate (¼ to ½ turn) when controls are neutralized. Altitude loss from initiating recovery to level flight is 400 to 500 feet [122 to 152 m]. Since the spin includes a component of roll rate as well as yaw rate, the aircraft rolls to an upright attitude during recovery on its own, without further pilot input. Airspeeds are typically 90 to 100 KIAS maximum [167 to 185 km/h] during inverted spin dive recoveries.

Definitions

Term	Definition (see page 5 of USAF-report)
Departure	Event in poststall flight, that precipitated entry into a post-stall gyration or spin. Momentary event, indicated by un-commanded, divergent aircraft motions, and synonymous with complete loss of control
Incipient spin	For the purpose of this report, an incipient spin means achieving a minimum of one turn, and the aircraft self-recovered in spite of maintaining prospin inputs.
Sustained Spin	For the purpose of this report, a sustained spin was a spin that continued at least five turns, or indefinitely, as long as prospin inputs were maintained.

6.1 Introduction

This Section describes the procedures for determining the empty mass and the empty mass moment of the aircraft. In addition, procedures for determining the Center of Gravity (C.G.) are provided.

A list of equipment fitted is contained in the most recent and currently valid aircraft inspection report.

As the C.G. position is of vital importance for safe flight, the limits laid down must not be exceeded on no account.

It is especially important after repairs, re-finishing and the fitting of additional equipment to ensure that the empty mass C.G. remains within permissible limits. If this cannot be proved by calculation, the aircraft must be re-weighed.

6.2 Weighing Procedure

The Datum (Reference) Point (German: **B**ezugs**P**unkt = **BP**) for weighing and calculating the C.G. is the **wing leading edge** at the root rib.

Prior to weighing, level the aircraft so that the top edge of a wedge 1000 : 52 placed on the tail boom in front of the fin, is horizontal (see Fig. 6.2-1). The weighing is best done on two scales.

CAUTION: *Only calibrated scales may be used for weighing. The lever arms for determining the empty mass c.g. have to be determined during every new weighing.*

3. Weighing and Spin Ballast Table

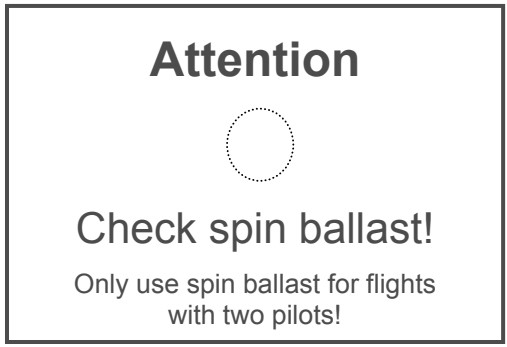
With every new weighing of the aircraft, any spin ballast-table (Flight Manual page 9.A.8 respectively 9.B.12) must be removed. Removing the spin ballast-table does not compromise airworthiness of the ASK 21 Mi. But spin ballast may not be used without valid spin ballast-table.

A new table for the spin weights can be requested from the manufacturer. For this purpose a copy of the weighing report and of the equipment list, signed and stamped by the inspector, must be forwarded to SCHLEICHER. The new table must be filed into the Flight Manual behind the page 9.A.7.

If the weighing was done with removed power-plant, this must be distinctly specified when ordering the new spin ballast table. In that case the new spin ballast table must be inserted behind page 9.B.11 and is only applicable for flights with removed power-plant.

4. Placards and Markings

An indicating label at the front instrument panel draws the attention to the fitted spin ballast:



A M8-screw must be mounted through the placard from the backside of the instrument panel. When the spin ballast is fitted at the fin (= DANGER), the placard is visible. When the spin ballast is removed, the placard must be covered using the nut and washer that otherwise hold the spin ballast.