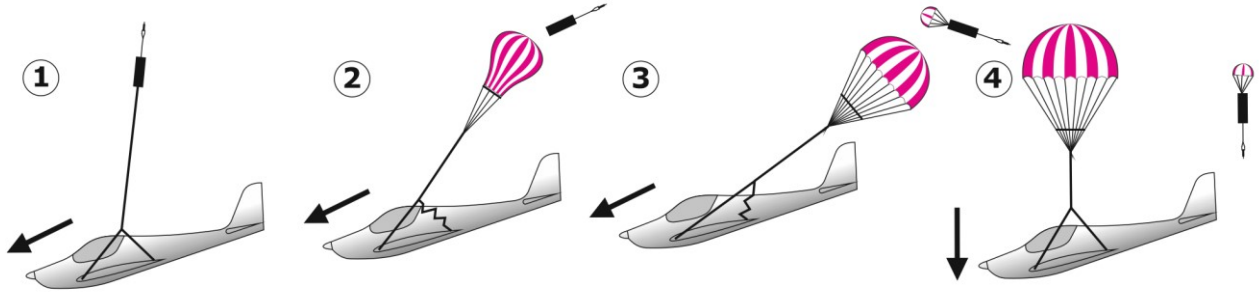
Does your aircraft have a rescue ballistic parachute system installed and are you sure when and in what situation to use it?

We will try to answer this question for you after 39 years of experience in the production of these rescue systems (RS) and the observation of air accidents and events associated with the use of this rescue device. The stated facts and technical data refer only to the products and long-term experience of the manufacturer of rescue parachute systems GALAXY GRS s.r.o.

Rescue Parachute Ballistic Parachute System (RS) is a device designed to save the pilot/crew/ and the aircraft in a critical borderline flight situation, when it is already assumed that the aircraft cannot be landed in an emergency without consequences and there is a risk of a fatal end to this flight.



This system is equipped with a parachute canopy, which in most cases is pulled up using a solid fuel rocket engine. The parachute canopy is connected to the aircraft by a suspension system (steel ropes/straps).

The system is mainly activated mechanically by activation a handle, which is connected to the rocket engine by a cable in bowden, which, in addition to the trigger cable, is equipped with another cable, which is connected between the RS activation handle and the rocket tube support and prevents the rocket from being initiated when the bowden is accidentally stretched. The working path of the handle is no longer than 5 cm for activation, and the force required to activate the system using the handle varies between 5-10 kg according to the relevant standard. Activation is by sharp pulling the handle.

After activating the rocket, the parachute is within 1 to 1.5 seconds dragged far enough from the aircraft and depending on the type of the selected RS /rescue parachute ballistic system/ it will be completely inflated in time "T".

The installation of RS is not mandatory in the Czech Republic, but it is mandatory in some EU countries and neighboring Germany. It is not possible to operate an ultralight aircraft without proving that the parachute canopy can be safely ejected, its function and the required DULV or DAeC test of the parachute tested under the supervision of their inspector.

How to install the system: it is always necessary to follow the manual/manufacturer's manual/. In a correctly compiled manual, it must be clearly stated how a safe extraction of the parachute from the container must be ensured, especially for integrated /RS/ inside the aircraft. There must always be a flawless punching out of the cover, which is always tested by the manufacturer. If the user/manufacturer of the aircraft proposes a different way of installing any part related to the RS function than that specified by the manufacturer in his manual, this design must always be consulted with the RS manufacturer. The aircraft must also be marked with warning stickers, informing about the presence of RS in the aircraft.

Activation handle location: The firing handle must be located within eye range of both the pilot and passenger. It must be reachable even when the maximum rear position of the seats is set /if they are adjustable/ in state of fully tightened belts. Unfortunately, the recent disaster with two fatalities was a lesson for the company that installed this system. The co-pilot, who had his seat in the rear position, did not reach the system during the destruction of the wing, because "the pilot stiffened" and was unable to activate the RS. The co-pilot loosen the seatbelts in order to reach the handle and when the functional parachute was successfully deployed, he was ejected from the cabin due to the deceleration of the aircraft.

Correct detachment of the suspension system (ropes or straps) is a very important aspect. The aircraft must be suspended on the parachute so that it is always pointing "nose to the ground" due to the impact kinetic forces acting on the crew in the cockpit of the aircraft. The recommended and tested tilt angle is between 15 and 30 degrees "nose to the ground" relative to the horizon.

What is absolutely unacceptable: Unfortunately, we have found in practice that some manufacturers do not respect the rule of safely pulling out Kevlar straps or ropes, and after activating the parachute, the straps or hanging ropes are not completely pulled out of their storage, or they are incorrectly installed, e.g. in front of the cabin frame, in the carriers inside cockpit or cabin frame. In such a case, the aircraft will descend "down the tail", which can cause severe injuries or fatal consequences for the crew when the aircraft hits the ground.

We therefore recommend that you look at your aircraft to see where the rear and front straps are routed and how its safe release is secured when the parachute is activated. In case of doubts, immediately contact the aircraft manufacturer or the organization that performed this installation and request a remedy.

Each manufacturing organization that manufactures RS clearly states in its manual when the system should be revised and serviced. Usually, after a period of time, the rocket motor is replaced and the parachute canopy is checked and repackaged at the same time. Therefore, it is necessary to check the date of the next service inspection. In case of trike wings, the attachment to the landing gear frame is always checked before flight, while in the case of integrated RS in the airplane, it is always after a longer interval, which is indicated in the manual.

Special attention is required during installation, or reinstallation after servicing the system, pay attention to the notes and warnings given by each manufacturer in order to ensure that the RS installation is correct.

It is necessary to respect the unlocking of the transport and safety elements. If these safeties are not removed according to the manual before assembly, or during the assembly process, they may cause the system to be **INOPERATIVE** when activated.

All known and manufactured systems have only one operating pin with a flag on the activation handle, which must always be removed before flight to unlock the system. Unfortunately, in the attached photos there are pictures of many pilots who do not have the pin removed before flight and fly with the locked system. After contacting these pilots, the reason we often hear is fear of an uninstructed passenger pulling the handle during flight. Another answer is the misconception that the pilot only remove the unlocking pin at the moment when it is necessary to activate the RS, or that they remove the pin only in bad weather conditions. In the critical situation this pin can be hard to reach and to be removed in flight because of possible high G loads. **The safety pin must always**

be removed before flight and the crew properly instructed. Unfortunately, the consequences of the mentioned reasons are fatal and we know of some cases when in a stressful situation there was no time left to remove this safety pin and especially with handles located outside the range of the eyes, or even a handle located behind the shoulder. Unfortunately, these pilots will not learn from their mistakes.

When and where to activate the system:

Fire on board, mid-air collision, structural failure, loss of control of aircraft, pilot incapacitated, low-ground corkscrew crash, engine failure over inhospitable terrain, pilot disorientation, short runway.

Fire on board: if a fire breaks out while the aircraft is still controllable, it is advisable to fly so that the fire is directed away from the passengers. For example, if a fire breaks out on a forward-mounted engine or under the dashboard, the airplane should go into a slide that directs any open fire out of the cockpit, start extinguishing - if you have any option and close the fuel valve in the first place. Immediately find out a possible place for emergency landing, if not - immediately activate RS.

Collision in the air: here we don't look at how high we are and where we are - we immediately activate RS. In this situation the aircraft can immediately go into rotation with a dramatic increase in "G" values, and with an inappropriately located RS activation handle, the pilot would not have a chance to reach the handle at all.

Structural failure: fortunately, structure and airframe failures of modern aircraft are very rare, but when a component fails for any reason, the RS can offer the only life-saving option. If it is a large-scale failure of catastrophic proportions, the use of RS is recommended and necessary. If the airplane is still controllable and if it remains on the horizon, then the airplane should be landed normally. If you are not sure about the structural strength required for the safe landing or that part affects the stability of the aircraft, then RS is the only solution.

Pilot incapacitation: can include situations such as heart attack, stroke, temporary blindness, stress where the pilot becomes stiff and unable to act properly. In this case, the passenger must activate RS immediately. Therefore, the pilot should show this RS activation handle to the passenger before the flight and try if he can reach it. Time by time is good to try to reach the activation handle position with closed eyes.

Falling into a spin: if we are high enough there is nothing to worry about if we know the parameters of our parachute. E.g. the company Galaxy GRS has on its website, in addition to the minimum safe activation height of the parachute for an aircraft flying in the horizon at a falling speed, calculations of how much height is required for safe use of a parachute for an aircraft at a MTOW of 473 Kg and for an MTOW of 600 Kg. In addition to these given data, the minimum safe heights for activating parachutes in a spin are listed on the

company's website, for airplanes with a MTOW of 473 Kg and 600 MTOW. Each of the listed ultralight categories have a different minimum stall speed. When dealing with a dangerous flight situation pilots simply forgets about and the consequences are often fatal.

In any case, it is necessary to know these data for the successful use of the parachute. For the calculations, the measured values of the BUT Brno laboratories during parachute tests were used. Galaxy GRS, placed on the load of tested parachutes. The most important calculations for understanding how the parachute behaves during a spin.

Regulation DULV abd DAeC from 1990 to 2006

Example 1: Rescue system GRS 5/472,5 UL.

Input data:

Weight of aircraft **MTOW= 472,5** kg , speed: **VNE =251km/h**

a) measured opening time at 45 km/h ... 3.85 sec /must be completely filled within 4 sec.
b) descending rate 6,6m/sec.

Minimum rescue height:

$$Ho = \frac{0{,}5 * g * t^2}{2} + 2 * v_{OP} \quad [m]$$

g (weight acceleration) [g = 9.81 m/s2]
t (recorded opening time) [s]
vOP (sinking rate of fully unrolled canopy) [m/s]

$$Ho = \frac{0{,}5 * 9{,}81 * 3{,}85^2}{2} + 2 * 6{,}6 = 49{,}5 \ [m]$$

When using the system in an inverted configuration (the aircraft is in the position on its back), +20m is added to the calculated height.

The minimum rescue height is therefore approx.: 49.5 + 20 = 69.5m (above the ground)

Conclusion:

This system can be used for speed v = 251km/h and MTOW = 472.5 kg or speed v = 260 km/h and MTOW = 450 kg.

DULV / DAeC regulation and amendment dated 6/9/2006)

The maximum time to fill the canopy from launch must not exceed 4.5 sec. at a speed of 65 km/h behind a test car or in a air drop test at 90 km/h. Test for UL airplanes exceeding a max. speed of 190 km/h The formula applies:

Rescue system GRS 6/473 SD UL

Input data:

Weight of aircraft **MTOW= 473** kg, speed: **VNE =310km/h**

a) measured opening time at 90 km/h ... 4,5 sec by drop test
b) descending rate 6,8m/sec.

Since the parachute is tested at a higher speed than the minimum stall speed of the UL aircraft (it must not be higher than 65 km/h), there will be a longer time delay when filling the parachute tested in this way. When falling into a spin, it is therefore necessary to add approx. 1.5s to the tested time at 90 km/h, which is 4.5s. Then the parachute filling time will not be 4.5s but 6.0s, which does not correspond to the rescue height of approx. 83 m calculated or even tested at a speed of 90 km/h, but higher by the time it takes to reach a speed of 90 km/h. The actual rescue height is then higher - see example.

Minimum rescue height:

$$Ho = \frac{0{,}5 * 9{,}81 * 6^2}{2} + 13{,}6 = 102\ [m]$$

When using the system in an inverted configuration (the aircraft is in the position on its back), +20m is added to the calculated height.

The minimum rescue height is therefore approx.: 102 + 20 = 122m (above the ground). Difference is 40m!

DULV and DAeC regulation for a weight of 600 Kg from 2019.

The opening time test is set at 6 sec during the test behind the car at a speed of 65 km/h or by drop test at 90 km/h.

Here, the rescue height resulting similar a for a parachute is 473 Kg, and airplanes are faster at 190 Km/h, because the test time is extended at a speed of 65 Km/H. to 6 sec.

Then the minimum rescue height is 102 m above the ground, and at least 130 m when the aircraft is inverted.

Unfortunately, our experience gained from some fatal aircraft accidents where the RS was activated in the spin is alarming. In several cases, the dealer demonstrated the flight to the customer at minimum speed. During the subsequent fall prevention demonstration, he did not reach a safe height and performed another dangerous maneuver at a lower height and continued until a flat spin occured at a height less than the minimum height for RS activation.

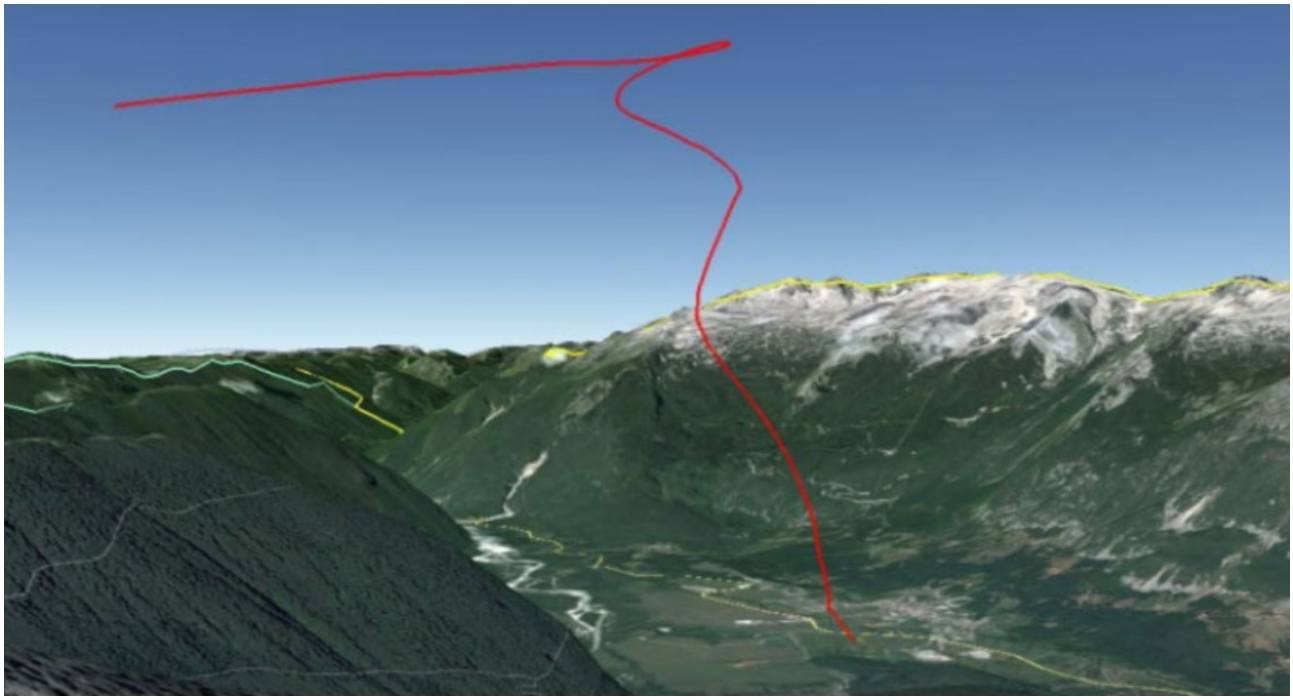
Falling into a spin low above the ground: a certain percentage of accidents are also caused by inexperienced pilots, e.g. when landing in the third or fourth turn, the aircraft falling into a spin due to the loss of speed of the aircraft or incorrect piloting in a stall turn. In this case, the pilot should not try to manage this spin, but immediately activate the RS.

Engine stalling over inhospitable terrain: many pilots are affraid of a situation that a highly reliable aircraft engine stalling or losing power. This should not be a reason to activate RS unless the terrain below does not permit a normal/emergency landing.

For example, after take-off, we always try to land in front of aircraft and not solve the landing by turning to the take-off point or activating RS. We have to keep in mind that this height we have may not be enough to fully fill the canopy. Activating the RS in this case can cause more damage than landing in front of you, because the plane will swing -pendulum system- and hit the ground. Before take-off, it is necessary to think about this, especially when we are at a foreign airport.

When landing, if the surface is extremely inhospitable and landing is impossible, if it is night or cloudy and visibility is reduced to make a normal landing maneuver impossible, activating of RS is the only solution. However, the pilot must always know the parameters of the installed RS and activate the system at a sufficient height. This is very important.

Pilot disorientation - is somewhat different from engine failure or pilot incapacitation. Some cases are serious, such as dizziness or spatial disorientation, which you cannot recognize from the ground. In bad weather conditions, the pilot can get sick, disoriented, or in bad weather the pilot gets lost, runs out of fuel, or the mountainous terrain can confuse the pilot. Unfortunately, we also registered this during the investigation of the accident, which fortunately turned out well for the crew. They flew into Nibostrat Ns without an artificial horizon, and both wings collapsed during the downward spiral. Fortunately, at a speed of 450Km/H they were between two mountain ridges above the valley and at a height of 520 m AGL they pulled the handle after flying out of the cloud. The parachute was tested at a speed of 315 Km/H. They were very lucky.



Another situation that can occur in mountainous terrain is the closing of cloud cover over the peaks, and in the valley strong turbulence and downdrafts due to the influence of the leeward side are manifested. This situation calls for finding an orientation and continuing flight or landing, but that's better said than done. Then the use of the GRS system can be the only solution from such a hopeless situation.

Short runway - in the case of a very short runway or a short downhill runway, the pilot must approach the ground to touch the wheels at a distance of max. 0.5 m above the terrain and then activate the RS. Activating the parachute slows down the aircraft, which stops aprox. after 30 meters. Never try at a higher height. Grown vegetation is considered as a solid terrain.

Already in the moment of ordering the aircraft or RS, the pilot should familiarize himself with the parameters of the parachute. RS are manufactured according to the MTOW and VNE of each aircraft category /ultralight aircraft/, which has similar technical parameters.

For this reason, it is important to familiarize yourself with the parachute that we have installed in our aircraft, whether we buy it with the RS already installed or we will install it additionally. The

reason is clear - we need to know how and when we can use it and when its use is out of the question. See the controversy above.

So what is the minimum safe height to activate RS Galaxy GRS?

Most ultralight aircraft up to MTOW 600 kg, equipped with RS Galaxy GRS use exclusively parachute series 5 and 6. The parachute series must be selected according to the VNE of the given aircraft type, and each parachute is always designed to open as quickly as possible in the given speed range of the aircraft. This also gives the minimum rescue height accordingly. For parachute systems of the 5 series with a maximum operating speed of up to 250 km/h, the system can be activated from 70 m above the ground. For parachute systems of the 6 series with a maximum operating speed of up to 365 km/h and higher, the system can be activated from 100 m above the ground. These values are given for activation in horizontal flight.

Another important finding from the long-term operation of ultralight aircraft and ultralight flying schools is that novice pilots/students/in training are not sufficiently familiar with the above-mentioned information and solutions of given emergency situations, and minimal attention is paid to RS topic. The novice pilot should be guided, in addition to actions to prevent the aircraft from falling, also when and how he can use RS and when NOT!

Before every flight, during training at the school, in the presence of the instructor, student pilot should reach for the RS handle and remove out the safety pin with the flag by himself. Pilot will then perform these actions automatically in his practice, just like everything he learns with a good instructor at school.

Then there should not be such situations with a fatal end, when an airplane with two instructors falls from a height of 400 m and none of them pulls the handle of the installed tested RS.

And beware, this is not the first case!

Here I would like to add some good advice to this issue "if the airplane is not under control at 400m after intervention in the steering and trying to recover from spin, it is almost foolish to think that I will succeed at 200 or 100 m above the ground."

This is where the right decision is really needed the most. In this case, after a failed steering corrections, we immediately activate RS!

I don't know if all pilots are aware that ultralight aircraft as a category of aircraft is not tested for spin recovery, nor are such tests conducted in school. Only fall prevention training is performed.

Even this maneuver is dangerous for some aircraft and I am convinced that this category of aircraft should be mandatorily equipped with RS. Unfortunately, there are known sad cases when an

airplane with a very experienced pilot (instructor) went into a spin while practicing this maneuver and the pilot was unable to recover it. I think that in Germany they are one step in front of us.

For this reason, as a parachute inspector, I would recommend that this issue be included for flight instructors and to the curriculum of the pilot training center LAAČR as another important point of standard winter training.

I would not like to forget that every fall on a parachute is quite a big impact to the ground for both - the aircraft and the crew/compared to a free fall from height of approx. 1.7 m on a solid surface/ and if there is time it is good for the crew to tighten their belts, curl up as much as possible and bend your legs and put your hands in front of your face - protect your eyes . The rate of descent of an aircraft with activated RS is usually up to 7.5 m/s relative to 1000 mASL, as given by the regulation.

We must also not forget that the pilot's body and head will always go forward, /with the correct installed length of suspension straps - see the beginning of the article/but this is the best knowledge we have from the tests and experience we have from the operation and analysis of accidents. It's the safest thing a crew can do.

If the aircraft has a retractable undercarriage and if we have enough time, it must be opened. The extended landing gear is also able to partially dampen the impact energy, and this applies to both the main landing gear and the nose wheel. The chassis is a good shock absorber and the repair is not difficult. Let's always keep in mind that we are dealing with injuries and LIFE! Sheet metal is always repaired.

After the successful opening of the RS in a critical situation and a successful parachute descent, the impact of the aircraft may not always be in the ideal place. Sometimes the plane with the crew ends up in a tree, sometimes in the forest, and the worst is urban areas, or falling into a river or the sea.

Unfortunately, the events described above have already happened and sometimes they did not turn out happily. We know a case where the crew over the sea successfully activated the RS in sight of the coast and were unable to open the cabin cover after the impact. On the contrary, the successful activation of the RS over Edmonton, when the pilot correctly continued the flight under high vibrations with a half-broken propeller until outside the urban area, where he activated the RS. This avoided the possibility of hitting houses and an unpredictable ending. With a bit of luck, where the machine with the crew ends up, from the many uses of RS activations, 80% of all aircraft are repairable and the crew is unharmed.

After landing on a flat surface in open country, the wind that fills the parachute after impact before the crew is able to pack it, drags the aircraft so long and so far that the aircraft catches on an obstacle. The crew is mostly uninjured, but the remains of the machine is not exactly a good look.

The worst case scenario is always when an aircraft with the system installed crashes with the crew and the system is not activated, which in this case led us to write this article. Unfortunately, this is not such a unique situation. It is sad to learn that the pilot at 3500 ft had a problem with orientation in the cloud and was unable to activate the RS during the entire spin. If the debris does not burn, the pyrotechnician must intervene and destroy the rocket engine, which can seriously injure or kill the firefighter. Great care must be taken and training has been done for these security forces on how to proceed.

In Liberec, 7.2.2024 Ing. Milan Bábovka – Galaxy GRS s.r.o.