Spring-Loaded Pilot Chute Hesitations

Performance Analysis - Causes & Solutions

Main Spring-Loaded Pilot Chute Systems
All Types – Military & Sport

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Main Spring-Loaded Pilot Chute Hesitations - Causes Identified – Solutions Proposed

For nearly 100 years, spring-loaded pilot chute hesitations have been a common occurrence in skydiving. Although more reliable deployment methods were developed and available since 1975, many military organizations and a number of sport jumpers and skydiving schools continue to utilize the spring-loaded pilot chute actuated by ripcord to deploy the main canopy.

In contrast, the reserve canopy's spring-loaded pilot chute, actuated by ripcord, remains the standard worldwide to deploy the reserve canopy for almost all harness/container systems. If hesitations with main spring-loaded pilot chutes are so prevalent, you might ask why we use this type of deployment system on the reserve. The primary reason is the ability of the jumper to pull the inboard-mounted reserve ripcord with either hand, which is a significant safety feature. (Note: Several manufacturers experimented with hand-deploy pilot chute-activated reserve systems with the pilot chute mounted at the top of the reserve container, just behind the jumper's neck. The problem with these systems is that ambidextrous activation is nearly impossible, and they are not compatible with modern AADs. Another reason is that most reserve deployments occur after a breakaway from a malfunctioning main canopy, and in a cutaway situation, there is rarely a burble behind the jumper to cause a hesitation. A hesitation resulting from a burble is more likely in total malfunction situations.)

The following information will provide guidance that may help to identify the causes of pilot chute hesitations and ways to improve the overall performance and reliability of canopy deployments:

Research has identified five (5) major factors that can affect pilot chute launch performance:

1. Pilot chute and container design
    a. Ensure the correct components are used
    b. Kicker flap material
    c. The closing loop's anchor location
2. Physical condition of the related components
    a. Pilot chute spring compression force
    b. Kicker flap condition
    c. Closing loop length
3. Packing technique
4. Length of time the parachute system remains in a "packed condition"
    a. Extreme environmental conditions
5. Body position of the jumper during deployment.

A better understanding of the five (5) factors listed above will shed some light on how each can affect pilot chute launch performance. For instance, with respect to using correct system components, the mismatching of deployment-related components can affect the overall performance of a parachute system. For example, a short bridle may not allow the pilot chute to clear the jumper's burble. Likewise, a pilot chute of the wrong size may not have sufficient drag to lift the weight of the main deployment bag at a proper deployment velocity (normally 40-60 feet per second).

The specific factors that influence spring-loaded pilot chute performance, described below, provide a better understanding of the capabilities and limitations of this type of deployment system.

Pilot Chute Spring Compression Force

Spring-loaded pilot chutes, depending on the manufacturer and model, have springs that differ widely regarding compression force; 20-45 lbs (9-20 kg) is typical for most when newly manufactured.

Over time however, spring force will slowly diminish. This loss of compression force varies dependent upon the model type and manufacturing lot of the spring. Several pilot chute manufacturers have developed field tests that help determine the "airworthiness" of used pilot chute springs. Here is an example:

- ***Spring Compression Force*** – Place a one (1) inch (2.54cm) spacer (circled in red) on top of a calibrated scale. Center the pilot chute over the spacer and compress the spring down to the spacer. Read the scale and repeat the test for accurate results. (Consult your pilot chute manufacturer for their minimum force requirement).

- ***Functional test -*** Pack the main canopy and pilot chute into the proper container. Pull the ripcord, ensure the pilot chute jumps well clear of the container in less than one (1) second after the ripcord pull.
    - Pilot chute should jump within a 45° vertical cone above the container.
    - In freefall, a pilot chute that launches at a slight angle from vertical will most likely hit the relative wind outside the jumper's burble quicker.
    - An expanded version of the *Functional Test* is included at the end of this document.

<u>Kicker Flap Material and Condition</u>

The original American-made kicker plate (circa 1950) was an aluminum disc specifically shaped to fit the base of the MA-1 pilot chute spring. Its use was mainly discontinued in the early 1980's when harness/container manufacturers began to produce their own spring-loaded pilot chutes that were not compatible with the size and shape of the original aluminum kicker plate.

The "kicker plate" was eventually replaced with a custom "kicker flap" built into most (post 1980's) harness/container systems, primarily for student and military use. The kicker flap helps to provide a stable launch platform upon which the spring-loaded pilot chute will sit. Some harness/container systems have the kicker flap built into the main deployment bag, thus eliminating the need for an extra flap. The material used to stiffen the kicker flap is typically MDS nylon or HDPE polypropylene. A correctly designed kicker flap will help keep the pilot chute properly centered and help prevent the spring from burrowing into the deployment bag, which can hinder the launch.

Incorrect packing techniques, improper storage, and/or age can cause the stiffener material in the kicker flap to crack or permanently deform. A damaged kicker flap may cause the pilot chute to launch poorly.

Closing Loop Length and Anchor Location

The main closing loop should be short enough to keep the spring-loaded pilot chute fully compressed and centered above the kicker flap within the container. This is a very critical point; anything less than full compression will effectively reduce the jump height of the pilot chute after the ripcord is pulled.

The location of the closing loop anchor point may also influence how well the pilot chute is controlled when the system remains in a packed condition for prolonged periods. As residual air inside the canopy escapes, the closing loop will appear to be too long and less effective in keeping the pilot chute fully compressed. This lack of pilot chute control typically has an adverse effect on the pilot chute launch.

An anchor point mounted on the main bag kicker flap is considered one of the more reliable methods of keeping the pilot chute centered in the container. The closing loop passes directly through the center of the pilot chute cap, guided by a grommet. However, this design also tends to increase the thickness of the packed main container, which is for some considered an undesirable characteristic. Nonetheless, this method often allows the pilot chute to jump higher and straighter.

Other loop anchoring locations, such as the bottom main flap, or attached to the base of the reserve/main divider flap, have demonstrated problems keeping the pilot chute properly centered, especially when the main canopy is left packed for extended periods of time. A pilot chute that does not remain "centered" while packed may be a contributing factor in pilot chute hesitations.

Packing Technique

One of the primary goals of the rigger/packer/jumper is to ensure the closing loop is set at the proper length. Closing loops will stretch after initial installation and will eventually stabilize in length once the loop's knot is fully seated. Check the loop length and the loop's airworthiness prior to packing. Again, the goal is to keep the pilot chute centered in the main container and fully compressed. Adjust the loop length accordingly. Log the ideal length in the packing log or other location for future reference.

The pilot chute fabric should be placed as directed by the manufacturer's packing manual. Normally, the pilot chute fabric should not be pushed down along the sides of the deployment bag. This technique could trap the fabric during pilot chute launch, causing a noticeable hesitation.

Length of Time the System Remains in a "Packed Condition"

When a spring-loaded pilot chute remains packed for extended periods, the air within the main canopy will slowly escape, resulting in the following:

- the closing loop will appear to be too long
- the pilot chute spring is allowed to extend
- the longer loop may allow the spring to shift off-center

Any of the above will have a negative effect on pilot chute launch energy and direction of launch.

Prior to jumping the system, perform this inspection:

- Ensure that the pilot chute is compressed 95-100%. This will:
    - maximize jump distance
    - increase the possibility of achieving a reasonable launch angle of 45° or less off perpendicular
    - result in maximum compression, which will help to prevent the pilot chute from tilting
- Ensure the pilot chute is centered in the container to aid in a proper launch direction.

If these two (2) criteria are not met, the container should be opened and the loop length checked and shortened if necessary. The pilot chute should then be recompressed and the container reclosed.

Extreme Environmental Conditions

Weather conditions around the world vary widely, in both temperature and humidity. Extreme environmental conditions, especially heat, can cause nylon and polypropylene kicker materials to permanently deform from their original physical shape. This can occur when the pilot chute spring is allowed to drift away from a centered alignment when fully packed, usually due to a long closing loop, sloppy packing or both. Even properly packed equipment can cause kicker flap/bag stiffener deformation if the equipment is stored in extreme heat for long periods.

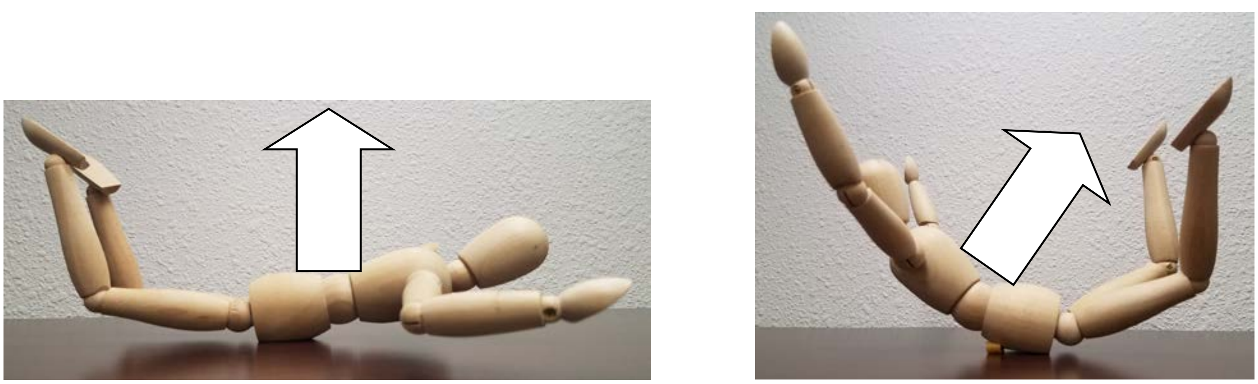
Another consideration relates to temporary storage and transport. Unpacked containers may develop problems when improperly stored away after the day's last jump. A system with an empty main container thoughtlessly stuffed into a gear bag may also experience flap damage if the kicker flap is bent out of shape and allowed to remain that way. Extreme heat will likely accelerate the deformation.

Humidity level can have a noticeable effect on closing loop length. For instance, an ideal loop length for a parachute system packed in Arizona (a dry climate) will probably have to be shortened if the same system is packed and jumped in Florida (a damp climate). "Moisture displaces air" is the basic reason a canopy packs smaller in Florida.

Body Position of the Jumper During Deployment

The jumper's freefall body position during the ripcord pull and subsequent deployment has the greatest influence on pilot chute launch performance and its ability to pull the entire main parachute assembly to line stretch in a timely fashion. Many experts agree that ***body position is the most important characteristic that contributes to reliable and timely deployments.*** All jumpers, sport and military alike, are subject to this basic principle.

In the military tactical environment, the additional equipment the jumper may carry (rucksack-PDB, weapons, oxygen, radio, night vision, navigation board, K9, etc.), and their attachment positions on the jumper can influence the size of the burble behind the jumper. Rock-solid stability during deployment, in a flat body position, is certainly one of the "major causes of pilot chute hesitations." In other words, an ideal freefall body position (left photo) is not the ideal body position during the ripcord pull through full deployment.



The white arrows indicate direction of pilot chute launch

Experienced jumpers who understand this principle will assume a position that is “head high” with a “strong arch” just prior to pulling the ripcord. The strong arch should be maintained all the way through canopy opening. This body position is described as 40° - 45° head-high (right photo) and is best attained by remaining in an arched body position with lower legs bent at the knees at an angle of 90° or less, with the arms fully stretched and hands above head level. This position, which puts the jumper into a “back-slide,” will provide more airflow across the back of the jumper, thus breaking the burble during deployment and will usually eliminate pilot chute hesitations.

Additionally, the jumper should look straight up after pulling the ripcord to observe the opening. Looking up helps to break the burble and visually confirms to the jumper that the pilot chute has successfully launched. Waiting three (3) seconds or more before checking may increase the possibility of a hesitation with a resulting increase in altitude loss during opening.

Over the years, we have improved our procedures. For instance, jumpers trained prior to the 1980’s had been instructed to look over one shoulder after the ripcord pull to ‘break the burble’ and check for a deploying canopy. We then discovered that this maneuver causes the jumper to drop a shoulder, which allows the deploying main risers to load asymmetrically, usually causing the canopy to turn during opening. This is one of the primary causes of line twists.

Line twists that occur with round canopies and low-performance ram-airs were a relatively benign common event 30-60 years ago. However, today’s skydiver who jumps a high-performance elliptical ram-air faces consequences that are potentially more serious. Looking over one’s shoulder during the deployment can result in a hard canopy opening, serious canopy damage that may lead to a malfunction, injury to the jumper or worse.

According to the U.S. Parachute Association, there have been sixteen (16) fatal incidents related to hard openings in the USA since 2001. The majority of these fatalities were jumpers with an average age of 59, and a median age of 62. Jumpers in this age range who started skydiving more than 30 years ago were probably taught to look over their shoulder after the ripcord pull. However, it is unclear if the jumper’s body position was a contributing factor in these hard openings, but it is clear that looking over your shoulder during main deployment could produce similar results.

Summary

If you experience pilot chute hesitations with spring-loaded pilot chutes on a regular basis, you now have the necessary information to help isolate the causes of those hesitations. It could be the equipment or your technique, or both. Replace deformed kicker flaps and pilot chutes with weak springs.

Although spring-loaded pilot chutes are generally reliable when packed, maintained and properly used by the jumper, it may be advisable to choose an updated deployment method, at least for the main parachute system. The spring-loaded pilot chute and the inevitable hesitations that accompany its use have plagued parachutists for almost 100 years. There are other effective options available and they should be considered by both military and sport jumpers.

The “Hand-Deployed Pilot Chute,” which includes both “Throw-Out” and “Pull-Out” designs were invented in the mid 1970’s to solve the hesitation problem. These deployment methods, especially the throw-out pilot chute, have an excellent safety record with hundreds of millions of successful sport and military jumps. About 90% of the experienced jumpers use the throw-out method. The military has slowly approved and adopted this deployment method, and many military groups have been using throw-out pilot chutes since the mid 1980’s.

Some might argue that the throw-out pilot chute might have a greater tendency to entangle with ancillary military combat equipment. In reality however, the throw-out version is far less likely to entangle simply because it rarely hesitates because it is thrown into clean air next to the jumper, whereas the spring-loaded pilot chute is much more likely to entangle with the jumper or the additional equipment being carried due to its potential to hesitate and tumble back down onto the jumper or the jumper's equipment.

Overall, the throw-out pilot chute has proven to be the most reliable and popular method of deploying the main canopy. However, there is good news for the jumper with a ripcord-deployed spring-loaded pilot chute in their main container. It may be possible to convert your harness/container into a hand-deploy set-up quite easily by qualified personnel. Contact the manufacturer of your harness/container or your local master rigger for more information and advice.

How to Evaluate Spring-Loaded Pilot Chutes

Perform the Test Described Below

(Consult the manufacturer of your parachute system for specific testing parameters)

The Functional Pilot Chute Launch Test:

1. Pack the pilot chute into the main container as directed by the system's user manual.
    a. Ensure the pilot chute is completely compressed (shorten the closing loop accordingly if the pilot chute is not fully compressed).
    b. Accurate results are best obtained when a jumper wears the system with the harness properly adjusted.
    c. Have the jumper lay on the floor or a packing table.
2. Have the jumper pull the ripcord.
    a. Observe the pilot chute launch.
    b. The straighter the spring, the straighter the launch.
    c. The pilot chute should jump well clear of the container in less than one (1) second after the ripcord is pulled.
    d. Perform multiple tests if so desired.
    e. Video-record the test for a more accurate review of the results.

Conditions that will Negatively Affect a Good Pilot Chute Launch:

- Closing loop is too long:
    - If the pilot chute is not completely compressed, the launch height will be less.
- Pilot chute not centered in the container:
    - The spring may "slide" sideways, which allows the base of the spring to slide off the kicker flap, negatively affecting launch capability.
        - This can happen if the closing loop is too long.
        - This can happen even while the container remains closed if a "long loop" is used.
    - A non-centered pilot chute, left packed over time, can cause the spring to deform permanently, thus affecting every subsequent launch.
    - Pilot chute springs can be bent or deformed when unpacked canopies are haphazardly thrown into gear bags. This condition can be compounded in the military environment when multiple gear bags are stacked on top of one another.

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