

Star Crest Skydiver's Guide

The Art of the Small-Way Skydive



Flying and Organizing Small-Way Skydives

by Jack Davis

Latest versions of this ***Star Crest Skydiver's Guide*** and companion ***Star Crest Jump Start*** are available at:

- <http://www.axzeo.com/star-crest-jump-start/>
- <http://www.axzeo.com/star-crest-skydivers-guide/>
(this document)

The ***Star Crest Skydiver's Guide*** provides information for participating in group Star Crest and speed star jumps, background reference material, plus templates for organizing your own group skydiving events.

The ***Star Crest Jump Start*** provides a summary of key points from the ***Star Crest Skydiver's Guide***.

Star Crest Skydiver's Guide

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Star Crest Skydiver's Guide

<http://www.axzeo.com/star-crest-skydivers-guide/>

LCCN	2016908768	Library of Congress Control Number
ISBN	978-0-9975876-6-1	ebook
ISBN	978-0-9975876-9-2	paperback, interior: full color
BISAC	SPO001000	Sports & Recreation / Air Sports
BISAC	SPO064000	Sports & Recreation / Extreme Sports
Revision	180215	9 8 7 6 5 4 3 2

Star Crest Jump Start

<http://www.axzeo.com/star-crest-jump-start/>

ISBN 978-0-9975876-3-0 ebook

Cover photo by Randy Forbes

CAUTION

Parachuting and flying in skydiving aircraft can be dangerous.

This guide is intended for licensed skydivers participating in Star Crest and speed star group jumps. The information herein is adapted from the inputs of multiple writers and contributors, and does not represent official policy of the USPA or any other organization. *Skydiving is an inherently dangerous sport* and while a goal is to represent best practices, this guide may also contain information that is incorrect or out of date.

This document is not a training or instruction manual. No liability is implied or assumed for losses or damages due to the information provided. Individuals should review the information, discuss with instructors, and assess the risks involved before employing any of the guidance outlined in this document. As with all aspects of skydiving, *you are responsible for your own actions, choices, and results.*

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1 Forward

- Before you get to 250 to 500 “mass-way” skydives,
- Before you get to 150 to 250 “large-way” skydives,
- Before you get to 75 to 150 “big-way” skydives,
- Before you get to 18 to 75 “mid-way” skydives,
- *Get really good at 6 to 16 “small-way” skydives!*

This guide is intended to build skills and help organize small-way [formation skydives](#) with 6 to 16 relative-work (RW) jumpers. Small-way formations range from quick and simple speed-stars, to organized *Star Crest Recipient (SCR)* jumps, to free-fly and hybrid formations such as *vertical Star Crest Recipient (vSCR)* jumps.

The information provided here is a compilation from [written and web resources \(Appendix E\)](#) along with inputs from experienced jumpers, organizers, and the author's experience.

This guide is organized in three sections.

- Chapters 1-14: Information and tips for flying 6 to 16 person skydives.
- Appendix A-C: Templates and tools for organizing your own group skydives.
- Appendix E: References for further information on formation skydiving.

2 Introduction

This guide is intended to summarize the best practices for participating in and organizing group relative work skydives. Small-ways keep things simple.

- Group size is from 6-16 jumpers.
- The jump is performed from a single aircraft, such as a Cessna Caravan or Twin Otter.
- Exit altitude is typically a maximum 15,000 feet (MSL).
- Skills are focused on:
 - Safety
 - Efficient group exits

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- Diving and braking
- Stadium flying and sector-radial approaches for docking
- How to recover when things don't go quite right
- Breakoff and tracking
- Opening priorities
- Canopy flight, vertical separation, and landing

Even with this limited set of objectives there's a lot to cover. So before getting into big-ways, get really good at *the Art of the Small-Way!*

2.1 Non-Goals

A couple notes about what's *not covered*.

- Linked exits. (*On the list for a future update.*)
- Additional safety guidelines for groups of more than 16.
- Exiting for formations from multiple aircraft.
- Use of oxygen when exiting aircraft above 15,000 feet MSL ([USPA SIM 2-1-M](#)).

Once you have your small-way skills down and are interested in bigger-ways, you might attend one of the big-way camps outlined in [Appendix E Resources](#) “Big-Way Camps” section.

3 Star Crest Awards

Star Crest jumps provide a means for jumpers to learn and improve their skills in group relative work skydives. These basic skills open the door to more advanced activities such as sequential relative work, big-way formations, and other forms of group relative work performed today. While USPA license classes (A/B/C/D) identify general skydiving experience based on number of jumps and fundamental skills, [Star Crest Awards](#) recognize an individual's RW abilities in working with a group of jumpers.

In addition to the original *Star Crest Recipient (SCR)* award, the Star Crest Awards program now includes ten possible awards.

- SCR** Star Crest Recipient
(unlinked exit, group of 8 or more, hold for 5 seconds or more)
- SCS** Star Crest Soloist
(like SCR, but individual docks 8th or later)

NSCR	Night Star Crest Recipient (like SCR, but in “the full dark of night”)
SCSA	Star Crest Skydiver Award (like SCR, but pass through hoop before forming and holding formation)
NSCSA	Night Star Crest Skydiver Award (like SCSA, but in “the full dark of night”)
USA*	Universal Skydiving Award (Four aerobatic maneuvers** between taking grips in 5 formations. **360° turn left, 360° turn right / front loop / back loop / barrel roll)
vSCR*	Vertical Star Crest Recipient (Up to 4-way linked exit, free-fly or hybrid formation of 8 or more, hold formation 5 or more seconds)
vSCS*	Vertical Star Crest Solo (like vSCR, but individual exits unlinked and docks 8th or later)
hSCR*	Halo Star Crest Recipient (Like SCR, but from a free-fly exit of 20,000 feet or higher,)
hSCS*	Halo Star Crest Solo (like hSCR, but individual docks 8th or later)
*Prereq:	USA/vSCR/vSCS/hSCR/hSCS awards require video or photo submitted with the award application.

This guide provides a summary of key points and suggestions to successfully complete your first SCR award. As has been said, *“every skydiver is a one-person star – but if you want to do something bigger, you’ve gotta’ get good at RW”*.

4 Getting Started

Hopefully someone (maybe you!) organizes a “Star Crest Day” or “Speed Star Day” at your drop zone. (Or if not, see [Appendix A - Organize Your Own Group Event](#) for information on how to plan your own event.)

A typical Star Crest event involves 3 to 5 jumps. Each jump includes time for a briefing, dirt dive, skydive, debrief, packing, plus breaks.

Jumpers should complete the **Participant Info** worksheet (either [on-line](#) or [written](#), see [Appendix A-2](#)), and turn this in to the event organizer who will assign initial positions. (If you’re uncomfortable with your exit position or flying any aspects of the jump, let the jump leader know.)

4.1 Pre-Jump – Be on Time!

A successful skydive starts with the pre-jump briefing. Be on time or you may miss key information for participating in the group jumps for the day. It's difficult for even a small-way to come together on the first jump, so it helps if the same group can work together for several jumps. With repacking, manifesting, bathroom and lunch breaks things only get more hectic later in the day.

4.2 Pre-Jump Briefing

The jump leader will organize the jump, assign exit positions, and slots for the base. The briefing for the first jump will usually be slightly longer to review the jump, safety procedures, and other information. The pre-jump briefing will cover the following key points.

1. **Safety** is always top priority. If you have concerns or suggestions, *speak up!*
2. **Jump plan** – The type of exit and type of formation.
3. **Exit position** – Your position for exit.
4. **Load order** - Who to follow and where to sit in the plane.
5. **Spotting** – Who will spot and signal climbout.
6. **Climbout** – The sequence to set up in the door.
7. **Launch** – Who and how the exit will be keyed to launch.
8. **Diving, Flying, and Docking** – Dive flow sequences.
9. **Recovery** – What to do if things don't go quite right (falling low, funnels, etc. Rebuild on base, or rebuild on lowest?)
10. **Breakoff and Opening Altitudes**
Breakoff – Altitude at which to breakoff, turn, and track.
(Wave-off – 500 feet above Opening where you flare out of track and initiate wave-offs.)
Opening – Altitude at which to throw your pilot chute.
11. **Tracking** – Avoid tracking along the flight path directly toward another group.
12. **Canopy Priorities** – Anticipate malfunctions, rear-riser steer off-heading openings.
13. **Canopy Flight** – Build vertical separation and continually scan to stay clear of others.
14. **Landing** – Landing-pattern and direction (drop zone policy).

15. **De-Brief** – Where and when to meet for debrief.

Ask if topics are missed or you're unsure about anything.

Be safe, wear a big smile, and have fun!

4.3 The Dirt Dive

After the briefing the group will run through dirt dives to practice the exit, visualize the jump, and reinforce what you'll be doing. Stay focused— what you do in the mockup is what you'll do in the air – *only it will be a lot noisier, bumpier, and windier up there!* We'll practice the dirt dive as many times as necessary for everyone to get a good picture. The dirt dive steps through the key sequences of the jump:

1. Boarding the aircraft.
2. In-aircraft positions, prepping to jump, spotting and climbout.
3. Moving into exit positions.
4. Executing the launch – {SHAKE} - READY – SET - GO!
5. Exiting straight out.
6. Flying to the formation and docking.

TIP: *While practicing in the mockup, note the person behind you – this is the person you'll follow when boarding the plane.*

From the dirt dive you should have a clear picture of your exit position, how to move to setup in the door, how the exit will be keyed, and what to do on “GO!”

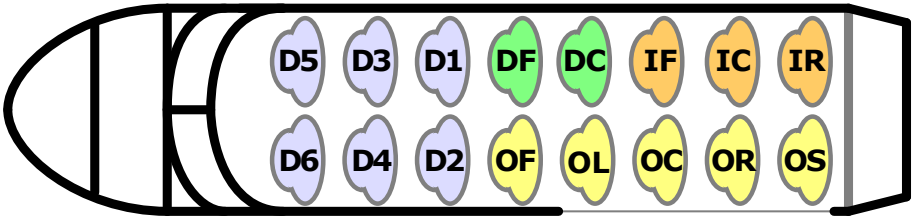
5 Boarding and Seating

Try to do all your checks and put-ons (pin checks, gloves, altimeter, helmet, goggles, etc.) with a minimum of fuss – ideally, before you load the plane. As usual, board the aircraft in reverse exit order – jumpers exiting last, board first; floaters and camera climbing out first, board last.

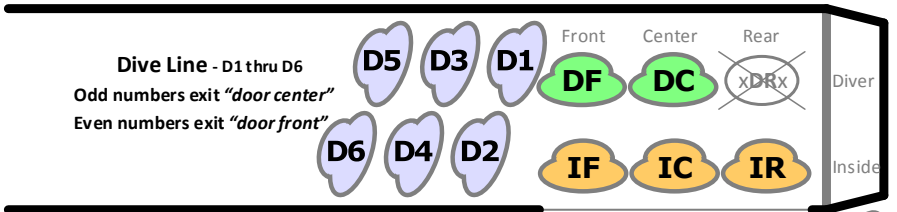
The following figures illustrate typical seating and exit positions for a Cessna Caravan or Twin Otter.

Important – *This document assumes the jump door is located on the left side of the plane. If the door is on the right side, you will need to make changes accordingly.*

Figure 1. Exiting with 5 Outside Floaters

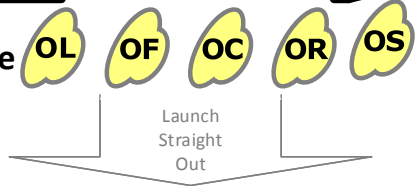


Seating Positions



Caravan Exit Positions: 5 Outside

Main launch body up to 10
(followed by dive-line)

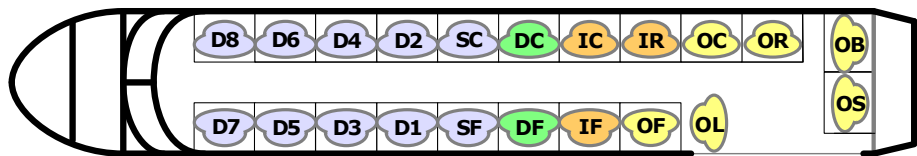


- | | | |
|--------------------------|-------------------------|--------------------------------|
| OL Outside Lead | OS Outside Step* | DF Diver Front |
| OF Outside Front | IF Inside Front | DC Diver Center |
| OC Outside Center | IC Inside Center | DR – empty** |
| OR Outside Rear | IR Inside Rear | D1-Dn Dive Line |

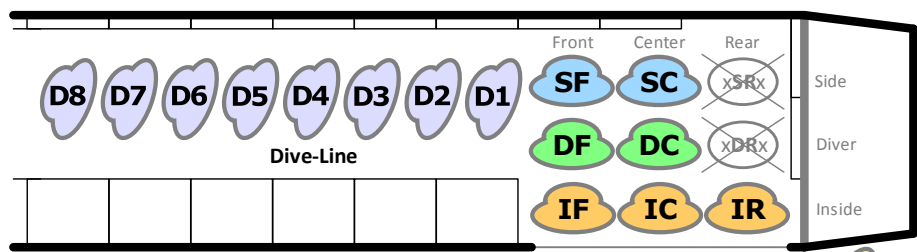
* Outside Step (OS) only on aircraft equipped with a camera step.

** The Diver Rear (DR) position is at risk for getting slammed into the rear door frame. To avoid injuries, always leave the Diver Rear (DR) position empty.

Figure 2. Exiting with 6 Outside Floaters

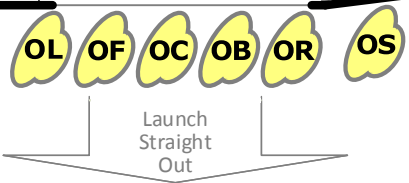


Seating Positions



Otter Exit Positions: 6 Outside

Main launch body up to 13
(followed by dive-line)



- | | | |
|--------------------------|-------------------------|-----------------------------------|
| OL Outside Lead | OS Outside Step* | DC Diver Center |
| OF Outside Front | IF Inside Front | SF Side Front |
| OC Outside Center | IC Inside Center | SC Side Center |
| OB Outside Back | IR Inside Rear | DR/SR – empty** |
| OR Outside Rear | DF Diver Front | D1-Dn Dive Line |

* Outside Step (OS) only on aircraft equipped with an outside camera step.

** The Diver Rear (DR) and Side Rear (SR) positions are high risk for getting slammed into the rear door frame. To avoid injuries, always leave the Diver Rear (DR) and Side Rear (SR) positions empty.

6 The Ride Up

On the ride to altitude, relax and visualize the jump. Don't rush to stand-up – standing or kneeling burns way more energy than sitting. For the last few thousand feet you'll be flying with low oxygen – stay relaxed, quiet and *breathe deeply* to focus on the jump.

As the plane closes the last 1000 feet to exit altitude, move to kneel or a hunched stance as you double check your gear. Those near doors and

windows should watch for any unexpected aircraft. When the pilot signals the aircraft is on jump run and good for exits, call and open the door. The spotter then confirms the plane's position and scans for stray aircraft. Once over the climbout spot and clear, the spotter gives "thumbs-up" for the floaters to move outside.

7 The Exit

Exits are where the fun begins. There are several factors that influence the type of exit to use:

- **Planning and practice.** Amount of time for ground preparation and practice.
- **Diving and building.** Diving to dock is fun but subtracts from the formation's flying time.
- **Flying the formation.** Is the formation to break and turn points? Shift with stingers dropping vertical? Hold for a minimum amount of time (e.g. Star Crest)?

There are three general types of exits to use for groups of six or more: Speed Star (aka inside dive-line), Unlinked, and Linked. The type of exit determines positions for launching the exit.

7.1 Exit Priorities

1. Move into position and launch safely.
 - Protect handles and move with caution to avoid accidental reserve, pilot chute, or locking pin accidents.
 - Launch the exit at the planned exit point to ensure everyone makes it back to the landing area.
 - Avoid collisions, slams, and falls that can cause an injury or accidental deployment.
2. Get out the door fast.
 - Launch as quickly, safely, and as close to each other as possible. Exiting quickly and safely is more important than exiting stable. Slow exits force those exiting last to cover more distance to reach the base.

3. Get out and get stable.
 - If you flip or take a tumble out the door, that's ok. Once out, get stable, then fly to the formation.

7.2 Mass Exit

Diving Exit versus Mass Exit

For groups with only a few inside divers and where moving to the door is just a step or two, the conventional “diving exit” where inside divers launch downward and toward the rear following the base as it falls away is simple. However as the number of inside jumpers grows, moving to the door for a diving exit needs to slow otherwise jumpers risk hitting the rear doorframe. Three factors come into play in moving to the door:

1. Exiting the door on a rearward angle reduces the space you have to get through. If your momentum is moving to the rear, you can injure yourself or others if (when) you miss.
2. As you exit, the wind will push you rearward, again potentially slamming you or the person on your left into the rear doorframe.
3. The dive-line also has its own momentum from the jumpers behind you (which you have no control over). Here again, if your exit angles rearward and you don't consciously correct, your momentum combined with the dive-line momentum can also get you slammed into the rear doorframe.

Slamming into the doorframe is potentially dangerous if a reserve handle or locking pin gets dislodged, or someone gets hurt. The following video shows a group exit with a dive-line using the conventional diving exit (fortunately, no apparent injuries).



Skydive Group Exit (Bepperuti, 2014)

<https://www.youtube.com/watch?v=It7wpb-VXnE>

The Mass Exit

Bigway camps and bigway events commonly teach and use a faster and safer “mass exit” technique. Like other exits the mass exit can be launched either linked or unlinked, but works faster to get a large number of jumpers in the air together quickly and safely.

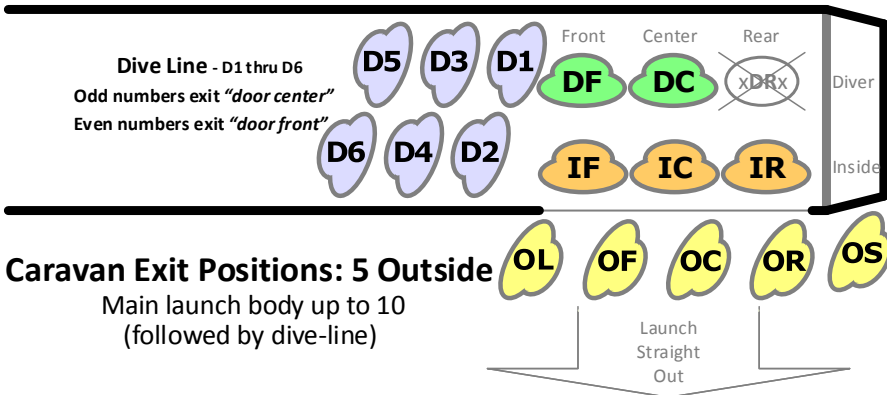
Instead of a downward dive to the rear, in the mass exit jumpers step out driving slightly forward toward the wing tip to launch themselves *perpendicularly straight out from the plane*. The following sections describe the mass exit technique for launching groups of five or more.

7.3 Exit Positions

For most exits the arrangement will be:

- For aircraft equipped with an outside step, one or two floaters outside on the step.
- Four or five outside floaters on the door.
- Three inside divers, front/center/rear, in the door.
- One pair (Caravan) or two pairs (Otter) of jumpers behind the front and center inside divers.
- Remaining divers queued in a line to follow the main body.

Figure 3. Exit Positions – 5 Floaters

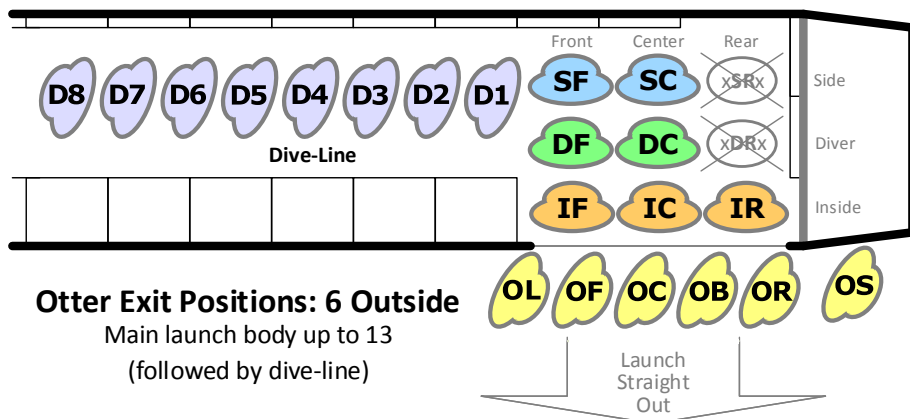


- | | | |
|--------------------------|-------------------------|--------------------------------|
| OL Outside Lead | OS Outside Step* | DF Diver Front |
| OF Outside Front | IF Inside Front | DC Diver Center |
| OC Outside Center | IC Inside Center | DR – empty** |
| OR Outside Rear | IR Inside Rear | D1-Dn Dive Line |

* Outside Step (OS) only on aircraft equipped with a camera step.

** Diver Front (DF) and Diver Center (DC) position *immediately behind* Inside Front (IF) and Inside Center (IC). The Diver Rear (DR) position is high risk for getting slammed into the rear door frame. To avoid injuries, always leave the Diver Rear (DR) position empty.

Figure 4. Exit Positions – 6 Floaters



Otter Exit Positions: 6 Outside

Main launch body up to 13
(followed by dive-line)

- | | | |
|--------------------------|-------------------------|-----------------------------------|
| OL Outside Lead | OS Outside Step* | DC Diver Center |
| OF Outside Front | IF Inside Front | SF Side Front |
| OC Outside Center | IC Inside Center | SC Side Center |
| OB Outside Back | IR Inside Rear | DR/SR – empty** |
| OR Outside Rear | DF Diver Front | D1-Dn Dive Line |

* Outside Step (OS) only on aircraft equipped with an outside camera step.

** Diver Front (DF) and Side Front (SF) position *immediately behind* Inside Front (IF); Diver Center (DC) and Side Center (SC) position *immediately behind* Inside Center (IC). The Diver Rear (DR) and Side Rear (SR) positions are high risk for getting slammed into the rear door frame. To avoid injuries, always leave the Diver Rear (DR) and Side Rear (SR) positions empty.

7.4 Spotting

Earlier on the ground the jump leader, spotters, and launch keyer review the jump plan and its three key ground reference points:

1. The “ideal-exit spot” – based on winds-aloft and inputs from immediate prior jumps, this would be the ideal point to exit if this were the only group.
2. The “split-exit spots” – when there are multiple groups exiting on the same jump run. Based on the number of jumpers in each group, split-exit spots account for the separation distances needed between each group.
3. The “climbout-spot” that precedes the group’s exit-spot is based on an estimate of how long it will take the group to climbout, setup, and launch.

Climbout time is largely determined by the number of jumpers and their familiarity in moving into position outside on the door. Generally, the more jumpers positioning outside, the longer it will take to setup. (With 5 to 7 people moving to outside positions, 15 to 30 seconds for setup is not uncommon. The section “*Timing Setup and Launch*” provides guidelines to estimate setup and launch times.)

7.5 Climbout

Know who’ll be checking the spot and watch for their motion to climb out, then proceed with the climbout as practiced in the mockup.

Outside Floaters: When moving to a position outside on the door, *always turn with your rig towards the center of the door!* If you turn in the wrong direction and scrape or hit the door frame it’s easy to pop a flap, locking pin, riser cover, handle, or pilot chute (*not good!*).

- When near the front of the door: turn right, clockwise towards the front.
- When near the rear of the door: turn left, counter-clockwise towards the back.

Here are a couple examples of *what not to do!*



Main Deploys on Door (1:02)
https://www.youtube.com/watch?v=T913e_HAAOc



Main Flap Opens on Door (0:23)
<https://www.youtube.com/watch?v=K7BWZ14dNn8>

To avoid hitting rigs, floaters climb out in pairs with the forward person moving out first followed by the rear person a moment later.

5 Outside: From a Caravan or Twin Otter with five outside floaters.

1. Outside-Lead (OL) followed by Outside-Step (OS) move first.
2. Outside-Front (OF) followed by Outside-Rear (OR) move next.
3. Outside-Center (OC) moves into position last.

6 Outside: From a Twin Otter with six outside floaters.

1. Outside-Lead (OL) followed by Outside-Step (OS) move first.
2. Outside-Front (OF) followed by Outside-Rear (OR) move next.
3. Outside-Back (OB) followed by Outside-Center (OC) move last.

7.5.1 Individual Notes

The following notes are related to specific exit positions – feel free to skim or skip this section. Once you have an assigned exit position, you can then come back and review the related note.

Outside-Lead (OL) – On jump run you should be kneeling in the door with your right hand gripping near the front of the inside bar. Look for any unexpected aircraft while watching for the climbout-spot. When the spotter confirms and gives thumbs-up for climbout, place your right foot next to the leading edge of the door with your toes pointed toward the front of the plane. Move yourself up, out and FORWARD while pivoting with your right arm and right foot. As you swing out and pivot right, hug your body to the plane. (Your right foot supports your weight, your left foot should be off the door in the slip-stream.) Move your left hand forward on

the outside of the plane. If the plane has an outside bar, take a grip on it with your left hand and then shift to take a grip on it with your right hand. Lean forward as best you can to make room for the Outside-Front (OF) who will be coming out behind you.

Look over your right shoulder to the center float to watch for the keying movements to launch. (You may not be able to see the keying movements for the launch, but the floaters nearest should be mirroring the movements as the launch sequence starts.)

Outside-Step (OS) – On jump run kneel in the door and take a left hand grip on the inside bar near the rear. Look for any unexpected aircraft while watching for the climbout-spot. When thumbs-up for climbout is given, move yourself up and out while pivoting left (counter-clockwise) with your left arm and left foot. As you swing out turning left, stay close to the plane. Move your right foot to the camera step and with your right hand take a grip on the outside bar. With your right hand gripping the upper outside bar, shift your weight to right foot on the camera step. Your left hand can let go of the inside bar while you now move your left foot off the door.

Outside-Front (OF) – Same as Outside-Lead (OL), but follow carefully. Take a forward grip on the inside bar with your right hand, then move up and out while pivoting right (clockwise) with your right arm and right foot – be careful not to push into OL. As you swing out and turn right, stay close to the plane and move your right foot forward close to OL's right foot on the door. (Your right foot supports your weight, your left foot should be off the door in the slip-stream.) If the plane has an outside bar, take a grip on it with your left hand and then shift to grip the outside bar with your right hand. Lean *slightly* forward into OL to make room for Outside-Center (OC) who will be coming out behind you. Straighten yourself once OC is out.

Outside-Rear (OR) – Like Outside-Step (OS), but *gently* - as you swing out and pivot left be careful the wind doesn't throw you against OS. With your left hand, grip the inside bar towards the rear and move your left foot to the edge of the door. Pivot up, out, and to the left with your left arm and left foot. Once outside, put your right foot at the rear of the door. Shift to take an underhand grip on the inside bar with your right hand, or if the plane has an outside bar take a grip on the outside bar with your right hand. Face forward as you transfer your weight to your right foot and take your

left foot off the door. Lean slightly rearward to make room for the Outside-Back (OB) or Outside-Center (OC) who will be coming out behind you. Straighten yourself once everyone is out.

Outside-Back (OB) – Like Outside-Rear (OR), but *gently* - as you swing out and pivot left be careful the wind doesn't throw you against OR. With your left hand, grip the inside bar towards the rear and move your left foot to the edge of the door. Pivot up, out, and to the left with your left arm and left foot. Once outside, put your right foot near the rear of the door. Shift to take an underhand grip on the inside bar with your right hand, or if the plane has an outside bar take a grip on the outside bar with your right hand. Face forward as you transfer your weight to your right foot and take your left foot off the door. Lean slightly rearward to make room for the Outside-Center (OC) who will be coming out behind you. Straighten yourself once everyone is out.

Outside-Center (OC) – You're last. Use the same motions as OF to move outside but you may need to squeeze into the hole. If you must push, *push up and forward*, NEVER down or to the rear. To minimize your width, rotate clockwise sideways facing forward before you push out the door. (Moving out, up, and rotating afterward requires more room.) As you move out, push into the wind. *Be careful not to let the wind push you into the person behind. (As you move, if your pack presses too strongly against the person you can scrape open your closing flap which will expose your locking pin.)*

Inside Door Divers (IF-IC-IR-DF-DC-SF-SC) – As the floaters move outside, move to your inside door positions. *Keep tight with your back straight - don't lean forward and don't put any pressure on the floaters outside.*

- Caravan – Up to 5 divers may position to launch straight out. 3 on the door (**IF-IC-IR**) followed by 2 behind (**DF-DC**).
- Twin Otter – Up to 7 divers may launch straight out. 3 on the door (**IF-IC-IR**) followed by two lines of 2 behind (**DF-DC** and **SF-SC**).

Three inside divers, (**IF**, **IC**, **IR**) create the first row facing the three outside floaters. The pairs of divers (**DF-DC** and **SF-SC**) following the first row should be *directly behind (NOT between)* the first two door

divers forward on the door – *there should not be anyone behind the Inside-Rear (IR) door diver.*

This inside dive formation minimizes the risk of slamming someone into the rear bulkhead. (“Been there, done that, not fun!”) Not only does slamming into the rear door bulkhead hurt, but things can get dangerous if a reserve handle or locking pin gets dislodged. Keep your back straight, butt down, and don’t lean.

The first row of door divers (**IF-IC-IR**) should have their left foot near the edge of the door with their right foot underneath them. Keep your back straight and knees bent enough that you can get out the door. Distribute your weight with about 40% on your lead left foot and 60% on your right foot. Place your left hand lightly on the hip of the floater in front of you. To present to the wind your right arm should be bent with your elbow up.

The **Inside-Rear (IR)** door diver should also reach out with their left hand to grip and brace against the rear doorframe. With your right elbow up and your left arm braced against the doorframe, this position helps you “guard” your space to keep from getting pushed into the doorframe when everyone exits.

Inside Dive Line (D1+) – The remaining divers form into a tight dive line WITHOUT pushing. If space allows you may be able to form two lines, side-by-side.

Divers should position tightly with their backs straight up/down, standing slightly squat with feet staggered: left foot forward with right foot to the rear. Watch and mirror the READY-SET-GO launch sequence shifting slightly forward, rearward, and out.

TIP: The Dive-Line Shuffle – *Rather than taking left and right steps, when the dive line starts to move shuffle forward with your left foot and slide your right foot behind you. When you reach the door, plant your right foot then pivot on it turning right so that your left foot leads through the door. The goal is for your left hip to lead your body through the door as you present into the relative wind.*

7.6 Keying the Launch

1. Once everyone is in position, the exit is usually keyed by either the Outside-Center (OC) or Inside-Center (IC) as announced in the pre-jump briefing. The exit launch is initiated with a usual sideways SHAKE-SHAKE-SHAKE, then shifting slightly out (READY), then inward (SET), and then hard out (GO).
2. Everyone should be moving on GO - don't wait for the jumper in front of you. Keep SLIGHT pressure on the person in front to let them know you're there, but DO NOT push so hard to cause them to fall or trip into the doorframe on their way out.

7.6.1 Don't Slam (into) the Door

It's important that everyone focus to exit STRAIGHT OUT the door, *parallel to the wing and perpendicular to the plane – NOT toward the rear*. As you pass the door, the wind will naturally push you rearward. If you don't focus to head straight out, you or the person on your left can easily get slammed into the rear doorframe. More than just painful, this is potentially dangerous if a reserve handle gets dislodged or someone gets seriously injured.

TIP – *Your body follows where your eyes are looking. If you watch the jumpers in front as they drop away to the rear, your body will follow a rearward angle through the door and you won't go straight out - putting you and others around you at risk of hitting the rear doorframe. To exit squarely, look STRAIGHT OUT toward the wing tip – this is the direction you want to go.*

7.6.2 Exit – Individual Notes

The following notes are related to specific exit positions – feel free to skim or skip this section. Once you have an assigned exit position, you can then come back and review the related note.

Floaters (OL-OF-OC-OB-OR-OS) When in position, floaters face the front of the plane with their weight on their right inside foot knee slightly bent, ready to push off. Ideally floaters launch in two quick groups, about 1/10th of a second apart from one another.

TIP – *Break the word “Go” into two syllables – “Ga”, “Oh”.*

To help the lead and step floaters who may not be able to see the jumper keying the exit, center floaters should mirror the movements for READY (lift slightly up and out), SET (shift down and in), then...

- On the “Ga” of GO – **OL-OS** (lead and step floaters):
 - **OL Outside-Lead** – You’ll be looking over your right shoulder to watch the count. *Turn to face forward*, then push off as hard as you can as if leaping to the plane’s wingtip. Your goal is to provide two body-widths of clean air to your right for the jumpers coming off behind you.
 - **OS Outside-Step** – Release and drop straight down.
- On the “Oh” of GO – **OF-OC-OB-OR** (center floaters):
 - **OF Outside-Front** – You’ll be looking over your right shoulder to watch for the count. *Turn to face forward*, then push off as hard as you can with your right foot. Your goal is to provide two to three (2-3) body-widths of clean air for the jumpers coming off behind you.
 - **OC Outside-Center** – Push off hard with your right foot. Your goal is to provide one to two (1-2) body-widths of clean air to your right for the jumpers coming off behind you.
 - **OB Outside-Back** – Push off with your right foot. You need to provide one (1) body-width of clean air to your right for the jumper coming off behind you.
 - **OR Outside-Rear** – Release and drop straight down.

Once away, get stable and go big to minimize the vertical distance between you and the other jumpers coming out of the plane.

Inside Door Divers (IF-IC-IR-DF-DC-SF-SR) – The jumper keying the launch (typically Outside-Center (OC) or Inside-Center (IC) initiates the movements for launching the exit with the usual SHAKE-SHAKE-SHAKE. All divers should then mirror the movements of READY (shifting slightly outward), SET (shifting back), and then on GO driving STRAIGHT OUT and slightly forward toward the wingtip to counter the wind.

On SET, raise your right elbow to be ready to present into the wind.

On GO, the first row of door divers (IF-IC-IR) lifts and simply sets their left foot outside the door to exit. Leading with their left foot, divers in the

following rows (DF-DC and SF-SC) takes short steps until they can place their left foot out the door to follow.

TIP: *Exiting stable is less important than exiting quickly and safely. If you exit and flip outside, no problem – you still have plenty of time to get stable and close on the formation. As long as you're in the plane however, you're quickly flying away from the formation – only after you exit is your distance to the formation fixed. An overly slow exit requires you, and everyone behind you, to dive harder, further, and longer.*

Inside Dive Line (D1+) – On GO, step forward with your left foot and slide your right foot behind to move quickly toward the door. As you reach the door, pivot on your right foot to turn and look toward the wing tip, then step STRAIGHT OUT leading with your left leg to position your hips in the relative wind. On exit, look forward to the wing as you fall away and stabilize. Once stable, turn your head to locate the base and gauge your approach.

If the dive line is formed in *two (2) lines, side-by-side*:

- Divers in the right line: as soon as you reach the FRONT of the door, *pivot hard right*, then push off hard to *launch straight out* toward the wing tip.
- Divers in the left line: as soon as you reach the CENTER of the door, *pivot hard right* and *launch straight out*.
- Alternate Exits. The jumper in the right line will reach the front of the door first – look toward the wing tip and launch straight out. The first jumper in the left line should reach the center of the door just as the first jumper's feet leaves – likewise, look at the wing tip and launch straight out. Alternate right-jumper/left-jumper in rapid succession out the door. Until you're out and stable don't waste time looking rearward for the base. Focus on the heels of the jumper going out just ahead of you, and look toward the wing tip to launch straight out.

Don't Cut Corners: As you reach the door, *pivot right* to launch yourself *perpendicularly straight out from the plane* – *don't launch with your momentum driving rearward*.

TIP: Dive-Line – *When the exit starts (on "GO") count the number of seconds it takes you to exit, then dive for that same*

number of seconds. Refine this time on subsequent jumps as you learn exactly how far below the base will be relative to your exit.

7.7 Out the Door Present–Identify–Intercept

Present – Exit straight out looking toward the wingtip as you present your hips squarely into the wind. Don't worry or look for the base just yet – *first priority is to present and get stable.*

Identify – Once you're stable, turn your head to locate the base and plan your approach.

Intercept – If you're a floater or door diver, you'll be near the base when you exit. Plan and fly your approach to a position to take grips. If you're in the dive-line, you'll be at a widening distance to the base and will need to immediately go into a dive to catch up.

7.7.1 Step on the Gas - Diving

If you're in the dive-line and late out the door, the base will be falling behind and after getting stable you'll need to immediately go into a dive to catch up. As you dive, keep your head up, shoulders rolled forward, arms swept back in a delta, with legs extended and toes pointed. Your speed is driven by extending your legs straight. Your vertical angle is controlled by your arms – swept out from the shoulders a low angle; swept back toward your hips, a steepening dive. Keep your HEAD UP to track the base, monitor your speed and distance, and to watch and avoid potential collisions with other divers. Dive-speed collisions are dangerous – be alert in your dive!

7.7.2 Hit the Brakes

If you're approaching the formation from a dive you'll need to brake hard to return to controlled flat-fly position. Your dive and braking need to be completed before you reach the "Red Zone" that starts 100 feet away from the formation. After braking as you enter the Red Zone, you should be flat-flying belly-to-earth, 100 feet away and 100 feet above, approaching the formation on a controlled 45° descent.

To be in a controlled position at the edge of the Red Zone, you'll need to brake hard out of your dive when you're about 150 feet away from the formation – any closer and you may not be able to cut your dive momentum fast enough. (If you can't complete braking outside the Red

Zone, you risk hitting the base, sailing past it, falling below it, or colliding with other jumpers – all bad things.)

To transition from your dive to brake, lift your head and drop your knees while sweeping your arms and hands forward above your head – then push hard against the relative wind. As you brake, your body position should shift head-high to almost a 45° angle. Hold this position a few seconds to kill your dive momentum, then shift to a neutral belly-to-earth position.

If timed and performed properly, your braking should finish with you belly-to-earth, 100 feet above and away, closely matching the fall rate of the formation. In this position you're ready to enter the Red Zone for a “stadium approach” to dock.

8 The Red-Zone

The area 100 feet around the formation is where jumpers will be moving quickly and in close proximity to dock. This area, commonly termed the “red-zone”, is where most problems occur. All diving and braking should be completed before entering the red-zone. Within 100 feet of the formation you should be flat-flying stable, belly-to-earth on a paced descent to dock.

Too Hot – *If you are still diving or braking as you enter within 100 feet of the formation, veer off and watch for others to avoid collisions. Only after you've slowed in a stable flat-fly should you start your final approach to the formation.*

8.1 Flying the Stadium

The “stadium approach” helps organize everyone to fly a predictable safe descent to dock in the formation. Similar to a real stadium, the formation base becomes the stadium floor, with non-docked jumpers (in the bleachers) descending down at a 45° to 30° angle¹.

¹ **NOTE:** Though many bigway training use a 45° descent angle (Desilets, et al., 2005), some organizers recommend a shallower descent angle of 35° (Brown, 2015), 20° (Jones, 2013), or a descending range from 45° to 30° as you near the formation. (Brennan, 2016). During the jump briefing, find out what descent angle the jump leader recommends, and go with that. What's important is to be consistent with others on your jump.

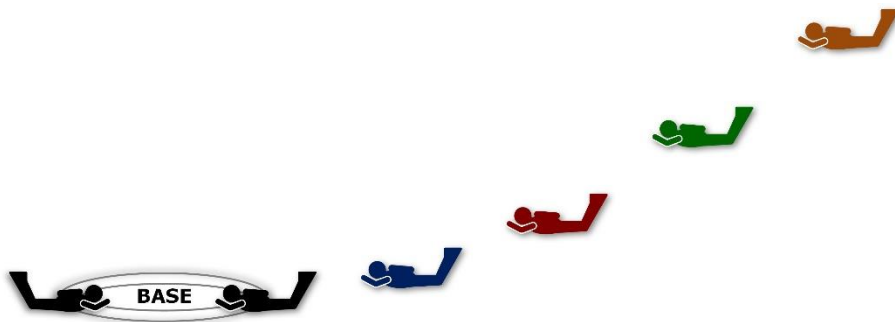


Figure 5. Stadium Approach to the Base

Starting at a 45° descent simplifies the sight-picture for the stadium – you want to be above the formation the same distance you are away from it. That is: at 100 feet away you should be 100 feet above. As you approach, gradually decrease the decent angle. At 10 feet out you should be roughly 5 feet above on a final descent.

Starting at 45° and gradually reducing the angle ensures you'll have enough altitude to avoid falling below the formation. A consistent descent also makes it easier to spot others, avoid collisions, and make a predictable approach to dock.

The following photo shows a mix of jumpers on approach to the base. While there are a couple low coming in on-level, most jumpers are roughly the same distance away as they are above the formation on a 45° approach. The camera position in the photo also shows a first-person perspective of a 45° approach.



Photo by Jack Davis

Figure 6. Stadium Approach

Be Careful Up There – Ideally everyone should approach the base on a 30° to 45° descent angle. A mix of descent angles (e.g., one jumper flying in on a 45° descent, another approaching on-level (0°), another on a 20° descent, and another on a 60° descent) makes it hard to see everyone, and easier to fly over or under someone. Any loss of altitude from crossing a burble will require extra time to get back up and into the formation.

Maintaining a 45° to 30° descent is ideal but also watch for expected situations. For example, should someone fall low, they'll likely be going big to regain altitude or closing to dock on a lower descent angle (or even on-level if they've fallen very low). Especially when flying with a new group or with less experienced jumpers, keep a sharp eye out for problems. If you see a bad situation or collision developing – *slow down your approach to keep everyone safe.*

Keep in mind that as the formation grows its fall-rate may slow. As you approach, you may need to slow your descent rate to stay above the formation. Even at 15-30 feet away, keep at least a 30° descent. As you close to dock be watchful – if the formation's fall-rate slows, you may need to quickly slow your own fall-rate to keep from sinking below.

The following video demonstrates the basics of mass exit, diving, and formation approach.



Big Way Approaches 1:48 (AXIS Flight School, 2014)

https://www.youtube.com/watch?v=_dAVzIqPfnY

8.2 Quadrants and Radials

At 20 to 30 feet away from the formation you should be descending on a straight-in approach toward the center of the formation. Sometimes the choice for an open slot is up to you as you approach the formation. In a large group however (8+), you may encounter congestion and have to slow your approach if several jumpers vie for the same slot.

To reduce congestion, the jump leader may assign a horizontal quadrant for your approach. Quadrants can be defined in one of three ways:

- 1) *Relative to the aircraft's jump-run*, where the flight path is considered "12 o'clock". (Lets jumpers start flying to their assigned quadrant even if they're far away and can't identify individuals in the base.)
- 2) *Relative to a designated "head" jumper in the base*, who is defined as the "12 o'clock". (Best if the formation is to be built in a given arrangement.)
- 3) *A combination of 1) and 2)*. An experienced base can orient its designated "head" at the 12 o'clock position on the flight path. (This allows jumpers to fly to their quadrant, then approach assigned positions once they can see the formation close up.)

For example in the following figure, the base can orient itself to position the designated "head" jumper (in green) at 12 o'clock.

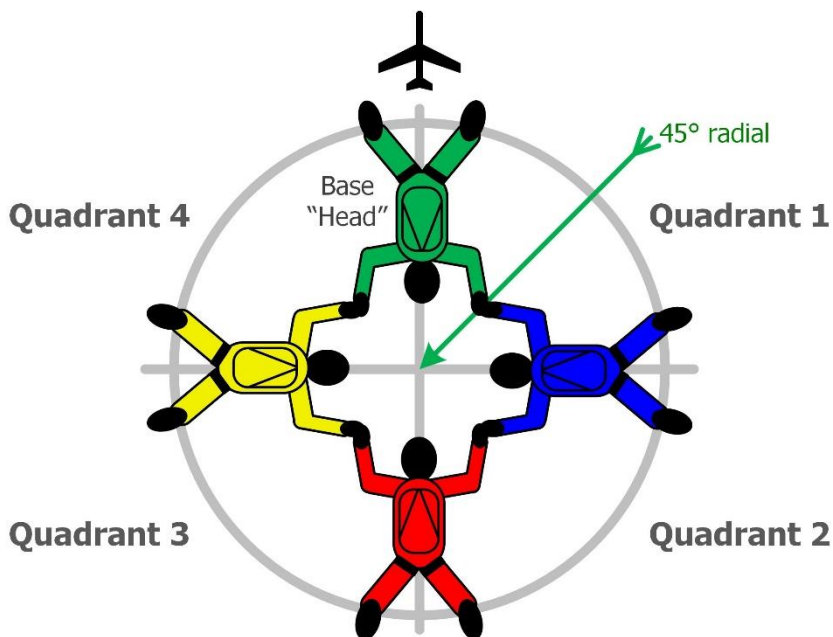


Figure 7. Quadrant and Radial Approaches for Docking

Radials

A radial is an angular approach vector to a position in the formation. If the formation is to be built in a given arrangement, jumpers may be given both quadrant and radial positions.

Assignments of positions, quadrants and radials will be reviewed at the pre-jump briefing.

8.3 Don't Fly Over or Under

Never fly over or under the formation.

- If you under-fly the formation the person above may fall onto you, risking to funnel the formation on top of you both.
- If you over-fly someone, you may fall onto them again risking the formation to funnel along with you.

8.4 Closing to Dock

As you close on the formation, don't rush to pass someone in front of you – keep your position on a paced descent following the jumpers ahead. As

you near the base, scan for jumpers who may be near you. Maintaining a paced descent, at 10 feet out you should be about 5 feet above. You should come on level with the formation about 2 feet away from taking grips. Match the fall rate as you fly your slot. Come to a stop and double-check your fall rate, hovering on-level as you prepare to take grips. The following video demonstrates good body position as you close to take grips.

Mantis Flat-fly Position 1:26 (AXIS Flight School, 2013)
<https://www.youtube.com/watch?v=aq1oUZVgeYA>



8.4.1 Don't Reach

Don't reach! (You will become unpopular when, not "if", your stretched reach creates instability or takes out the formation.) *If you have to reach, you're not in position!*

- A stretched reach to the front, side, or high will lift your upper body causing you to spill air off and slip into a back-slide. In a back-slide you can pull the formation down along with you.
- A stretched reach down or to the rear will drop your head low spilling air off your legs and driving you forward into the center of the formation as you pitch down. In a forward-slide you can again pull the formation down along with you.

Take grips *only when you're on level and in position*. (Yes, it can be hard to keep from grabbing. If you're not in a good position, resist the urge to reach.) When making vertical adjustments stay centered in your slot.

8.4.2 Sometimes It's Better to Wait

Within 2000 feet of breakoff, *slow down and approach with care*. When approaching near breakoff it's often better to fly to your slot and hover, rather than dock late.

1. A late rushed dock risks funneling the formation at breakoff-altitude. If the formation funnels at breakoff, jumpers may be recovering from the funnel at opening altitude without any time for tracking. Inadequate tracking means limited separation which raises the risk for canopy collisions on deployment.
2. For the jump to qualify for Star Crest, the formation must be complete and hold for a minimum 5 seconds. Each dock restarts the clock. If the formation already has enough jumpers and is within 10 seconds (~2000 feet) of breakoff, you'll be more popular if you let the formation complete its qualification, rather than dock with insufficient time.

8.5 Dock

Before taking grips you should hover in your slot and stop a moment without touching the formation. Ideally those you're docking on should barely feel that you are there. If the formation is wobbly, wait until it settles. When you're ready to grip, check that you're not reaching forward of your head. Rather than reaching forward, extend your legs to drive deeper into your slot. As you hover in place, take a grip on each wrist of the other jumpers then give a quick gentle shake indicating they can release and begin flying with you.

Be Ready! *As soon as you are docked, be prepared for others to move in and dock on you.*

9 Fly the Formation

After you dock, you become part of the formation. Your flying doesn't stop, you now need keep the base stable!

9.1 Flying the Base

Once you're docked, work to keep the formation stable while others dock.

Make it Flat: Look across the formation to check that you're on-level with the opposite side.

- If you see containers, you're too high (falling too slow).
- If you see bellies, you're too low (falling too fast).

Keep it Moving: As you dock, engage your arch to keep the formation's fall rate fast. Often jumpers will be overly cautious of falling low and shift to a slow-fall position as they dock. A slowing fall rate creates problems for approaching jumpers who may miss and sink low.

Relieve Tension: There should be no tension on your arms, hands, and grips as you're flying in the formation. (If you're flying properly, you theoretically should be able to release and re-take grips without affecting the formation as you fly your slot.)

Feel if there's tension on your arms and hands, as if the formation is pulling to break your grip. This is a common problem. Either the jumper(s) next to you may be pulling, or you yourself may be back-sliding. Taking grips often puts jumpers in a slightly chest-high, back-sliding position. If you feel tension on your hands and arms, extend your legs and drive toward the center of the formation and closer to one another. Whenever you change body position, also look across the formation to keep your fall rate level.

Close Breaks: Occasionally the grip between two jumpers may break (see "[Tension](#)" above). *If a break occurs, do not chase it.* Chasing by side-slipping or turning to close a gap will pull the formation around and start it rotating. *If there is a break, everyone should fly towards the center to relieve the tension and close the gap.*

Stop Rotations: Jumpers docking with too much horizontal momentum can cause the formation to start to spin. Stop the rotation by dropping a knee (side-slipping) in the opposite direction. Again, whenever changing body position, look across the formation to keep your fall rate on-level.

Absorb Waves: Jumpers docking with too much vertical momentum can cause the formation to start to wave. Work to keep the formation level by tensioning your muscles to absorb the waves, and look across to adjust your fall rate and bring the formation back to level.

Don't Reach Out: Do not reach out to "help" others as they close to dock. Reaching out to help someone dock induces rotations, level changes, and instabilities that can ripple through the formation. Hold your grip until the new docker indicates they are stable "on slot", have both hands in position on you and the jumper next to you, and ready for you to release.

Stay with it: Don't give up if you notice someone has gone low – keep the formation strong and the fall rate moving. Low fallers will be working to go big, level up, recover, and make it in. Give them time – it's how we learn. Stay working and flying the formation until breakoff altitude.

9.2 If (When) Weird Things Happen

Jumps often don't go perfectly and here are some typical problems that can occur. (Of course when things don't go quite right, do your best to help out and keep everyone safe.)

9.2.1 If It Starts To Funnel

If someone comes in hard or the formation starts to pull apart, release your grip on that side immediately. It's quicker to break a couple grips, than to rebuild an entire formation. When there's a break, *fly toward the center* of the formation to shorten the gap. Chasing a person to the side will start the formation rotating – *do not chase the break, fly to the center*.

9.2.2 Formation Funnels – Recoveries

Recovery plans should be discussed in the pre-jump briefing. Here are two common recovery scenarios:

- **Partial collapse:** If a majority of the formation remains intact, stay with it. Those that have broken away or fallen low should work back up to rejoin.
- **Complete collapse:** If a majority of the formation breaks apart, there are two options for rebuilding:
 - **On Base:** With larger groups, the formation often rebuilds on a designated jumper or group of jumpers identified as “base”. (With large groups it can be hard to tell who and where the lowest jumper is. Locating jumpsuits, helmets, or rigs of a designated base is typically quickest.)
 - **On Lowest:** Alternatively groups may choose to rebuild on the lowest jumper. (Dependent upon your location, larger groups make it difficult to identify who is “lowest” – which often leads to multiple bases being built.)

Follow the “on base” or “on lowest” guidance outlined by the jump leader in the [pre-jump briefing](#).

9.2.3 Falling Low – What Now?

If you fall lower than the formation you need to recognize what's happening and act quickly.

- **Do not fly under the formation:** Unhappy campers will pile onto your back.
- **Do not lift your head to look up:** You'll spill air to fall even faster and further below.
- **Stay off to the side:** Turn 90°, and stay at least 15-20 feet off to the side.
- **Go big:** Go to your max slow-fall position to work back up (see [4. GO BIG](#) below).
- **Don't give up:** Stay with the formation until breakoff, do not track away early.

1. Don't Fly Under the Formation. If your burble clips the formation it will begin collapsing and people will start falling onto your back (they won't be happy campers and mid-air collisions are hazardous). If you're falling low and heading under, turn 90° to the side and sideslip hard away from the formation. If you don't have time to turn, immediately hard stop (see section 7.7.2 *Hit the Brakes* above) and backslide away from the formation.

2. Don't Look Up. If you've fallen below the formation, *don't lift your head to watch it*. Raising your head and chest will spill more air and cause you to sink even faster. To maximize the surface area of your head and watch the formation, turn your head to the side and keep it level.

3. Move off to the Side. As you turn 90° to the formation, turn your head to the side keeping its side-profile level to maximize its surface area. Keeping your head and chest level will help you from spilling air and falling faster.

Watch the formation to guard against drifting closer. *Stay at least 15 feet away to keep your burble from affecting the formation.*

4. GO BIG. Once turned and off to the side of the formation, go big into your max slow-fall position to maximize your surface on the wind and work back up.

TIP: X-Man (see picture following): With your jumpsuit on, lay down on the floor to practice the X-Man position. This will be, head turned to the side for largest side-profile, arms straight out at 45° level with your shoulders, elbows locked, hands palms-down with fingers stretched flat. Similarly, legs should be out at 45° level and flat to your hips with your knees locked straight. Now further maximize your surface area by tensioning the jumpsuit material under your armpits by rolling your shoulders and stretching your arms (tightens and expands the wing material between your arms and body), and across your thighs by widening your legs (tightens and expands the wing material between your hips and legs).

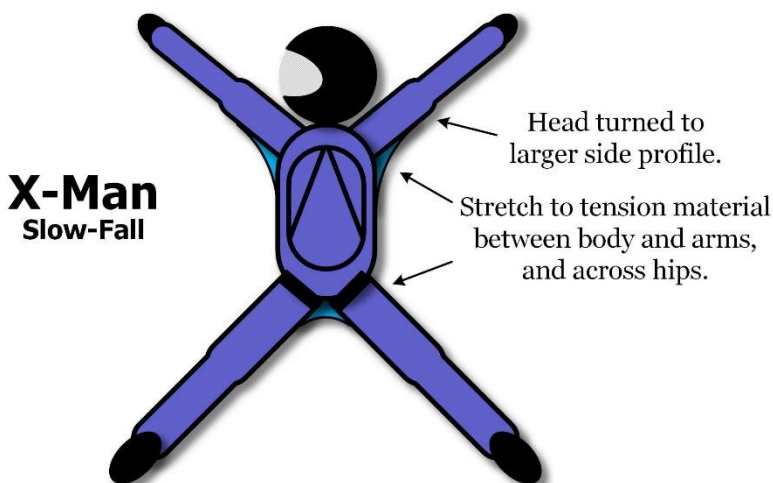


Figure 8. X-Man Slow Fall Position

TIP: Bootie Boost: The X-Man position is usually enough but if your jumpsuit includes booties, you can also add a “Bootie Boost”. Like the side-profile of your head, the side-profile of your booties is a larger surface area than when flown vertically straight on. To maximize this surface, turn your feet horizontally out to the side while you point your toes to tighten the material on your booties. Now push downward with your arms and legs to level your body with your limbs (flattening and de-arching). (“Bootie Boost” with legs and knees locked straight is a max surface

*/ max slow-fall variant of the more generic slow-fall “**Bootie Trick**”
(AXIS Flight School, 2011).)*

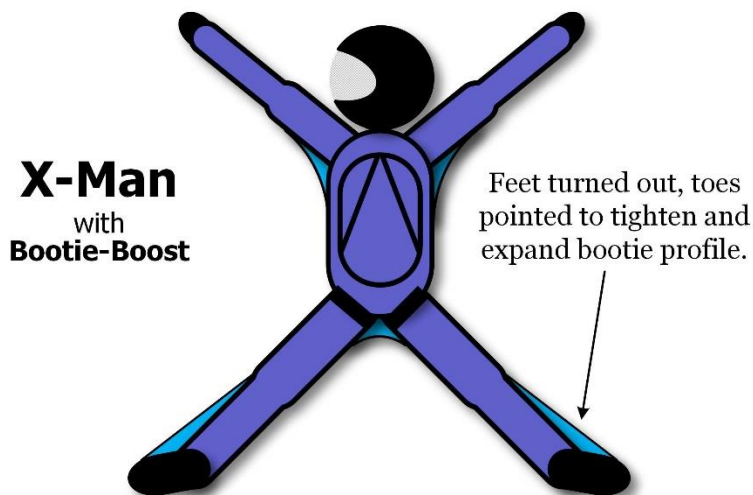


Figure 9. X-Man with Bootie Boost

5. Don't Give Up. As you work to float back up, stay sideways watching the formation 15-25 feet off to the side. One of three things will happen.

1. You'll float back up where you can then turn and restart your approach to the formation. Wait until you're 5 to 10 feet above before restarting your approach.
2. You won't float up, but jumpers in the formation may tighten to accelerate down to you.
3. You won't float back up and the formation doesn't come down. Do your best at getting big, and work to stay with the formation until you reach breakoff altitude.

On the first jump it's hard to say what the formation's fall rate will be. Later on the ground review what didn't work or what changes you might make in what you're wearing that would put you more in the center of the formation's fall rate.



http://axisflightschool.com/pdf/media_articles_Foundations_of_Flight_11_06.pdf

Level Changes While Belly Flying (AXIS Flight School, 2011) shows body position techniques for adjusting your fall rate faster or slower.

9.2.4 The Extreme Low-Faller Scenario (avoid!!)

Falling low is usually recoverable. Follow steps 1 through 5 in the **Falling Low** section above to keep the formation in sight and work to recover as much altitude as you can. Even if you can't make it in to the formation, as long as you're near where everyone can see each other, ***stay with the formation until breakoff.***

IMPORTANT – *Appendix B: Planning Breakoff and Opening* recommends that jump leaders set the group's *assigned opening altitude* to be 500 feet or more above the group's *USPA minimum opening altitude*. 500 feet provides a margin to handle the *Extreme Low-Faller* and *Close-Proximity Deployment* scenarios, and still open within USPA minimums. If the group's *assigned opening altitude* is the same as your licensed minimum, ***do not delay – deploy at your minimum opening altitude.***

feet AGL ↘	Groups with <u>any</u> A-licensed jumpers	Groups with <u>only</u> B/C/D-licensed jumpers
Assigned Opening Altitude – recommended –	3500	3000
Minimum Opening Altitude (USPA SIM 2.1.H)	3000	2500

The extreme low-faller scenario is an unusual situation where a jumper who, for whatever reason, has fallen far below the formation and all attempts to slow their fall-rate to even hold a relative distance (much less work back up) are not succeeding. Here, despite best efforts to “go big”, the jumper continues to sink fast even further below the formation. As the distance below the formation increases, they now begin to visually merge into the ground clutter. If others can't see the extreme low-faller when they

turn to track, the low-faller becomes a hazard both to themselves and to the group.

Horizontal and Vertical Separation

The breakoff and deployment strategy for an extreme low-faller is drastic. Once resolved that you cannot hold position with the formation and are continuing to fall even further below, *the extreme low-faller must commit to two actions:*

1. **Track away *early above the breakoff altitude.***
Leaving early to track away ideally should put you at a far limit of tracking and beyond the range of other jumpers. *You start your track 500 feet or more above the assigned breakoff altitude,* tracking away on a perpendicular to the jump run.
2. **Deploy at your licensed *minimum opening altitude***
Tracking away early doesn't totally solve the problem. More experienced jumpers or jumpers with "super booties" may still out-track someone who has tracked away early – it's still possible to end up with someone directly above if you deploy early or at the assigned opening altitude. The extreme low-faller must both *track hard all the way* and deploy at your licensed *minimum opening altitude* – 3000 feet for A license-holders or 2500 feet for B/C/D license-holders.

Example: Assume a group of B/C/D-licensed jumpers (licensed *minimum opening altitude* 2500 feet) with an *assigned breakoff altitude* of 5000 feet and an *assigned opening altitude* of 3000 feet. An extreme low-faller would start their track by 5500 feet and then pull at their licensed *minimum opening altitude* of 2500 feet. Other jumpers with the formation would still breakoff at 5000 feet and pull at the group's *assigned opening altitude* of 3000 feet. In doing this, jumpers from the formation track ~500 feet shorter (1000 feet less vertically) and open 500 feet higher than the extreme low faller.

If you're in a situation where you've fallen so low that others can't see you, tracking away early and deploying at your minimum opening altitude maximizes both horizontal and vertical separation. (Again, this scenario only works if the group's *assigned opening altitude* is 500 feet or more above your licensed *minimum opening altitude*.)

Again, avoid the extreme low-faller scenario if at all possible. Guard against falling below the formation, however if you do, your best option is

to *stay with the formation*. Work to slow your fall rate to hold level and move up as best you can. Stay nearby off to the side where everyone can see you; then at breakoff, turn and track with everyone else.

9.2.5 Falling Low – How Not to Go There

There are three common reasons jumpers miss their approach and fall below the formation. Recognizing the early stages will give you time to take actions to avoid them.

1. **Over-diving:** too fast, too long, and not being able to stop.
2. **Collisions:** flying under or over someone.
3. **Fast Faller:** too slick or too tight a jumpsuit, poor slow-fall technique, or higher than average body mass-to-surface ratio.

Over-diving: Diving and braking takes practice. You should be out of your dive in a controlled flat-fly approach the last 100 feet to the formation. When diving, start by setting midpoints and then shifting to brake position to see how quickly you can stop (section 7.7.2 “[Hit the Brakes](#)”); if you’re still far away, resume your dive then brake again when you get closer.

Collisions: Pay attention for the following situations.

- When diving, keep your head up and scan for others in front, and on your left and right. There is no reason to pass someone. If someone is ahead of you, follow them in.
- As you close within 100 feet of the formation and enter the red-zone:
 - Fly a predictable, paced stadium approach. If you bump into someone on the same level, push away and continue.
 - Be watchful for jumpers moving above or below:
 - If someone flies under you, you’ll cross their burble and drop rapidly. Quickly sideslip away and [Go Big](#) to retain as much altitude as possible.
 - If someone flies over you, they can fall onto your back. [Go Big](#) and shift away as they slide off.
 - Watch and *stay clear* of jumpers who are approaching low or have fallen low – they likely can’t see you and may move unexpectedly. If they’ve fallen low they’ll be focused

on the formation, moving to the side, and then going big to slow their fall rate.

Fast Faller: Fast fall issues can occur from poor slow-fall habits, too fast or too tight a jumpsuit, a heavy body mass, or a combination of the three.

- **Slow-Fall:** See section 9.2.3 “Go Big” for tips on how to maximize your slow-fall. If you need, contact an instructor to help you with your slow-fall technique.
- **Jumpsuit:** The fall rate of a jumpsuit with a nylon body and Spandex sleeves is much faster than a looser polycotton jumpsuit. If you consistently fall low when jumping with different groups, consider a looser polycotton jumpsuit and/or one with larger winglets for a slower fall-rate.
- **Body Mass:** If there’s no easy way to reduce mass, try adding a large cotton sweatshirt (or two), switch to a larger jumpsuit, or a jumpsuit with swoop cords and winglets.

9.2.6 Floating High

Occasionally you may find yourself high above the formation where you can’t effectively dive or fly a stadium approach. Here are a couple ideas to drop altitude quickly.

Distance	Technique
100 feet or less	Fast-Fall: When near but high, tuck to a “fast-fall” position by bringing your hands to your shoulders, elbows to your sides, feet on your butt, while lifting your head and pressing hips forward in a hard arch.
100 to 200 feet	Pinwheel: If a tucked fast-fall position is too slow, add a tight 360° turn to burn altitude. Dropping one shoulder while dropping with the opposite leg initiates a centered spin that spills air off both your chest and legs. <i>Keep a sharp eye out for other jumpers to avoid collisions.</i>
200 feet or more	Spiral Dive: If you’re above the formation but too high for a normal dive, shift to a spiral dive with one arm swept further back from the other to spiral down in an arc. <i>Watch for other jumpers to avoid collisions, and complete all diving and braking outside the 100 foot radius of the red-zone.</i>

Anywhere	No Free Fly Please: Free fly speeds are too fast. With limited visibility of slower jumpers converging from behind, free fly speeds add risks for hard collisions and injuries.
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If matching the formation's fall rate is difficult, consider wearing a tighter jumpsuit (a jumpsuit with a slick nylon or spandex front, spandex arms, and only basic booties), a free-fly suit without booties, or adding [weights](#).

Weights Note: *Keep in mind when adding weights that you'll also be increasing your canopy's wing loading, descending faster, and increasing risks should you land in water. For additional information, see the Dropzone.com article "Jumping with Weights" (Jonsman, 2012).*

http://www.dropzone.com/safety/General_Safety/Jumping_with_Weights_774.html

10 Breakoff

You're jumping as a member of a group, stay with the group until breakoff to keep it in sight.

Do not breakoff early. As noted in the [Extreme Low-Faller Scenario](#), breaking off to track away on your own early is hazardous to everyone. If others don't see you and you can't see them, you've set up for a potential opening collision.

If you've fallen low, stay 10-25 feet off to the side of the formation as you go big and work back up. Even if you can't make it up and in, *do not breakoff and track away early – keep the group in sight and stay near where others can see you.*

At breakoff altitude, turn 180° from the *center of the formation* before tracking. (If you're not directly facing the formation center, your turn will be something less than 180°.) As you turn, cup slightly into a *lifting turn* (a fast tight turn will cause you to sink and drop low.) The following video demonstrates the key elements of breakoff.

Breakoff (6:13) (SDC Rhythm XP, 2016)

<https://www.youtube.com/watch?v=JV5NyF45uKs>



10.1 Breakoff Altitude

Breakoff altitude and opening altitude are set by the jump leader at the pre-jump briefing – make sure you know these before boarding the plane.

- **Breakoff Altitude (SIM 6-1C):** This is the altitude at which the formation breaks, everyone turns 180° from center, and tracks away for maximum separation.
(USPA SIM 6-1C notes that breakoff should be at least 1500 feet above deployment altitude for groups of 5 or fewer; and at least 2000 feet above deployment altitude for groups of 6 or more.)
- **Opening Altitude (SIM 2-1H):** This is the altitude at which you throw your pilot chute to deploy. *Pull at the assigned opening altitude, no sooner!* If someone is tracking above, *pulling early* can get you or others killed.

(USPA SIM 2-1H notes “minimum container opening” altitudes of 3000 feet for A license holders, and 2500 feet for B/C/D license holders.)

TIP: Consider 500 feet above the assigned breakoff altitude as your **Breakoff Alert**. This provides a 2½ second lead as you near breakoff. When you reach Breakoff Alert, stop and locate the center of the formation as you prepare to turn and track. As an option, set Breakoff Alert (500 feet above the assigned breakoff altitude) as your first audible alarm.

TIP: Consider 500 feet above the assigned opening altitude as your **Wave-off Alert**. This gives you 2½ seconds to brake out of your track and flare hard as you initiate wave-off, and then deploy at the assigned opening altitude. As an option, set Wave-off Alert (500 feet above the assigned opening altitude) as your second audible alarm.

11 Tracking

Track as if your life depends on it – it does!

Tracking is a key (and fun!) survival skill. You want your track to be flat and fast so that it puts as much distance between yourself and other jumpers as possible prior to opening.

At breakoff altitude, turn 180° from the *center of the formation* before tracking. (If you're not directly facing the formation center, your turn will be something less than 180°.) *Do not pick a random tracking direction.* If you're uncertain where the center of the formation is, locate the nearest jumpers right and left, and set a track centered between them.

As you turn, keep your arms forward to avoid tipping too steeply at the start. While turning, locate other flyers high and low near you, and center yourself between the jumpers on your left and right. As you complete your turn, extend your legs to start your track, then sweep your arms back to build a fast flat track.

TIP: *Avoid sweeping your arms back too soon. Sweeping your arms too quickly will pitch you head low and start your track at a steep descent angle.*

After you have completed your turn to track and extended your legs to accelerate, tighten your abs and roll your shoulders forward. Your arms should be back near your hips with your hands cupped and pushing down to create lift. Fully extend your legs and point your toes to tighten your booties as you press your legs downward to further build lift. When performed properly your horizontal speed increases, your fall rate lessens, and as you reach maximum lift the air will start to become quiet. As you track, scan for jumpers high and low, then check the jumpers to your left and right and center yourself between them for maximum separation. The following video and article describe the key elements of tracking.

Tracking at Breakoff (3:56)

(SDC Rhythm XP, 2016)

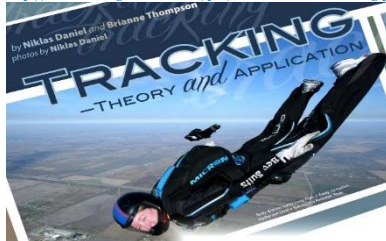
<https://www.youtube.com/watch?v=8Spju7dxfc>



Tracking

(USPA Parachutist Magazine, 2010)

http://www.axisflightschool.com/pdf/media_articles_tracking.pdf



To gain as much separation as possible *track hard until you reach wave-off altitude*, 500 feet above opening altitude. Even if you realize the spot is bad and you're tracking out away from the landing area, *keep going – separation is paramount!* Track all the way to the wave-off altitude regardless of where you are over the ground.

Tracking for maximum separation cannot be over-emphasized. Here's a video of a close-call opening between two jumpers. Had there been a pilot chute entanglement, or had the second jumper been a foot or two closer to collide and collapse into the first jumper's main, the results could have been much worse.

Skydiver Skims Canopy (snags pilot chute!)

<https://www.youtube.com/watch?v=a5VAVsipACo> (1:01)



11.1 Tracking – Separation is survival

Effective tracking is a key survival skill when jumping with others. At the end of your track you should ideally be 750 feet or more away from other

jumpers when you deploy, *but at least an absolute minimum 300 feet*. The math is simple*.

- With brakes set, a typical ram-air canopy on opening flies horizontally at around 30 MPH (44 feet/sec or more).
- Canopies frequently open off-heading. (Even a few simple line twists can have you heading off in a random direction.)
- It takes *a minimum of 3 seconds** to recognize, react, and turn a canopy to avoid a collision.
 - If one canopy opens off-heading and flies toward another canopy 300 feet away, closing at 44 feet/second the two canopies can collide in about 6 seconds. Six seconds is short enough, *but...*
 - *If two canopies open off-heading and fly head-on at 44 feet/sec, they will each close 150 feet (300 feet total) and collide in just over 3 seconds – a minimum reaction time.*

*For more details see [Appendix D: The Mathematics of Opening Separation](#).

A canopy collision will ruin your day. Three seconds (300 feet) to react and avoid a head-on collision is quick. Obviously, it would be better to have double (6 seconds, 600 feet), triple (9 seconds, 900 feet), or more time to react. To maximize separation you need to get good at two key skills.

1. Learn to fly a fast, flat track that maximizes distance, and
2. Track hard *all the way* to wave-off altitude (500 feet above opening altitude).

At wave-off altitude, break from your track, initiate wave-offs while scanning for others nearby, then when clear, pull at the assigned opening altitude.

“The only sure way to survive a canopy collision is (...wait for it...) not to have one.”

11.2 “No Track Zones” toward other groups

Ideally there would be no other groups or individuals exiting on the same jump run as your group, but this isn't always the case. The [Pre-Jump Briefing](#) should note if there are others exiting before or after your group, but you should also look to see when you're boarding. When there are no

other groups exiting on the same jump run, you only need to worry about the jumpers in your group to maximize separation.

However, if there are other groups exiting the aircraft before or after you, you also need to avoid tracking along the flight path in their direction. If jumpers from two different groups track directly toward each other, it's conceivable they could cross one another's airspace at opening. Even with an exit distance and time delay separating each group, exit timings can be off or a jumper could track farther than usual towards another group putting them at risk of a close-proximity deployment.

To minimize the risk of tracking into another group, treat a 15° vector to each side of the flight path toward another group as a “no fly zone”. As you turn to track, if you see you'd be flying near the flight path in the direction of another group, center yourself between the no-fly-zone boundary and the jumper on your opposite side. As you track, everyone should continually check the jumpers to their left and right, and center themselves for maximum separation.

12 Wave-off

TIP: Wave-off Altitude: *Set your second audible alarm for 500 feet above the assigned opening-altitude. This will give you a 2½ second alert to break out of your track and flare hard as you initiate wave-off, and then deploy at opening altitude.*

500 feet above the assigned opening altitude, break from your track by sweeping your arms forward and dropping your knees. As your body flares and shifts head-high, push into the relative wind to kill your forward speed while scanning left, right, above, and below for other jumpers. Keep in mind that you'll always have a blind spot above and behind. Level your hips and shoulders as you *give two (2) big wave-offs**, then when clear – throw your pilot chute.

* If someone is above in your blind spot, they'll need your wave-off time to get out of the way!

Example: *If the opening-altitude is 3000 feet, set your audible to 3500 feet to alert you to break from your track, initiate wave-offs, and then throw your pilot chute (as you reach 3000 feet).*

Focus Forward, Sides, and Below – No Barrel Rolls Please

As you track to wave-off altitude stay focused and *scan for jumpers ahead, left, right, above, and below*. Do not perform a barrel roll or look through

your legs to see if you might spot someone above or behind. If you barrel roll or look away, you can miss a jumper ahead or below when they wave-off and deploy – and whose canopy will shortly be racing up at you.

Tracking Near Miss

Inattentiveness in not focusing forward can create hazardous situations.

<https://www.youtube.com/watch?v=YoX2RQtk6H8> (1:45)



When tracking, look ahead scanning for other jumpers. Even if you see something late, two wave-offs from another jumper should still give you time to get out of the way.

13 Opening

Pull at the assigned opening altitude – pulling early can get you or others killed.

13.1 Opening Altitude

Be aware that different organizers may have different meanings for “opening altitude”. Is it:

- The altitude at which you throw your pilot chute to deploy?
– or –
- The altitude at which you’re “in the saddle” under canopy?

USPA SIM 2.1.H Minimum Opening Altitudes uses the wording “minimum container opening altitudes” (3000 feet for A license holders, and 2500 feet for B/C/D license holders). The term “container opening altitude” is in-line with “the altitude at which you throw your pilot chute” to open your

container. (The SIM makes no mention of “under canopy” or “in the saddle” altitudes.)

Beyond USPA guidance, there are two key safety issues.

1. *Track for maximum separation, –and–*
2. *Don't pull early.*

Given the variance in opening times between canopy models (and even the same canopy packed slightly differently), defining opening altitude as the altitude to be under an open canopy “in the saddle” means each jumper independently chooses their own altitude at which to pull. To be “in the saddle” at a given altitude, slower opening canopies would need to stop tracking earlier with less separation and pull higher than other normal or faster opening canopies – this violates safety points 1 and 2 above.

There are actually several benefits in defining opening altitude as “*the altitude at which you throw your pilot chute*”.

1. *Everyone tracks for maximum separation to a set wave-off altitude (500' above opening altitude) – no tracking short!*
2. *Everyone pulls at the same opening altitude – no masses of fabric ballooning up at varying altitudes. (Minimizes randomness for what altitude to pull at.)*
3. *Canopies opening at slightly different “in the saddle” altitudes adds vertical separation, which is actually good.*
 - Two canopies opening off-heading toward one another at *the same altitude* is a potential collision.
 - Two canopies opening off-heading toward one another at *different altitudes* is a reduced collision risk.
4. Consistency with USPA “container opening” and meaning “to initiate”:
 - *initiate Breakoff, initiate Wave-off, initiate Opening.*

For the above reasons, this guide uses “opening altitude” to mean “*the altitude at which you throw your pilot chute*” to open your container and deploy.

Double-Check – Given that different organizers may have different meanings for “opening altitude”, check with your jump leader to confirm

their guidance. If you're uncomfortable with the assigned opening altitude, let the jump leader know so they might adjust.

13.2 Close-Proximity Deployment

IMPORTANT – *Appendix B: Planning Breakoff and Opening Altitudes* recommends that jump leaders set the group's assigned opening altitude to be at least 500 feet above *USPA minimum opening altitudes*. 500 feet provides a margin to handle the *Extreme Low-Faller* and *Close-Proximity Deployment* scenarios, and still open within USPA minimums. *If the group's assigned opening altitude is the same as your licensed minimum, do not delay – deploy at your minimum opening altitude.*

feet AGL ↘	Groups with <i>any</i> A-licensed jumpers	Groups with <i>only</i> B/C/D-licensed jumpers
Assigned Opening Altitude (recommended)	3500	3000
Minimum Opening Altitude (USPA SIM 2.1.H)	3000	2500

If you've continually scanned for others and tracked effectively for maximum separation, your risk of being near someone at deployment should be very low. Mistakes and accidents do happen however, so even while rare, you should give some thought as to how you would handle a situation if you spot someone nearby just as you're looking to wave-off and deploy. These situations can be dicey, you must both:

- 1) Avoid impacting the other jumper and canopy as it opens, and
- 2) Not have your canopy opening at the same time theirs does (avoid colliding during deployment when you have little control).

While vertical separation is not reliable in a close-proximity situation, you may be forced to use it by waiting and deploying a few hundred feet lower if someone is close to you. When close to another jumper, you certainly don't want to deploy at the same time and altitude. The risk is, however, that even if one person deploys first followed by the second jumper a few seconds later, the first jumper's canopy could snivel for a time and still leave both canopies opening on collision course at the same altitude. So whether they've seen you or not, if the other person is in the process of pulling let them pull first while you move away, drop a few hundred feet to

add vertical separation, and then pull yourself. Other cases come to difficult choices. Here are a couple scenarios and thoughts to consider.

13.2.1 Scenario 1: Other Jumper Near and Above

Never open with someone near or immediately above. And keep in mind, they may not have seen you. If you find someone near and above, quickly track or side-slip away. Sweep your arms forward to show you've stopped your wave-off, and point at them to indicate *they should pull first!* A few moments after they've pulled and you're clear – you pull. Even if they haven't seen you, they should be pulling at the assigned opening altitude with you then pulling a moment later below.

13.2.2 Scenario 2: Other Jumper Near and To the Side

You must avoid deploying your canopy at the same time they do.

- If they're pointing at you to indicate for you to go first, then pull! They're being gracious and following [Scenario 1](#).
- If they've haven't seen you or you can't tell if they've seen you, side-slip or track further away to gain as much separation as you can. Watch and let them pull first (ideally they'll pull at the assigned opening altitude), and then a few moments later when you're a few hundred feet lower – you pull.

13.2.3 Scenario 3: Other Jumper Near and Below

Extremely dicey – you must both: 1) avoid impacting the other jumper and their canopy when it deploys, and 2) not deploy your canopy at the same time they do.

- First Priority: Quickly move out of the way of the other canopy should it deploy.
- Once moving away to the side, if the other jumper is pointing at you to indicate for you to go first, then pull! You're off to the side and above them, and they're following [Scenario 1](#).
- Once moving away to the side, if they've haven't seen you or you can't tell if they've seen you, then continue to move away to gain as much separation as you can. Watch and let them pull first (ideally they'll pull at the assigned opening altitude), and then a few moments later when you're clear – you pull.

Close-proximity deployments are extremely dangerous. Track effectively and scan for others to maximize separation. If you ever find yourself in close-proximity on deployment, use your training and wits to minimize the risk of collision.

It's crucial to also maintain altitude awareness. These situations are at free-fall speeds and typically at critically low altitudes. *If you're in close proximity at 3000 feet, you only have a few seconds to react and deploy. (If lower, you have even less time!)*

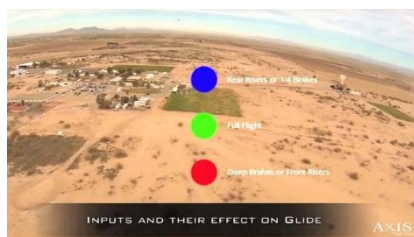
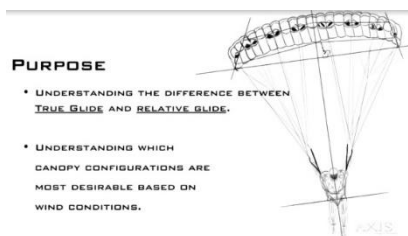
14 Under Canopy

On opening, malfunctions and canopy collisions are the main issues to watch for. Anticipate a malfunction or off-heading opening – either by you or the person next to you.

1. *First, hands immediately to rear risers!* As your canopy inflates scan for traffic and use your rear risers to steer your canopy on-heading and out of line twists as it opens. (As canopy instructor [Greg Windmiller](#) asks, “When your canopy is deploying, is there any reason your hands should not go immediately to the risers?”)
2. *If you're headed directly towards someone, pull hard right rear-riser to veer to the right.*
3. *If not headed on a direct collision course, rear-riser left or right to steer clear of any nearby canopies.*
4. *If collision is imminent with no time to turn, pull both rear risers to put your canopy into a stall.* (In a hard stall, your canopy can quickly drop altitude while backsliding 20 to 30 feet per second.)
5. Fly your canopy on your track heading for ten seconds more to further extend separation and avoid other groups.
6. Check that it's clear, then make a rear-riser turn to head to the landing area.⁽⁵⁾
7. After you've re-checked that your airspace is clear, collapse your slider, then release brakes and perform your canopy control checks – work to complete these above 2000 feet.⁽⁶⁾

- (5) If the spot is off or your track put you far out, you need to turn back toward the landing area quickly.
- (6) If releasing brakes or your canopy control check encounters problems you need altitude, ideally 1800 feet or more, to cut away and deploy your reserve. Don't rely on your RSL – cutaway then always pull your reserve.

If it turns out that you're far out from the landing area, trim your canopy for maximum distance using rear risers or small amount of brake. The following videos illustrate how to trim your canopy to adjust glide slope.



Long Spot / Relative Glide (4:04)
<https://www.youtube.com/watch?v=sGeTqaGS46Y>

The Accuracy Trick (2:36)
<https://www.youtube.com/watch?v=5OHYTvdQdjk>

14.1 Canopy Flight

Continually scan and watch for other canopies as you fly – as they say, *keep your head on a swivel*.

Everyone is going to land and, while you will initially be separated after tracking away and opening, everyone is going to land in a relatively short time and within a relatively small area. The key is to avoid canopy collisions from varying descent speeds and converging paths. Once open and stable under canopy, work to build vertical separation while steering clear of others.

14.1.1 Maximize Vertical Separation

Your canopy's wing-loading is a primary factor of how fast your canopy descends. Ideally, higher wing-loaded canopies that descend faster should land first, followed by lower wing-loaded canopies that descend slower next. When approaching the landing area, your ideal place in the pattern is where:

- Canopies ahead or below are descending faster.
- Canopies behind or above are descending slower.

Based on your canopy's wing-loading and descent rate, position yourself in the landing sequence for maximum vertical separation.

The [pre-jump briefing](#) should review the range of canopy wing-loadings for everyone on the jump. The pre-jump briefing also should provide a guide for three basic wing-loading groups: high, median, and low. As you descend toward the landing area work to follow the appropriate guideline for your canopy's wing-loading group.

- If you're in the "**high wing-load group**" (fastest descending canopies), *clear your airspace to the sides and below*, then motor down to a lower altitude to provide greater separation for the slower canopies above.
- If you're in the "**low wing-load group**" (slowest descending canopies), *check your airspace to the sides and above*, then go into brakes to stay high and provide greater separation for the faster descending canopies below.
- If you're in the "**median wing-load group**", avoid spiraling down below the "high wing-load group", and likewise avoid going into deep brakes to where you'd float into or above the "low wing-load group".

Work to organize your position and landing order for maximum vertical separation before you enter the landing pattern.

14.2 Landing

After the initial period on opening, the landing pattern is the next most hazardous time for canopy collisions. Keep alert and continually scan for traffic as you close in proximity to land. Instructions for the landing-pattern and landing-direction will have been reviewed in the pre-jump briefing.

- Follow the landing-pattern guidance defined by the drop zone and reviewed in the pre-jump briefing. (How is the landing-direction set? By the first jumper down? A fixed direction? Or ???)
- Keep pattern turns to 90° or less – no swooping or high performance landings.
- If the landing area uses a "split pattern" (see [Landing Patterns](#)) do not cross the wind line. It's easy to miss (and collide with) someone approaching from the opposite landing pattern.

- Give everyone enough space to land safely.
Don't worry about shooting for accuracy or landing close in.

14.2.1 Landing Patterns

Basics:

- **Left-Hand Pattern:** All pattern turns from “downwind to base” and “base to final” are to the left.
- **Right-Hand Pattern:** All pattern turns from “downwind to base” and “base to final” are to the right.
- **Split Pattern:** The landing area is split into halves along the wind-line. Looking up the wind-line (facing into the wind), jumpers in a left-hand pattern land on the left side, jumpers in a right-hand pattern land on the right side. Center of the wind-line is a “No-Fly Zone” that is not to be crossed. (Center is reserved for jumpers downwind on a straight-in approach.)

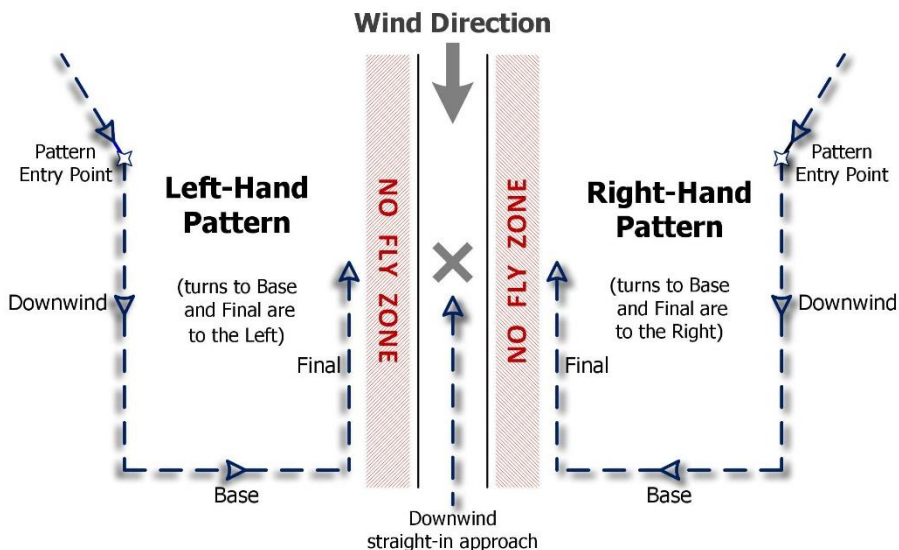


Figure 10. Split Landing Pattern

14.2.2 Flying the Pattern

- In the landing pattern, no spirals or turns greater than 90°.
- Follow the landing-pattern guidance as discussed in the pre-jump briefing.

- If you believe you cannot land safely, choose an alternate spot that's clear and *far away* from the main landing area. Even when landing far away fly a predictable downwind, base, and final pattern in case others decide to follow you.
- Do not fly in brakes or perform "S" turns in the pattern. (Both creates traffic jams behind you and increases collision risks.)
- On final, get your canopy square overhead.

14.3 On the Ground

After you land, turn around and look downwind to watch for on-coming traffic as you collapse your canopy. Continue to keep an eye out for others landing as you reset your slider, set your brakes, and gather your lines and equipment. As you walk out, stay alert and yield to others who are still landing.

14.3.1 Debrief

Meet back with the group at the designated debrief time. If you have video(s), observe your performance and note what you did well and what you could have done better. Keep suggestions positive. If someone screwed up, they are likely well aware of it.

Ask questions if you don't understand, especially any safety issues. The debrief should touch on the following points.

1. **What went right** – What could be improved – What could be done safer
2. **Pre-jump Briefing.** Any items missed in the pre-jump briefing or dirt-dive?
3. **Load Order** – Everyone seated in good position for climbout?
4. **Spotting** – Was the spot good or should it be adjusted?
5. **Climbout** – Climbout sequence good? How long did it take?
6. **Launch** – How did the exit launch go?
7. **Exits** – How did individual exits go?
8. **Diving** – Any major issues or collisions?
9. **Stadium** – Any approaches issues or collisions?
10. **Docks** – Congestion? Hard docks? Low fallers?

11. **Formation** – Good base? Any rotations or waves? Fall rate: too fast/too slow?
12. **Weirdness** - Funnels or breaks? Any low-fallers too low to recover?
13. **Breakoff** – Everyone see everyone? Good tracking separation?
14. **Opening** – Adequate opening separation? Any issues or malfunctions?
15. **Canopy Flight** – Good vertical separation? Any near-misses?
16. **Landing** – Any issues with the landing pattern or direction?
17. **General** – Other thoughts for improvement?

The jump leader will then announce the time for the next pre-jump briefing, dirt-dive, and jump. Get packed, get something to drink and eat, then meet back on-time with your gear ready for the next jump.

15 Safety Checks

- **It's up to you to be safe** – *don't be complacent!*
- **Take responsibility** for both your safety and those around you.
- **Emergency procedures** – review them before every jump.
- **Pin and gear checks** – **do one before every jump.**
Check your bridle cord window to ensure the pilot chute kill line is cocked, then check that both your reserve and main pins are snug and fully seated. Check that your pilot chute is securely stowed and that there's no loose or exposed bridle. Double-check that chest straps are properly routed.
- **Know the separation timing** needed between groups.
- **Always approach aircraft from the rear or side.**
- **Follow aircraft rules for seatbelts and helmets.**
- **Operate aircraft door according to the aircraft rules.**

For example on a hot day, if the pilot says "ok", you might open the door above 2500'.

Before opening the door, everyone should check that their equipment and pilot chutes are secure. When opening the door,

open it all the way. (If a pilot chute snakes out, someone is going out after it – it's best to have a clear path!)

- **Cameras** – Per [SIM 6-8-E-1-c](#) guidelines, you should have at least a C-license. Additionally you should have at least 100 camera jumps with smaller groups, before jumping with a camera in a larger group of 6 or more.
- **As you setup to exit, double-check that your cutaway and reserve handles** are securely in place.
- **On breakoff** stay aware of everyone around you and track as far away as you can.
- **Anticipate a canopy malfunction** and be ready to perform emergency procedures.
- **Good canopy overhead?** If you have doubt, execute your emergency procedures.
- **Keep your head on a swivel** and watch for other canopies as you descend.
- **Landing direction** Follow the drop zone's landing-pattern guidance as discussed in the pre-jump briefing. If you believe it is unsafe and wish to land in a different direction, fly a pattern to land *far out* where you won't be a hazard to others.
- **If the landing area looks crowded** decide at a high altitude to land elsewhere. If you decide to land out, still fly a standard pattern in case others decide to follow you.
- **Below 1500 feet**, keep turns to *no more than 90 degrees*.

HAVE FUN – AND BE SAFE!

16 Keeping Current



... when things don't go quite right —
an odd feeling watching your main canopy pass you by ...

"In skydiving, unexpected issues can add a bit more excitement to your day." – Jack 😊

16.1 Emergency Procedures Refresh

Hanging on the outside of an airplane and then letting go to fly with friends is always a thrill. Having to deal with unexpected problems however, can push one's limits for "enjoyable excitement". Like most aspects of aviation, with proper training and equipment skydiving mishaps are rare. A key to safety is training to identify and quickly respond to unlikely but potentially challenging situations.

The [Australian Parachute Federation](#) (APF, Australia's version of USPA) produces a great series of skydive training and malfunction handling videos — see the [list with links below](#).

TIP1: *To keep your emergency skills sharp, watch the APF "Cutaway!" series twice a year – it only takes ~30 minutes. "Reserve repack" makes for a good time to review.*

TIP2: Better yet, also make it monthly and automatic. *Schedule your calendar with a monthly recurring appointment to watch the three key malfunction handling videos (CH5, CH6, CH7) every month (takes ~20 minutes). Example:*

Type: Recurring appointment
Day: First Thursday each month
Time: 8:00PM – 8:30PM
Subject: Skydive Emergency Procedures Refresh
Message: Review APF “*Cutaway!*” videos
<https://www.youtube.com/watch?v=PTYsjH7DSVA&list=PLHdmFp89rAHBsZwLtEzkZ8wWeRk7GCrTt>

Keep current and stay safe up there!

16.2 APF “*Cutaway!*” Video Series

APF “*Cutaway!*” series:

<https://www.youtube.com/watch?v=PTYsjH7DSVA&list=PLHdmFp89rAHBsZwLtEzkZ8wWeRk7GCrTt>

CH1 – Good Canopy (4:43)

Deploy: Locate / Grip / Throw / Arch / Count123-Check-Count456

Canopy: Size / Shape / Straight / Slider / Twist-Free / Toggles / 2Flares / Pilot Chute Hesitation

<https://www.youtube.com/watch?v=PTYsjH7DSVAthe>

CH2 – Routine Opening Problems (5:12)

Line Twists / End-Cell Closures / Premature Brake Release / Slider Hang-up

<https://www.youtube.com/watch?v=MZx3lN-lwok>

CH3 – The Decision Making Process (2:31)

https://www.youtube.com/watch?v=TsxYEBLNh_8

CH4a – Emergency Procedures – Dual-Handle System (3:14)

2-handle (e.g. Licensed Jumper Rig)

Legs / Look-Grip-Right(cutaway) / Look-Grip-Left(reserve) / Peel-Punch-Right / Peel-Punch-Left / Arch

<https://www.youtube.com/watch?v=YD1we-F9-3c>

CH4b – Emergency Procedures – Single-Handle System (2:40)

1-handle (e.g. Student Jumper Rig)

Legs / Look / Reach / Punch / Arch / Clear

https://www.youtube.com/watch?v=gpZ_GeJ1rxk

CH5 – Low Speed Malfunctions (7:16)

Tension Knots / Line-Over / Damaged Canopy / Broken Lines / Pilot Chute over Nose / Jammed Brake

<https://www.youtube.com/watch?v=UL87Ceoo2L4>

CH6 – High Speed Malfunctions (8:40)

Hard-pull / Pilot Chute in Tow / Total Malfunction / Baglock / Streamer / Horseshoe

<https://www.youtube.com/watch?v=iBNf-HsD3Ms>

CH7 – Two Out (5:41)

Side-by-Side / Bi-Plane / Down-Plane / Deflated 2nd Canopy

<https://www.youtube.com/watch?v=S4x1ptlBF1Q>

CH8 – The Journey Begins (2:39)

<https://www.youtube.com/watch?v=79TWUxK1q2o>

16.3 Rhythm Skydiving: Canopy Flight Series

The Accuracy Trick under Canopy (2:02)

<https://youtu.be/VU-H2g1EdX4>

Landing Patterns 1: Basic safety and getting to the holding area (5:00)

<https://youtu.be/gUtVminRoro>

Landing Patterns 2: Adjustments in the landing pattern (2:35)

https://youtu.be/Lr_ylqaTAT8

Landing Patterns 3: Changing the pattern in the sky (3:57)

<https://youtu.be/x6GAQ7fjfh8>

The landing flare (2:50)

<https://youtu.be/tUFSs3guic>

Collapsing and Gathering your canopy after landing (1:40)

<https://youtu.be/6PK61arhFwM>

17 Glossary

Summary of basic terms.

Altitudes (in descending order)

Exit: Altitude at which you leave the plane.

Breakoff: Altitude at which the formation breaks, every turns 180° from center, and tracks away for maximum separation to open. *(USPA SIM 6.1.C defines minimum breakoff-altitudes relative to opening-altitudes: 1500 feet above opening for groups of 5 or less, 2000 feet above opening for groups of 6 or more.)*

Wave-off: 500 feet above opening-altitude where you flare from your track and wave-off prior to opening.

Opening: Altitude at which you throw your pilot chute to open your container and deploy your main canopy. [USPA SIM 2.1.H](#) defines minimum container opening altitudes: 2500 feet [AGL](#) for B/C/D license-holders, and 3000 feet [AGL](#) for A license-holders. *To provide more margin and time resolve common simple issues (line twists, collapsed cells, controllability checks) before decision-altitude, this guide recommends setting assigned opening altitudes 500 feet or more above minimums: 3000 feet [AGL](#) for groups with only B/C/D license holders, and 3500 feet [AGL](#) from groups with any A license-holders.*

Decision: If not under a fully controllable canopy, the altitude at which to decide upon “appropriate actions” (e.g. cutaway). [USPA SIM 5.1.E.4](#) recommends a decision-altitude of 1800 feet [AGL](#) for B/C/D license-holders, and 2500 feet [AGL](#) for A license-holders. *Remember that a canopy is not fully steerable and safe until you have released the brakes and completed a full control check.*

Hard-Deck: Altitude below which you only deploy your reserve and do not cutaway (at least until you have a fully open reserve). *Hard-deck altitude is a personal decision that may vary dependent on the type of equipment used (e.g. Skyhook RSL, versus standard RSL, versus manual reserve activation.) A hard-deck might be a predefined altitude (e.g. “below 1000 feet”) or situation (e.g. “once in the pattern”). (For more information see, “When Should You Cut Away?” (Pilcher, 2014).)*

Base: The center person or group who start and set the fall rate for the formation. Bases may be launched from either a linked exit, or free built from an unlinked exit.

Divers: Jumpers who exit from inside the plane.

Dive-line: Jumpers following the initial body of divers out the door.

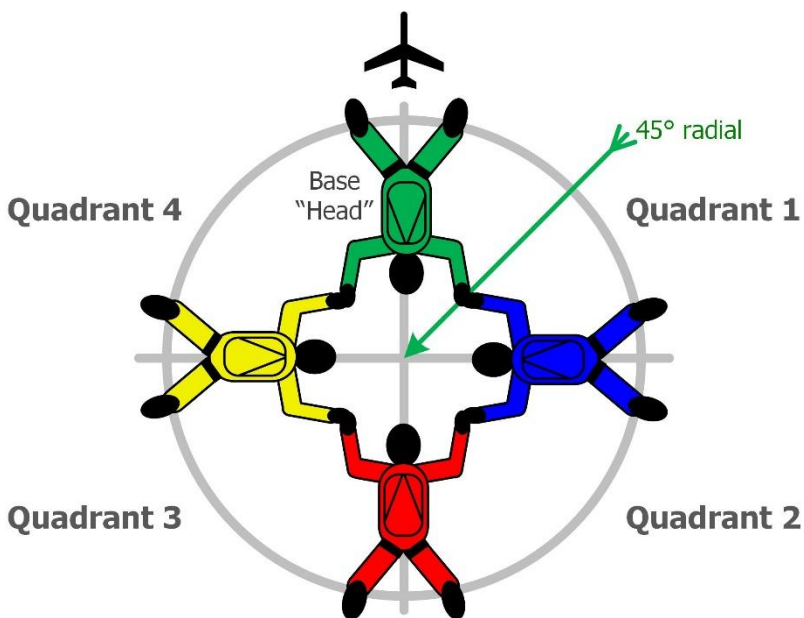
Floater: Jumpers who position and exit from outside the plane.

Present-Identify-Intercept: The three key sequences on exiting:

1) present and get stable on the wind, 2) identify the base, 3) fly to intercept and dock with the formation.

Quadrants (also see Radials): Based on either the aircraft's jump run or a designated "head" jumper (or both) as 12 o'clock, four pie-shaped segments centered on the formation.

Radials: An angular approach vector to a position in the formation. If the formation is to be built in a given arrangement, jumpers may be given both quadrant and radial positions. With a quadrant and radial a jumper can fly to their quadrant, then move to dock on a radial to their position once they can see the formation close up.



Quadrant and Radial Positions

Red-Zone: A sphere 100 feet around the formation where jumpers are converging in flat-fly approaches to dock with the formation.

(All diving and braking should be completed outside the red-zone.)

Stadium Approach: Helps organize everyone to fly a predictable safe descent to dock in the formation. Similar to a real stadium, the formation base becomes the stadium floor, with non-docked jumpers (in the bleachers) descending down at a 45° to 30° angle.

Appendix A - Organize Your Own Event

Facebook and Google Docs make it easy to create and invite others to your own group event. This appendix contains “how to” information for the following items.

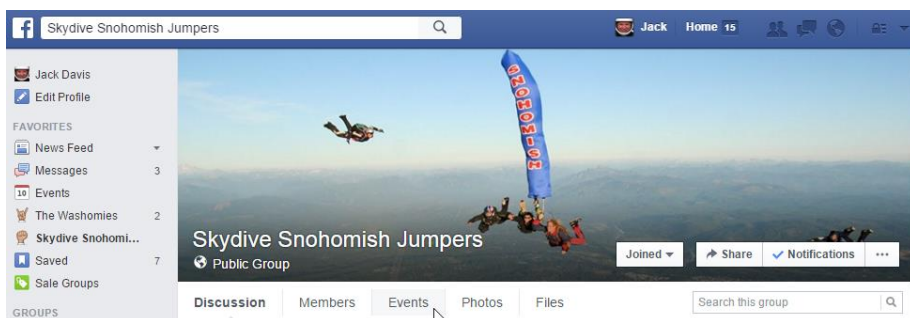
- Scheduling and inviting jumpers using a Facebook event.
- Collecting participant info (names, experience, canopy loadings, etc.)
- Jump organizing – Worksheets for noting: jump leaders, load number and time, exit assignments, wing-loadings, etc.

Use this information as a starting point to create your own event.

A.1 Create a Facebook Event

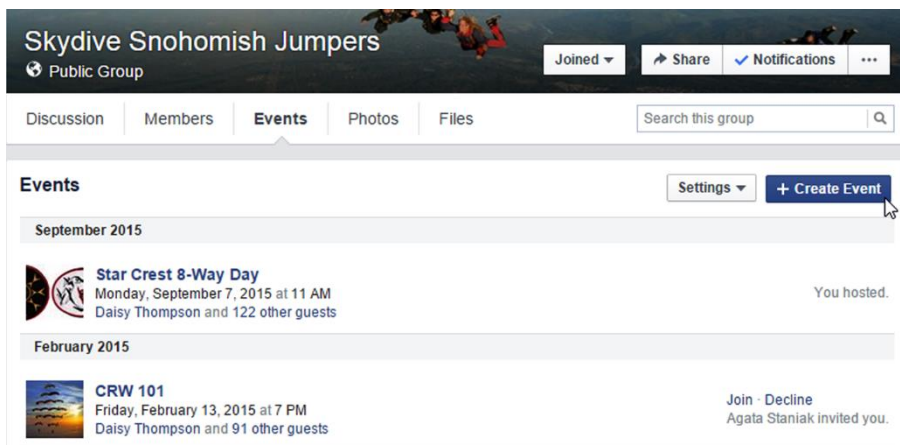
The following sample assumes that you have permissions to post to a selected Facebook group page either as a member or group admin. If you don't have the needed permissions to post, go to the group page and click **Members**, then below the menu bar click on the number next to “Admin” to see the current admins for the group. Contact one of the admins to ask if they will post your event or if they will give you temporary admin access for you to do it yourself.

1. Go to the Facebook group page for your local drop zone.
(Example, for our local drop zone it's the *Skydive Snohomish* Facebook page at <https://www.facebook.com/groups/snohojumpers/>)



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2. In the menu bar just under the cover photo, click on the **Events** button to open the current list of events.




The screenshot shows the Facebook interface for the group "Skydive Snohomish Jumpers". At the top, there is a cover photo of skydivers. Below it, the group name and "Public Group" are displayed. A navigation bar includes "Joined", "Share", "Notifications", and a menu icon. Below the navigation bar, there are tabs for "Discussion", "Members", "Events", "Photos", and "Files". A search bar is present on the right. The "Events" tab is active, showing a "Settings" dropdown and a "+ Create Event" button. The event list is organized by month:

- September 2015**
 - Star Crest 8-Way Day**
Monday, September 7, 2015 at 11 AM
Daisy Thompson and 122 other guests
You hosted.
- February 2015**
 - CRW 101**
Friday, February 13, 2015 at 7 PM
Daisy Thompson and 91 other guests
Join · Decline
Agata Staniak invited you.

3. On the group's "Events" page, now click the **+Create Event** button.

Create Public Event for Skydive Snohomish Ju...

Event Photo 

Event Name

Location

Start PST

End PST Remove

Description

Set aside that Sunday, March 6th, to come out to fly some 8+ large-ways, and qualify for your Star Crest (SCR) award. (Or come out just to have fun flying some larger speed stars!) If we have enough free-fly "stingers", we'll also organize hybrids for a try at Vertical Star Crest awards (vSCRs) - "who says flatties and freeflyers can't have fun together?".

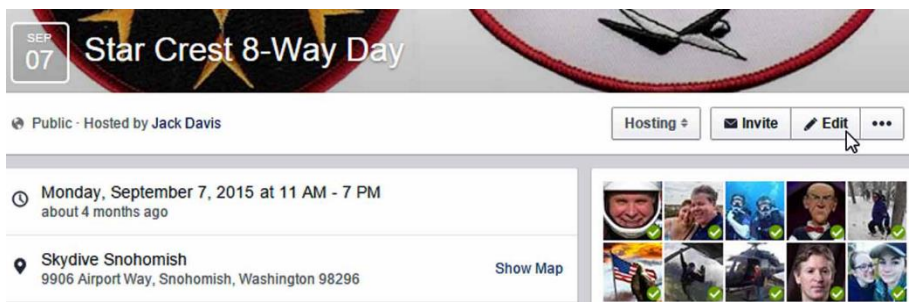
To participate in these larger group jumps you should have a B license (50 jumps) or more. Note that 8-ways and larger also count toward C license performance requirements, re SIM 3-1:E-3.d.2<http://sim.uspa.org/>

Check out the FB Star Crest Skydiving Awards page:
<https://www.facebook.com/StarCrestSkydivingAwards>

Invite your friends in Skydive Snohomish Jumpers Cancel Create

4. On the "Create Public Event" dialog enter the information about your event including a photo, an Event Name, the location, event date with start and end times, along with a description for the event.
5. Make sure the checkbox for " Invite your friends in ..." is checked, and then click the **Create** button to create the event and send out invitations.

6. If you need to make any corrections or changes later, simply go to your event page and click the **Edit** button.



Facebook makes it easy to create and manage group events.

A.1.1 Event Description Example Text

Follows is sample text that you can use as a template to create your own Star Crest Day events on Facebook.

For those with a B license or better (50 jumps or more), set aside Sunday to come out to fly some large-ways (8-ways plus?!), and qualify for Star Crest (SCR) awards. (Or come out just to have fun flying some larger fast speed stars!) If we have four or more free-fly "stingers", we'll also throw in a couple hybrids for Vertical Star Crest awards (vSCRs) --- who ever said, "flatties and freeflyers can't have fun playing together?!"

We'll start with a pre-jump briefing promptly at 11:00 (be on time!), followed by dirt dives, then onward and upward!

For those participating, please complete the short on-line form to help get things organized. (It's quick and will save having to complete this when you get to the DZ.)

<http://goo.gl/forms/Po17D994sC>

Also please review the "Star Crest Jump Start" document before the event.

<http://www.axzeo.com/star-crest-jump-start/>

Look forward to seeing everyone in some nice big stars! – Jack 8-)

For more information, also see the Star Crest Skydivers Guide
<http://www.axzeo.com/star-crest-skydivers-guide/>

Note that 8-ways and larger can also count toward C license performance requirements, see USPA SIM 3-1:E-3.d.2
<http://sim.uspa.org/#1=1|2=4|3=16|page=62>

Check out the Facebook Star Crest Skydiving Awards page:
<https://www.facebook.com/StarCrestSkydivingAwards>

Star Crest Awards criteria:
http://www.starcrestawards.com/awards/awards_criteria.html

Qualifying skydivers will be eligible to order SCR/vSCR cards, certificates, patches, decals, and other swag - you pick and pay for what you want, see
<http://www.starcrestawards.com/store/>

The Australian Parachute Federation (APF) has also published a nice "Star Crest and Bigway Guide", check it out at:
http://www.apf.asn.au/ArticleDocuments/157/Star_Crests_and_Bigways_Guide_v6_20150612.pdf.aspx

A.2 Collecting Participant Info

In preparing for your event you'll need some basic information about the people who will be participating (their names, jump experience, etc.). There are several ways to do this, but here are two of the easiest.

- **Web Form.** Participants fill out a quick on-line form. (Using Google Docs on-line forms, the completed information feeds into an on-line accessible Excel worksheet.)
- **Paper Form.** Participants fill out paper questionnaire. If you don't have access to Google Docs or jumpers miss filling out the on-line form, print out the paper form and ask participants to complete the information to sign up.

A.2.1 Participant Info – Web Form

To help planning you need a bit of information about each jumper participating in the event. An easy way to do this is using an on-line Google Docs worksheet with a form that provides a series of questions for each jumper to complete.

Keeping the form simple and short is key – if it gets too complicated people won't complete it (and you'll have to manually get the information later

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when they show up). The sample template provided below prompts participants for the following items.

1. Name, canopy wing-loading, and USPA license number.
2. Overall number of jumps, number of jumps this year, and largest group jump to date.
3. Outside, Inside, or preferred exit positions.
4. General fall-rate range (general ranges: very-slow to very-fast).
5. Can you free-fly as a “stinger” for a hybrid?
6. Other notes.

Follows is a sample event registration template for a Google Docs on-line form that can be used to capture jumper information for a Star Crest event. The on-line version of this form can be viewed at <https://goo.gl/forms/Po17D994sC>

- Show progress bar at the bottom of form pages
- Only allow one response per person (requires login)
- Shuffle question order

Form Title: **Star Crest Event Registration**
Description: Jumper information for participating in Star Crest events.

Question Title: **Name**
Help Text: Your first and last name
Question Type: Text
Required question: (yes, checked)

Question Title: **USPA License**
Help Text: Your USPA License (A, B, C, or D followed by your license number)
Question Type: Text
Required question: (yes, checked)

Question Title: **Total number of jumps**
Help Text:
Question Type: Text
Data Validation: Number Greater than 0
Required question: (yes, checked)

Question Title: **Number of jumps this year**
Help Text:
Question Type: Text
Data Validation: Number Greater than 0
Required question: (yes, checked)

Question Title: **Canopy wing loading**
Help Text: You canopy wing loading
Question Type: Choose from a list

1. 0.8 or less
2. 0.9
3. 1.0
4. 1.1
5. 1.2
6. 1.3
7. 1.4
8. 1.5
9. 1.6
10. 1.7
11. 1.8 or greater

Required question: (yes, checked)

Question Title: **Largest group jump to date**
Help Text: What is the largest group you've successfully jumped with?

Question Type: Choose from a list

1. 5-way or less
2. 6- to 8-way
3. 9- to 11-way
4. 12-way or larger

Required question: (yes, checked)

Question Title: **Preferred minimum opening altitude (AGL)**
Help Text: The minimum altitude for throwing your pilot chute?

Question Type: Choose from a list

1. 2500 feet
2. 3000 feet
3. 3500 feet

Required question: (yes, checked)

Question Title: **Outside exit position(s) you feel comfortable with.**

Help Text: We may launch with up to 5 or 6 outside on the door.

Question Type: Checkboxes

- Put me outside anywhere
- On door, Outside-Lead (OL)
- On door, Outside-Front (OF)
- On door, Outside-Center (OC)
- On door, Outside-Back (OB)
- On door, Outside-Rear (OR)
- On step, Outside-Step (OS)
- On step, Outside-Tail (OT)
- I'd prefer to be an "inside diver"

Required question: (yes, checked)

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- Question Title: **Inside exit position(s) you feel comfortable with.**
Help Text: Inside position(s) you feel comfortable launching from.
Question Type: Checkboxes
 Inside diver – Early
 Inside diver – Late
 Put me anywhere inside
 Prefer to launch from outside
Required question: (yes, checked)
- Question Title: **Do you have a preferred exit position?**
Help Text: (Exit positions will be set by jump leader who will try to accommodate preferences, though no guarantees.)
Question Type: Text
Required question: (no, unchecked)
- Question Title: **Your typical flat-fly fall rate range**
Help Text: Your typical belly-fly fall rate in an average group
Question Type: Checkboxes
 Very-slow -to- Slow (tend to float)
 Very-slow -to- Slow -to- Average (broad slow)
 Slow -to- Average
 Slow -to- Average -to- Fast (broad average)
 Average -to- Fast
 Average -to- Fast -to- Very Fast (broad fast)
 Fast -to- Very Fast (tend to sink)
Required question: (yes, checked)
- Question Title: **Are you experienced in vertical free-fly and open to participate as a "stinger"?**
Help Text: Once linked in the star, on signal, stringers transition from flat-fly to vertical-fly to create a hybrid star.
Question Type: Choose from a list
1. No
2. Yes
Required question: (no, unchecked - If not specified, assume "No")
- Question Title: **Comments or other notes**
Help Text: (For example, times if arriving late or leaving early)
Question Type: Paragraph text
Required question: (no, unchecked)

For more information about Google Doc worksheet forms see the following:

- <https://docs.google.com/spreadsheets/u/o/>
- YouTube query: [Google docs forms](#)

A.2.2 Participant Info – Paper Form

Name _____ USPA License # _____

Contact Email: _____ Contact Phone: _____

Total # of Jumps: _____ # Jumps past year: _____

Canopy Wing Loading:

- 0.8≤ 0.9 1.0 1.1 1.2 1.3
 1.4 1.5 1.6 1.7 1.8≥

Largest group jump to date:

- 5-way or less 6- to 8-way 9- to 12-way 13- to 16-way
 17-way or larger _____

Preferred minimum opening altitude:

- 2500 feet 3000 feet 3500 feet

Preferred outside exit position(s):

- Lead (OL) Front (OF) Center (OC) Back (OB) Rear (OR)
 Step (OS) Tail (OT)
 Outside anywhere Prefer an inside diver position

Preferred inside exit position(s):

- Inside diver – Early Inside diver – Late Prefer outside

Preferred exit position: _____

(Exit positions will be set by jump leader who will try to accommodate preferences, though no guarantees.)

General fall-rate range (Slow–Average–Fast):

Experienced to free-fly as a hybrid “stinger”? Yes No

Notes:

Appendix B - Jump Organizing

Once you have information about the individuals participating in your event you can begin to organize the actual jumps. Two sample worksheets are provided as a starting point for organizing jumps.

- *Jump Worksheet – Caravan*
- *Jump Worksheet – Twin Otter*

B.1 Wing-Loading Group Worksheet

To help build vertical separation for landing, jumpers can be organized into three canopy wing-loading groups: **Low** (slowest descending), **Median**, and **High** (fastest descending). To determine the range of wing-loadings for each group, first simply count the number jumpers at each wing-loading, separate into three equal groups, and record the two values that bound the **Low** and **High** groups. You can use the following table to organize wing-loading groups.

Loading	Jumpers	Total	<h3 style="margin: 0;">Wing-Loading Groups</h3> <p style="margin: 10px 0;">Low ≤ _____</p> <p style="margin: 10px 0;">> Median <</p> <p style="margin: 10px 0;">_____ ≥ High</p>
0.8 ≤	_____	= _____	
0.9	_____	= _____	
1.0	_____	= _____	
1.1	_____	= _____	
1.2	_____	= _____	
1.3	_____	= _____	
1.4	_____	= _____	
1.5	_____	= _____	
1.6	_____	= _____	
1.7	_____	= _____	
1.8 ≥	_____	= _____	

Table 1. Organizing Wing-Loading Groups

Enter these values on the *Jump Worksheet – Caravan* or *Jump Worksheet – Twin Otter*), and review these values at the pre-jump briefing.

B.2 Jump Worksheet: 5 Outside Floaters

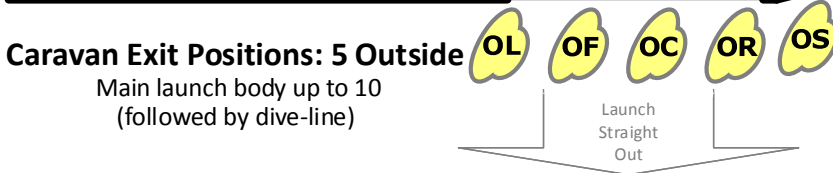
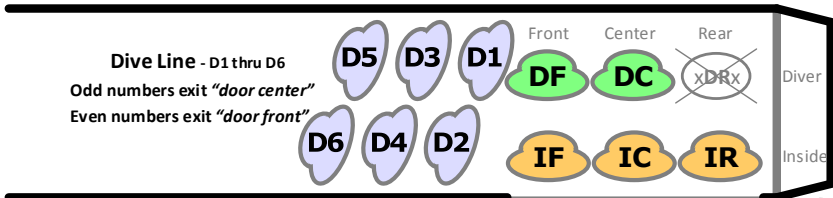
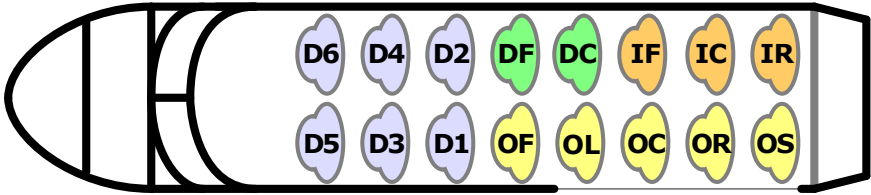
Load #: ____ Load time: _____ Jump Leader(s): _____

Wing-Loading: Low ≤ _____ > Median < _____ ≥ High

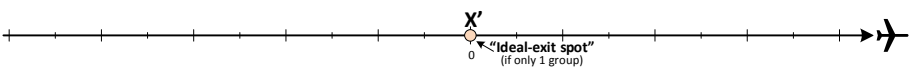
Exit: Unlinked (Star Crest) Linked Speed Star (all inside)

Groups exiting before ours? No Yes—no tracking down jump run

Groups exiting after ours? No Yes—no tracking up jump run



- | | |
|-------------------------|-----------------------|
| _____ OL Outside-Lead | _____ DF Diver-Front |
| _____ OF Outside-Front | _____ DC Diver-Center |
| _____ OC Outside-Center | _____ D1 Diver-1 |
| _____ OR Outside-Rear | _____ D2 Diver-2 |
| _____ OS Outside-Step | _____ D3 Diver-3 |
| _____ IF Inside-Front | _____ D4 Diver-4 |
| _____ IF Inside-Center | _____ D5 Diver-5 |
| _____ IF Inside-Rear | _____ D6 Diver-6 |



B.3 Jump Worksheet: 6 Outside Floaters

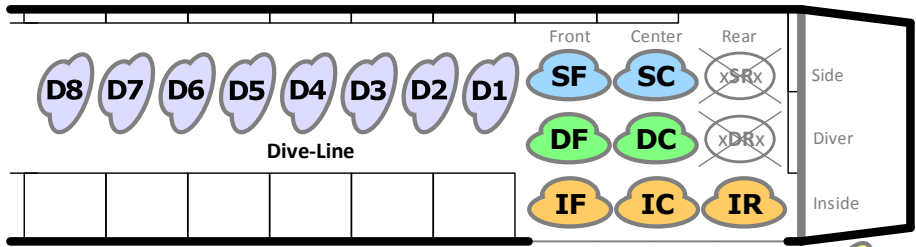
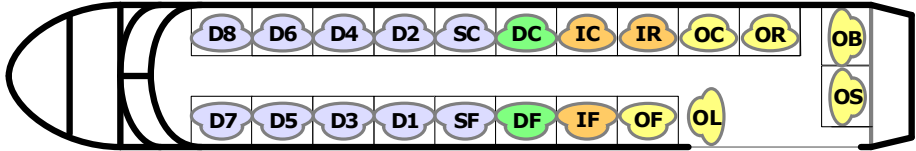
Load #: _____ Load time: _____ Jump Leader(s): _____

Wing-Loading: Low ≤ _____ > Median < _____ ≥ High

Exit: Unlinked (Star Crest) Linked Speed Star (all inside)

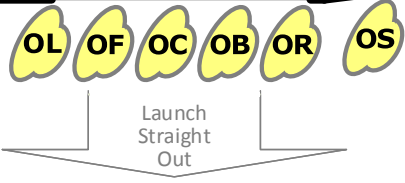
Groups exiting before ours? No Yes—no tracking down jump run

Groups exiting after ours? No Yes—no tracking up jump run

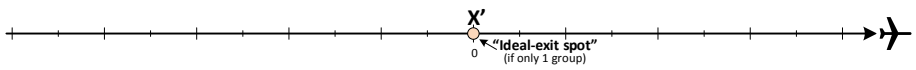


Otter Exit Positions: 6 Outside

Main launch body up to 13
(followed by dive-line)



- | | |
|-------------------------|-----------------------|
| _____ OL Outside-Lead | _____ DC Diver-Center |
| _____ OF Outside-Front | _____ SF Side-Front |
| _____ OC Outside-Center | _____ SC Side-Center |
| _____ OB Outside-Back | _____ D1 Diver-1 |
| _____ OR Outside-Rear | _____ D2 Diver-2 |
| _____ OS Outside-Step | _____ D3 Diver-3 |
| _____ IF Inside-Front | _____ D4 Diver-4 |
| _____ IF Inside-Center | _____ D5 Diver-5 |
| _____ IF Inside-Rear | _____ D6 Diver-6 |
| _____ DF Diver-Front | _____ D7 Diver-7 |



B.4 Planning Breakoff and Opening

USPA SIM 2.1.H defines minimum *container opening altitudes* of:

- 3000 feet **AGL** for A-license holders, and
- 2500 feet **AGL** for B-, C-, and D-license holders.

USPA SIM 6.1.C specifies that the minimum *breakoff altitude* should be at least:

- 1500 feet higher than the planned opening altitude for groups of five (5) or fewer, and
- 2000 feet higher than the planned opening altitude for groups of six (6) or more.

Based on USPA **SIM 2.1.H** and **SIM 6.1.C** guidance for group size, the following table shows minimum breakoff and opening altitudes.

Table 2. USPA Minimum Breakoff and Opening Altitudes

	Size: 2-5 Licensed A-D Altitude (AGL)	Size: 2-5 Licensed B-D Altitude (AGL)	Size: 6-11 Licensed B-D Altitude (AGL)	Size: 12-16 Licensed B-D Altitude (AGL)
Breakoff: formation	4500	4000	4500	5000
Wave-off: camera*	4500	4000	4500	5000
Opening: camera*	4000	3500	4000	5000
Wave-off: formation	3500	3000	3000	3000
Opening: formation	3000	2500	2500	2500
<i>USPA minimum opening</i>	<i>3000</i>	<i>2500</i>	<i>2500</i>	<i>2500</i>
<i>(Opening-750) "in the saddle" by</i>	<i>2250</i>	<i>1750</i>	<i>1750</i>	<i>1750</i>
<i>Breakoff-to-Opening distance</i>	<i>+1500</i>	<i>+1500</i>	<i>+2000</i>	<i>+2500</i>

*One jumper may be designated "camera flyer" who at breakoff waves off and when clear, pulls in-place.

B.4.1 Considerations for Opening Altitude

Most important is opening-altitude, breakoff and wave-off altitudes follow from that.

Important: Review the experience, comfort levels, and decision altitudes of the jumpers in the group. Raise the assigned breakoff and opening altitudes higher if appropriate.

USPA SIM 2.1.H Minimum Opening Altitudes uses the words "minimum container opening altitudes" (AGL, 3000 feet for A license holders, 2500 feet for B/C/D license holders). The wording "container opening altitude" is consistent with "the altitude at which you throw your pilot chute" that

opens your container. The jump leader should consider the following factors for raising the group's *assigned opening altitude* to be higher than USPA minimums.

Opening Altitude

As noted in section 13.1 [Opening Altitude](#), there are often differences in instructors, coaches, and jumpers understanding as to the meaning of "opening altitude". Is it:

- The altitude at which you throw your pilot chute to deploy?
– or –
- The altitude at which you're "in the saddle" under canopy?

[USPA SIM 2.1.H Minimum Opening Altitudes](#) uses the wording "minimum container opening altitudes" (3000 feet for A license holders, and 2500 feet for B/C/D license holders). The term "container opening altitude" is in-line with "the altitude at which you throw your pilot chute" to open your container. (The SIM makes no mention of "under canopy" or "in the saddle" altitudes.)

Beyond USPA guidance, there are two key safety issues.

1. *Track for maximum separation, –and–*
2. *Don't pull early.*

Given the variance in opening times between canopy models (and even the same canopy packed differently), defining opening altitude as the altitude to be under an open canopy "in the saddle" means each jumper independently chooses their own altitude at which to pull. To be "in the saddle" at a given altitude, slower opening canopies would need to stop tracking earlier and pull higher than other normal or faster opening canopies – this violates safety points 1 and 2 above.

There are actually several benefits in defining opening altitude as "*the altitude at which you throw your pilot chute*".

1. *Everyone tracks for maximum separation* to a set wave-off altitude – 500 feet above opening-altitude – *no tracking short!*
2. *Everyone pulls at the same opening-altitude* – no masses of fabric ballooning up at varying altitudes. (Minimizes randomness for what altitude to pull at.)

3. Canopies *opening at slightly different “in the saddle” altitudes* adds vertical separation, *which is actually good.*
 - Two canopies opening off-heading toward one another at *the same altitude* is a potential collision.
 - Two canopies opening off-heading toward one another at *different altitudes* is a reduced collision risk.
4. USPA “container opening” consistency and meaning “to initiate” – *initiate Breakoff, initiate Wave-off, initiate Opening.*

For the above reasons, this guide uses “opening-altitude” to mean “*the altitude at which you throw your pilot chute*” to open your container and deploy.

Aside from USPA minimums, there are four additional considerations that should be taken into account when deciding on an opening-altitude.

- 1) Experience Levels and Implied Commitment
- 2) Decision Altitudes
- 3) App-based Exit Timing
- 4) Extreme Low-Faller and Close-Proximity Scenarios

1. Experience Levels and Implied Commitment

If there are less-experienced (A/B/C) or new jumpers joining the group, raise the group’s *assigned opening-altitude* to at least 500 feet above USPA minimums. See how individuals perform before considering minimums.

Part of the opening-altitude decision comes down to what’s more important for members of your group:

- 2½ more seconds in freefall, -or-
- 30 seconds under canopy to resolve potential nuisance issues (line twists, end-cell closures, stuck slider, control checks, etc.) before reaching decision-altitude.

A USPA B/C/D minimum opening-altitude of 2500 feet results in an “in the saddle” altitude near or below the USPA recommended decision-altitude of 1800 feet. *This implies jumpers will perform a quick cutaway if their canopy does not open perfectly.*

2. Decision Altitudes

From [USPA SIM 2.1H](#), opening-altitude is when the pilot chute is thrown to open the container and deploy. After the pilot chute is thrown, it may take another 500 to 800 feet (sometimes more) before the canopy is open and the jumper is “in the saddle”.

- For a group with *only* B/C/D license-holders throwing at an *assigned opening altitude* of 2500 feet (B/C/D minimum), jumpers will typically be “in the saddle” at between 1700 to 2000 feet. The [USPA SIM 5.1.E.4.b](#) decision-altitude recommendation for B/C/D license-holders is 1800 feet which places jumpers near or below their recommended decision-altitude.
- For a group with *any* A license-holders and throwing at an *assigned opening altitude* of 3000 feet (A license minimum), jumpers will typically be “in the saddle” at between 2200 to 2500 feet. The [USPA SIM 5.1.E.4.a](#) decision-altitude recommendation for A license-holders is 2500 feet which places these jumpers at or below their recommended decision-altitude.

Opening near or below one's decision-altitude leaves little or no time to resolve common minor opening issues such as:

- Line twists
 - How many twists, are they accelerating into a spin?
 - Am I drifting toward trees or water?
 - Do I have time and altitude to kick out, and still land safe?
 - Is kicking out making good progress?
- End-cell closures
 - Is it just slow inflating? A torn cell? A line-over? or ???
- Premature Brake Release
 - Does releasing the other brake give me a good canopy, or is there some other problem causing a turn or spin?
- Slider Hang-up
 - Does pumping the brakes release the slider, or is there some other problem (e.g. tension knots)?
- Is the canopy controllable and landable?

Based on a good/bad canopy cutaway decision-altitude at 1800 feet and 30 seconds (500 feet under canopy) to resolve line twists, collapsed end-cell, and controllability checks yields the following.

1800 feet Decision-Altitude

- +500 feet 30 seconds to resolve canopy issues and controllability checks
 - +700 feet Canopy deployment (until open canopy “in the saddle”)
-

3000 feet Opening-Altitude

A lower opening-altitude of 2500 feet with a decision-altitude of 1800 feet implies jumpers will immediately cutaway if a canopy has *any* issues. An opening-altitude of 3000 feet gives everyone about 30 seconds to resolve nuisance canopy issues and complete controllability checks.

Again, check with the individuals in your group for their comfort levels, decision altitudes, and preferred minimum “under canopy” times.

3. App-based Exit Timing

Many dropzones operate aircraft with an on-board computer that factors winds-aloft data with the aircraft's GPS to control the light(s) that signals “ok to exit”. To help ensure jumpers can reach the landing area, the app computes canopy ranges based on an expected “under canopy” altitude.

If the group is the first to exit (i.e. exiting downwind), jumpers tracking further downwind or opening below the app's expected “under canopy” setting may not have enough altitude to make it back to the landing area.

***Example:** If the app's “under canopy” setting is 2500 feet, jumpers deploying at 2500 feet will actually be under canopy at between 1500 to 2000 feet. This may turn out to be too low to make it back to the landing area (especially for those who have tracked further downwind).*

If your jump aircraft uses an app to compute exit timing and you're the first group exiting (downwind), check with operations to find what “under canopy” altitude the app uses. Add 500 to 1000 feet to the app's “under canopy” altitude to ensure your group's opening-altitude is adequate.

4. Extreme Low-Faller and Close-Proximity Scenarios

Both the **9.2.4 Extreme Low-Faller** and **13.2 Close-Proximity Deployment** scenarios are only usable if the group's *assigned opening altitude* is 500 feet or more above USPA minimums. To provide the necessary margin for these scenarios, the group's *assigned opening altitude* needs to be at least 500 feet above minimums.

B.5 Recommended Altitudes

Based on the considerations above, this guide recommends setting the group’s *assigned opening altitude* to deploy *at least 500 feet above* USPA minimums.

Table 3. **Recommended Breakoff and Opening Altitudes**
(SIM 2.1H USPA Opening Minimums +500 feet)

	Size: 2-5 Licensed A/B/C/D Altitude (AGL)	Size: 2-5 Licensed B/C/D Altitude (AGL)	Size: 6-11 Licensed B/C/D Altitude (AGL)	Size: 12-16 Licensed B/C/D Altitude (AGL)
Breakoff: formation	5000	4500	5000	5500
Wave-off: camera*	5000	4500	5000	5500
Opening: camera*	4500	4000	4500	5000
Wave-off: formation	4000	3500	3500	3500
Opening: formation <i>(USPA minimum)</i>	3500 <i>3000</i>	3000 <i>2500</i>	3000 <i>2500</i>	3000 <i>2500</i>
<i>(Opening-750) “in the saddle”</i>	<i>2750</i>	<i>2250</i>	<i>2250</i>	<i>2250</i>
<i>Breakoff-to-Opening distance</i>	<i>+1500</i>	<i>+1500</i>	<i>+2000</i>	<i>+2500</i>

*One jumper may be designated “camera flyer” who at breakoff, waves off and when clear, pulls in-place.

Larger Groups

While the focus of this guide is on small-way groups of 6 to 16 jumpers, larger groups may be accommodated by incrementally raising the breakoff altitude to facilitate longer tracking times to build further separation. With a group of 17 or more, in addition to raising the breakoff altitude, jumpers may be split into multiple tracking groups: 1) a larger main body of “*formation flyers*” who breakoff and track starting at a higher altitude, and 2) a smaller body of “*base flyers*” who hold position a short time then breakoff and track starting slightly later. The following table illustrates breakoff and opening altitudes for groups of 17 to 30 jumpers.

As noted before, the jump leader should review the experience and comfort levels of the individuals in the group, and raise the breakoff and opening altitudes higher if appropriate.

Table 4. Sample Breakoff and Opening Altitudes
Group Size: 17-30

	Group Size 17-23 Licensed C/D Altitude (AGL)	Group Size 24-30 Licensed C/D Altitude (AGL)
Breakoff: formation	5500	6000
Breakoff: base	4500	5000
Wave-off: camera*	4500	5000
Opening: camera*	4000	4500
Wave-off: formation & base	3500	3500
Opening: formation & base	3000	3000
<i>(opening-750) "in the saddle" by</i>	<i>2250</i>	<i>2250</i>
<i>Breakoff-to-Opening distances (feet)</i>	<i>+2500/+1500</i>	<i>+3000/+2000</i>

*One jumper may be designated "camera flyer" who at breakoff, waves off and when clear, pulls in-place.

The "formation" group that breaks away at the highest altitude and tracks longest should be larger than the "base" group that breaks away later and tracks a shorter distance. Based on the overall group size, the following table shows sample numbers for formation and base flyers.

Table 5. Sample Formation and Base Group Sizes

Overall Group Size:	17-19	20-23	24-27	28-30
Camera flyer	1	1	1	1
Formation flyers	12-13	14-16	17-19	20-21
Base flyers	4-5	5-6	6-7	7-8

Appendix C - Planning Climbout and Exit Spots

Determining the spot for where your group exits is key for whether your group and other groups can make it back to the landing area safely. “Landing out” adds hazards that a good spot and exit plan work to minimize. The *USPA SIM* sections 4-E-F and 4-F-F describe the fundamentals of exit spotting.

With multiple groups exiting on a single jump-run, most drop zones follow *USPA SIM* 5-7-D guidelines for a recommended exit order.

- 1) RW groups first, in sequence by group size, largest to smallest.
- 2) Freefly groups, in sequence by group size, largest to smallest.
- 3) Students with instructors, followed by tandems.
- 4) Tracking groups, angle flying groups, and wingsuit flyers.

With eight or more RW jumpers in a Star Crest group, you'll often be the largest RW and first group out the door. The responsibility for determining split-exit spots with appropriate separations will likely fall to your jump leader. You'll need someone experienced in determining split-exit spots and organizing the exit, not only for your group but also for others following your exit on the load.

Creating a good spot and exit plan is performed in three steps:

1. **First, locating the “Ideal-Exit” spot**
The ideal spot for your group to exit if there were no other jumpers exiting the plane on the same jump-run (rarely the case).
2. **Adjusting for “Split-Exit” spots**
When there are others exiting on the same jump-run (typical), you'll need to “split the spot” to define workable exits for each group. Based on the number of jumpers in each group you'll need to factor separations between each group so groups don't drift into one another.
3. **Leading for the “Climbout” spot**
Larger groups take more time to set-up in the door and launch. To exit over the selected exit-spot, a group will need time to get in position and launch the exit.

C.1 The Ideal-Exit Spot

In preparing for any jump, the winds aloft on jump run, in freefall, and under canopy determine an “ideal-exit spot” (noted in the figures as **X**).

The ideal-exit spot is the best position for your group to leave the plane if there were no other groups exiting on the same jump run. Several methods are typically used to estimate the ideal-exit spot.

C.1.1 Observe and Ask Jumpers from a Previous Load

If another group has been up previously, they likely have the most recent and accurate picture for where the ideal-exit spot should be – talk to others who have jumped most recently!

C.1.2 Manual Estimate Based on Forecasted Winds Aloft

The *USPA SIM* section 4-E-F describes the procedure for estimating the ideal-exit spot using forecasted aviation winds-aloft data. The process averages forecasted wind speeds and directions to calculate estimates for drift-in-freefall² and drift-under-canopy³. The two drift speed and direction estimates are factored over the landing target to determine the ideal-exit spot.

C.1.3 Local Drop zone's "Where's the Spot" Web Page

Many drop zones provide a "Where's the Spot" page as part of their web site. (Here's the page for [Skydive Snohomish](#).) A "Where's the Spot" web page automates the "Manual Estimate" process above and overlays the results onto a map of the local drop zone.

Keep in mind that FAA forecasts are just that, "forecasts", and as such, can be incorrect or change. If the aviation forecast changes, the results of your manual estimate or "Where's the Spot" web page will be off. It's always best to double check any manual or web estimate of the ideal-spot with other jumpers who've been up on a recent load.

² Drift-in-freefall averages forecasted aviation wind speeds and directions from exit-altitude to opening-altitude (e.g. 12K, 9K, 6K, and 3K) for the duration of the freefall.

³ Drift-under-canopy averages the wind speed and direction at opening altitude (e.g. 3000 feet) with the wind speed and direction on the ground direction, for the duration of the canopy descent (e.g. ~3 minutes).

C.2 The Split-Exit Spot

When there are multiple groups exiting on the same jump run, adjustments from the ideal-exit spot need to be made to determine a “split-exit spot” (aka, “splitting the spot”).

C.2.1 Exit Separation

A split-exit spot factors the ground separation distances needed between each group to minimize the risk of groups drifting into one another in freefall or on opening. As shown in the **Group Separation Distances** table below, the amount of ground separation needed increases as the size of the group increases.

Note that group exit separations are specified as distances between points *over the ground*. Based on the group's size and the associated separation distance, **the timing between exits will vary** given: 1) the specific distance, and 2) the aircraft's ground-speed (*not airspeed!*). The aircraft's ground-speed is a factor of the aircraft's indicated-airspeed when trimmed on jump-run, combined with strength and direction of the winds-aloft. Winds-aloft typically vary from day to day, and can even change throughout the same day. With a known aircraft ground-speed, the section **Exit Timing** describes how to time group exits.

Table 6. Group Separation Distances

Group Size	Group to Group Separation
1	1000 feet*
2-5	1500 feet*
6-11	2000 feet
12-16	2500 feet
	*USPA SIM 5-7-C

C.2.2 Exit Order

Most drop zones follow **USPA SIM 5-7-D** guidelines for exit order to minimize the risk of groups drifting into one another.

- 1) RW groups first, in sequence by group size, largest to smallest.
- 2) Freefly groups, in sequence by group size, largest to smallest.
- 3) Students with instructors, followed by tandems.
- 4) Tracking groups, angle flying groups, and wingsuit flyers.

Once the number of groups, type of groups, and the size of each group is known you can calculate the split-exit spot locations.

For example, if you have a load with the following groups sequenced in the following order, the ground separation distances between each group would be as follows.

Table 7. Example 5-Group Exit Sequence and Separations

Exit	Size	Group	Group Separation	Separation
1	10	10-Way RW (e.g. Star Crest)	2000 feet	
			<i>Larger of above and below →</i>	2000 feet
2	4	4-Way RW	1500 feet	
			<i>Larger of above and below →</i>	1500 feet
3	1	Solo bellyfly	1000 feet	
			<i>Larger of above and below →</i>	2000 feet
4	6	6-Way freefly	2000 feet	
			<i>Larger of above and below →</i>	2000 feet
5	1	Solo freefly	1000 feet	
		Overall Separation:	<i>(sum of Exit Separations)</i>	7500 feet
		Split Distance:	<i>(Overall Separation / 2)</i>	3750 feet

In the above example, the overall separation between the first and last exits would be a distance of 7500 feet. “Splitting the spot” means that the first group’s exit point (X₁) should be 3750 feet *in advance* of the ideal-exit spot (X’), and that the last group’s exit point (X₅) should be 3750 feet *after* the ideal-exit spot. The figure below illustrates the exit sequence, separations, and exit points (X₁-X₅) for the five groups in this example.

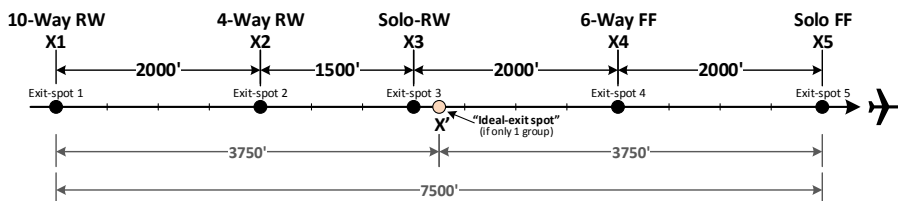
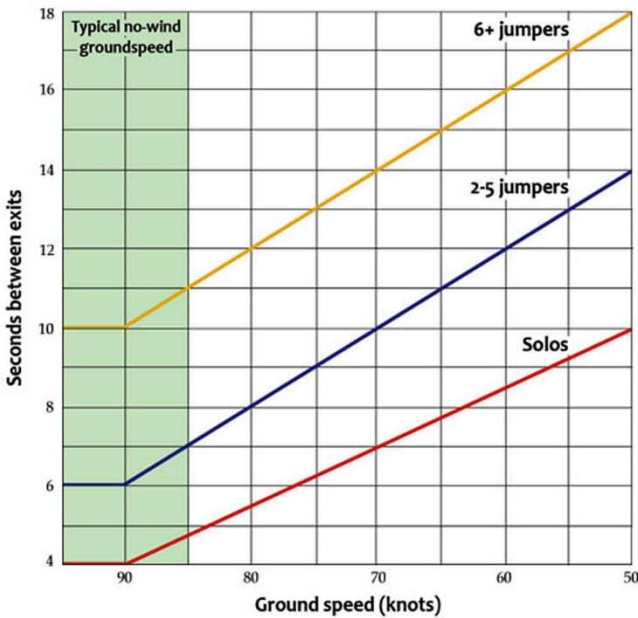


Figure 11. Sample Sequencing, Separations, and Spots

C.2.3 Exit Timing

As noted in determining the *Split-Exit Spot*, exit separations are defined as distances between points *over the ground*. On jump run though, after the first group exits, it's usually easiest for the following groups to time their exit separations. The number of seconds each group needs to wait will vary based on the aircraft's ground-speed at the time on jump run. Once trimmed on jump run the pilot can relay the aircraft's ground speed, which jump groups can then use to time their exits to 1000 feet (solos), 1500 feet (small groups, 2-5), or 2000 feet (larger groups, 6+) separations.



Exit Separation Graph (courtesy Skydive Spaceland)

C.3 The Climbout-spot

Obviously if your group starts climbing out when you're just over your exit-spot and it takes 20 to 30 seconds more to setup before launching the exit, you're going to be well past your exit-spot when the group actually leaves the plane. Assuming light uppers and an aircraft ground-speed of 95 knots:

- 10 seconds will put you 1600 feet past your exit point
- 20 seconds will put you 3200 feet past your exit point
- 30 seconds will put you 4800 feet past your exit point

For a large group with more floaters moving outside, 20 to 30 seconds for five or six people to climbout isn't unusual. The added distance associated with any exit delay may not affect early groups but can hit the groups going out last pretty hard. An initial 20 to 30 second delay on the part of the lead group will ripple down to an extra 3000 to 5000 feet of distance to cover after opening for the groups exiting last – the later groups out will be at higher risk of having to land off site.

To minimize the risk of landing out, it's important that groups leave the aircraft at their designated exit-spots. This is most important for the first group exiting since following groups will typically be timing their exits for the needed separations. For this reason, the first group out should identify its "climbout-spot" at which point they'll start setting up in the door. The amount of distance to lead for the climbout-spot is dependent on two factors:

- The amount of time it takes the group to setup and launch.
- The aircraft's jump run ground-speed.

C.3.1 Timing for Setup and Launch

There are two main factors that affect how long it will take a group to setup and launch:

- The number of jumpers that need to position outside.
- The familiarity of the jumpers in performing the climbout.

In a study of group exit videos⁴, the largest factor affecting climbout time is the number of jumpers positioning outside the door – the more jumpers moving outside, the longer it takes to position, setup, and launch.

The table below provides a guide for setup and launch times based on the number of outside jumpers and the group's familiarity in performing the climbout to their positions.

⁴ ***Star Crest Climbout Study*** (<http://www.axzeo.com/star-crest-climbout-study/>) (Davis, 2016)

Table 8. Typical Climbout Times

		Typical Climbout and Launch Times (seconds)		
Outside	Inside	Initial	Intermediate	Practiced
5 - 7	3+	25	20	15
3 - 4	2+	20	15	10
1 - 2	2+	15	10	5

“Initial” are typical times for a new group of to perform the climbout, setup, and launch for the first time.

“Intermediate” are typical times the same group to perform climbout, setup, and launch second or third times.

“Practiced” are typical times for the same group to perform climbout, setup, and launch after four or more times.

A group will commonly down-level from **“Practiced”** to **“Intermediate”** whenever a new person joins, someone leaves, or people change positions. When there are changes the group will need to learn a new and slightly different sequence of movements.

It’s better to slightly overestimate the group’s climbout time rather than underestimate. If climbout takes longer than estimated, the exit will leave late, past the group’s planned exit-spot. A late exit in turn ripples to all other groups following, placing the last group exiting at risk of not being able to make it back to the landing area.

C.3.2 Mockup Dirt Dive

Rehearsing the exit several times on the ground mockup is key to familiarize everyone in how to efficiently set up on the door. The ground rehearsal will also give you an initial estimate of how long the exit setup and launch will take.

TIP: Measure Ground Climbout Times, then add 25%.
 While it’s key to practice the exit climbout and launch using the ground mockup, keep in mind the mockup is stable and there’s no noise or wind. Performing the exit on jump-run in a loud aircraft that’s bouncing along while hanging on outside chilled in a 100 MPH gale will be a more challenging. To estimate the climbout time with the added jump-run difficulties, add 25% to your ground mockup practice times.

C.3.3 Locating the Climbout-Spot

The climbout-spot is the point over the ground that your group's spotter looks to give "thumbs up" for floaters to move into their outside door positions. The amount of distance to lead the exit-spot for the climbout-spot will vary based on:

- The climbout time (seconds to setup and launch), - and -
- The aircraft's jump-run *ground-speed* (in *knots-per-hour*).

The sample times provided in the [Typical Climbout Times](#) table combined with your own [Mockup Dirt Dive](#) times will give you a starting estimate for your group's climbout time. (You'll refine the climbout time further in following jumps.)

***TIP:** Check with the pilot, an instructor, or an experienced jumper from a recent prior load for the latest estimate on what aircraft ground speed and exit timings to expect.*

Since the climbout point should be known to the spotter before boarding, the best estimate for the aircraft's ground-speed will be that of a recent prior jump from the load or two before yours. If you can't get an actual figure of the aircraft's ground-speed from a prior load, next best is to estimate the aircraft's ground-speed based on the aircraft's usual jump-run "indicated air-speed" (IAS) less the forecasted winds aloft from the closest aviation weather service. For example, if jump runs are typically made at an indicated air-speed of 90 knots and aviation weather forecasts winds aloft at jump altitude to be a 20 knot headwind, the aircraft's estimated ground-speed would be 70 knots (90 knots IAS – 20 knots headwind).

Given climbout time and aircraft ground-speed estimates, you can use either of the formulas below or tables that follow to estimate the distance to lead the exit-spot for your climbout-spot.

Given:

T = *time* in seconds for climbout, setup, and launch.

V = *velocity*, aircraft *ground-speed* in knots per hour

D = *distance* in feet to lead the climbout-spot before the exit-spot.

Then⁵:

for **Distance**: $D = T * V * 1.68781$ for **Time**: $T = D / V * 0.59248$

For example, if T=15 seconds and V=80 knots, then:

$$D = 15 * 80 * 1.68781 = 2025 \text{ feet}$$

Given an aircraft *ground speed* (knots) and estimated climbout time (seconds), the following table shows the distance to lead the climbout-spot ahead of a group's exit-spot.

Table 9. Distance given Climbout Time and Ground-Speed

Distance (feet) ∇	Climbout Time (seconds)					
	1	5	10	15	20	30
Ground Speed (knots)						
110	186	928	1857	2785	3713	5570
100	169	844	1688	2532	3376	5063
90	152	760	1519	2279	3038	4557
80	135	675	1350	2025	2700	4051
70	118	591	1181	1772	2363	3544
60	101	506	1013	1519	2025	3038
50	84	422	844	1266	1688	2532
40	68	338	675	1013	1350	2025

Given an aircraft *ground speed* (knots) and group separation distance (feet), the following table shows the amount of time (seconds) to fly the specified distance.

⁵ 1.68781 = conversion factor for [knots-per-hour](#) to [feet-per-second](#).
 0.59248 = conversion factor for [knots-per-hour](#) to [seconds-per-foot](#).

Table 10. Time given Separation Distance and Speed

Time (seconds) \searrow	Exit Separation Distance (feet)			
Ground Speed (knots)	1000	1500	2000	2500
110	5	8	11	13
100	6	9	12	15
90	7	10	13	16
80	7	11	15	19
70	8	13	17	21
60	10	15	20	25
50	12	18	24	30
40	15	22	30	37
	1	2-5	6-11	12-16
	Group Size			

C.3.4 Example Exit, Three Groups

Example, three groups exiting one after another on a single jump-run. The individual group sizes determine the needed exit separations, as shown in the following table.

Table 11. Example 3-Group Exit Separations

Exit	Size	Group Type	Group Separation	Separation
1	10	10-Way RW (e.g. Star Crest)	2000 feet	
			<i>Larger of above and below</i> →	2000 feet
2	4	4-Way RW	1500 feet	
			<i>Larger of above and below</i> →	1500 feet
3	1	Solo belly-fly	1000 feet	
		Overall Separation:	<i>(sum of Exit Separations)</i>	3500 feet
		Split Distance:	<i>(Overall Separation / 2)</i>	1750 feet

Given an ideal exit-spot (X') and that the three groups need an overall exit separation of 3500 feet, splitting the spot ($3500/2=1750$) means:

- The first exit-spot would be 1750 feet *before* the ideal exit-spot.
- The last exit-spot would be 1750 feet *after* the ideal exit-spot.

For this example we'll also assume that for the load immediately prior the pilot reported the aircraft's jump-run *ground speed* to be 80 knots (V). Allocating 20 seconds (T) for the outside floaters to climbout and setup,

means the climbout-spot (C1) needs to lead the group's exit-spot (X1) by 2700 feet (2700 feet = 20 seconds * 80 knots * 1.68781; $D = T * V * 1.68781$).

The following figure illustrates the climbout-spot and exit-spot for group 1 (C1/X1), along with the exit-spots for groups 2 and 3 (X2/X3).

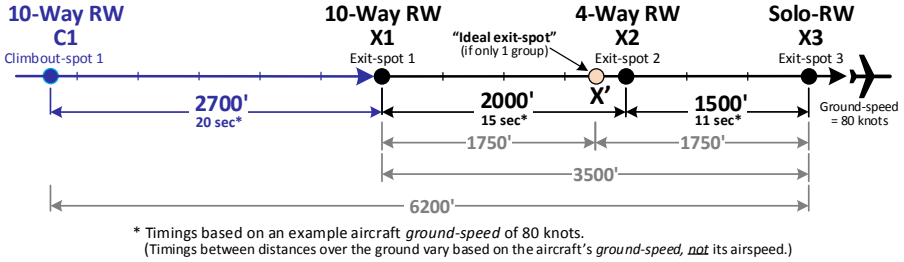


Figure 12. 3 Groups: Sample Climbout-Spot and Exit-Spots
 Aircraft ground-speed = 80 knots, Climbout = 20 seconds,
 Climbout lead to exit = 2700 feet ($D = T * V * 1.68781$)

C.4 Exit Planning Worksheet

The *Star Crest Organizer's Workbook* provides an 8½ x 11 copy of this page. *USPA SIM 5-7-D* exit order guidelines.

- 1) RW groups first, in sequence by group size, largest to smallest.
- 2) Freefly groups, in sequence by group size, largest to smallest.
- 3) Students with instructors, followed by tandems.
- 4) Tracking groups, angle flying groups, and wingsuit flyers.

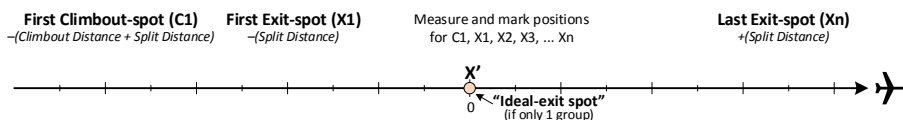
Group Separation Distances

Group Size	Group to Group Separation
1	1000 feet*
2-5	1500 feet*
6-11	2000 feet
12-16	2500 feet
*USPA SIM 5-7-C	

Group Exit Sequence and Separation Worksheet

Exit	Size	Group Type	Group Separation	Separation
1				
			<i>Larger of above and below →</i>	
2				
			<i>Larger of above and below →</i>	
3				
			<i>Larger of above and below →</i>	
4				
			<i>Larger of above and below →</i>	
5				
			<i>Larger of above and below →</i>	
6				
			<i>Larger of above and below →</i>	
7				
		Overall Separation:	<i>(sum of Exit Separations)</i>	feet
		Split Distance:	<i>(Overall Separation / 2)</i>	feet
		Climbout Time:	<i>(T, seconds)</i>	sec
		Ground-Speed	<i>(V, knots)</i>	knots
		Climbout Distance:	$D = T * V * 1.68781$	feet

Climbout and Exit Sequence Graphic



Using the **Exit Separation Time** table below, note the timing between each spot in the **Exit Sequence Graphic** above.

Table 12. Exit Separation Times

Aircraft Ground-Speed	1000 feet	1500 feet	2000 feet	2500 feet
110 knots	5 sec	8 sec	11 sec	13 sec
100 knots	6 sec	9 sec	12 sec	15 sec
90 knots	7 sec	10 sec	13 sec	16 sec
80 knots	7 sec	11 sec	15 sec	19 sec
70 knots	8 sec	13 sec	17 sec	21 sec
60 knots	10 sec	15 sec	20 sec	25 sec
50 knots	12 sec	18 sec	24 sec	30 sec
40 knots	15 sec	22 sec	30 sec	37 sec
Group Size:	1	2-5	6-11	12-16

You can also use the following formulas to calculate distance or time given arbitrary values.

for Distance: $D = T * V * 1.68781$ *for Time:* $T = D / V * 0.59248$

Where:

D = *distance* in feet.

T = *time* in seconds.

V = *velocity*, aircraft *ground-speed* in knots-per-hour,

1.68781 = conversion factor for **knots-per-hour** to **feet-per-second**.

0.59248 = conversion factor for **knots-per-hour** to **seconds-per-foot**.

C.7 Jump Planning Worksheet – Manifest

The *Star Crest Organizer's Workbook* provides an 8½ x 11 copy of this page.

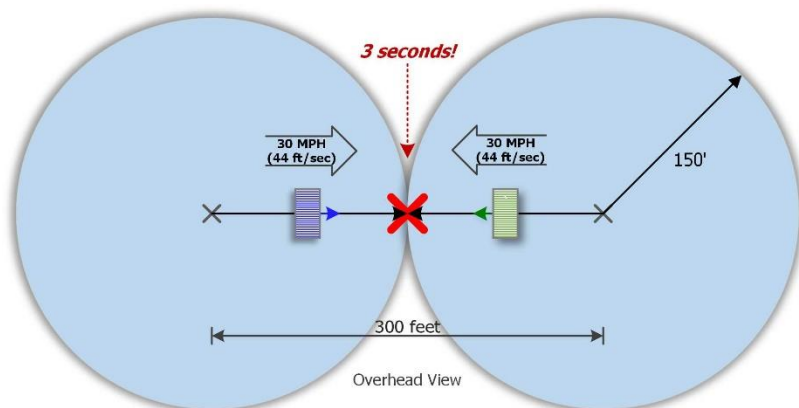
Load # _____ Time: _____ Breakoff: _____ Open: _____ WLG: Low ≤ _____ < Median > _____ ≥ High	Load # _____ Time: _____ Breakoff: _____ Open: _____ WLG: Low ≤ _____ < Median > _____ ≥ High																																																																																																																																								
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Appendix D - The Mathematics of Separation

The papers and presentations by *Dr. John Kallend (PhD)*, professor of Physics and Materials Engineering at the *Illinois Institute of Technology* provide a good background on the mathematics behind tracking and opening separation. (In addition to his academic expertise, Dr Kallend is also a skydiver with over **3000 jumps!**) The following is an extract from Dr. Kallend's **Exit Safety – Spotting, Winds, and Separation** presentation (Kallend, 2004).

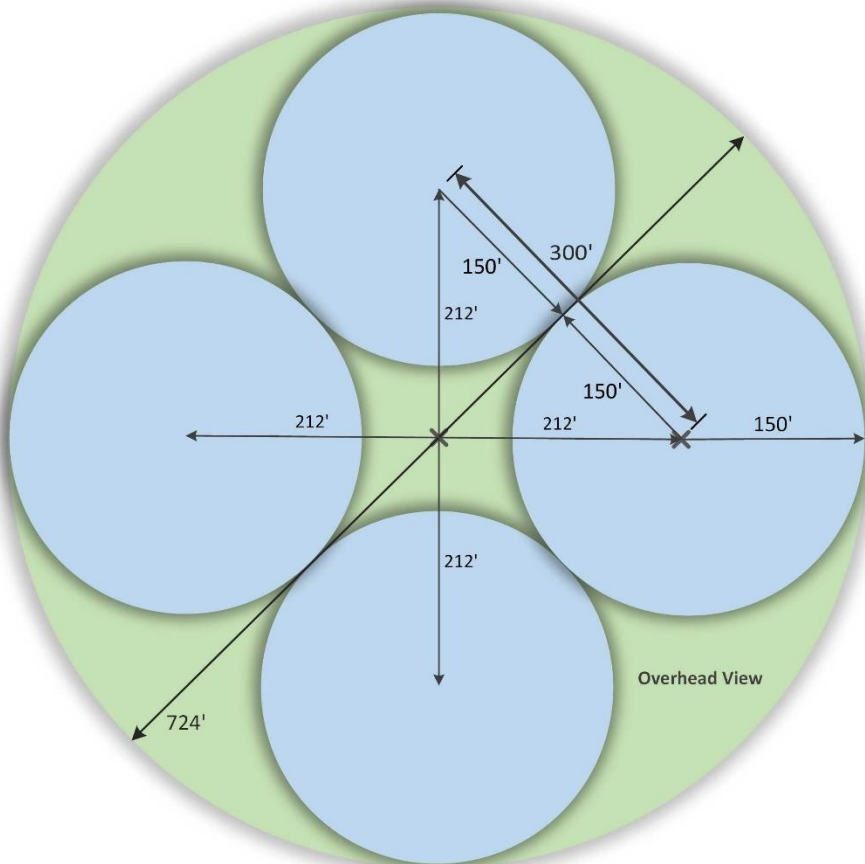
As we know, tracking is a key survival skill when jumping with others. At the end of your track you should ideally be 750 feet or more away from other jumpers when you deploy, *but at least an absolute minimum 300 feet*. The math tells the story (Kallend, 2004 p. 17).

- With brakes set, a typical ram-air canopy on opening surges and flies horizontally at around 30 MPH (44 feet/sec or more).
- Canopies often open off-heading, and even a couple simple line twists will have you heading off in a random direction.
- It takes a *minimum of 3 seconds* to recognize, react, and turn a canopy to avoid a collision.
- *If one canopy opens off-heading and fly's toward another canopy 300 feet away, closing at 44 feet/sec the two canopies can collide within about 6 seconds. Six seconds is short enough, but...*
- *If two canopies open off-heading and fly head-on at 44 feet/sec, they will each close 150 feet (300 feet total) and collide in just over 3 seconds – a minimum reaction time.*



**Figure 13. Min Opening Separation, 2-Way
Minimum Track = 150 feet**

On a 2-way, each jumper needs to track a minimum of 150 feet to attain a minimum 300 feet of separation. As the number of jumpers in the group grows larger, each jumper needs to track an increasing distance to attain the minimum 300 feet of opening separation. For example in a 4-way, each jumper needs to track *212 feet* to obtain a minimum of 300 feet for opening separation (figure below).



**Figure 14. Minimum Opening Separation, 4-Way
Minimum Track = 212 feet**

As the number of jumpers increase, each person needs to track an increasing distance to have a clear minimum 300 feet area (150' radius) for opening separation. The following table summarizes the distances jumpers need to track for a *minimum 300 feet of separation*.

Table 13. Min Tracking Distances to Attain 300' Separation

Group Size	Pull in-Place*	Trackers	Min Tracking Distance** (feet)	Breakoff *** above Opening (feet)
1	1		0	(feet)
2		2	150	+1500
3		3	173	+1500
4		4	212	+1500
5		5	254	+1500
6		6	300	+2000
7	1	6	300	+2000
8	1	7	345	+2000
9	1	8	391	+2000
10	1	9	438	+2000
11	1	10	485	+2000

* Pull-in-Place: After others track clear, one jumper (e.g. camera flyer) deploys high in-place.

** Source: *Exit Safety – Spotting, Winds, and Separation*, PowerPoint by Dr. John Kallend (Kallend, 2004)
Distances are *minimums* to attain a 300' opening separation (*in practice, as far as possible is best!*)

*** Reference [SIM 6.1C](#) "Breakoff" (and [SIM2.1H](#) "Minimum opening altitudes").

Groups of 12 or more should be staged to break-off in waves (see [Sample Breakoff and Opening Altitudes](#)).

Three seconds (300') to recognize, react and avoid a head-on collision is quick. Obviously, it would be better to have double, 6 seconds (600'); triple, 9 seconds (900'); or more time to react to a head-on opening situation. To maximize separation you need to get good at two skills.

- Learn to fly a fast, flat track that maximizes distance (see [Track](#)), and
- Track all the way to wave-off altitude, 500 feet above opening-altitude.

At wave-off altitude, flare out of your track, initiate wave-offs while scanning for others nearby, then when clear, pull at the assigned opening altitude.

D.1 The Three Second Min Reaction Time

In a separate article on [Driver Reaction Time](#) (Green, 2013), Dr. Marc Green notes a general human perception-reaction time of 1.5 seconds for an initial "Mental Processing" perception period that precedes the two subsequent events of "Physical Movement" and "Device Response".

- 5) **Mental Processing Time** – Composed of four sub-stages:
 1. **Sensation** – Primarily subconscious, the time it takes to detect the sensory input. (Auditory signals are generally faster than visual.)

2. **Perception/recognition** – The time needed to recognize the meaning of the sensation.
3. **Situational awareness** – The time needed to recognize and interpret the scene, extract its meaning and extrapolate into the future.
4. **Response selection and programming** – The time needed to decide which if any response to make and to mentally program the movement.
- 6) **Movement Time** – Time to physically move muscles and limbs.
 - e.g. The time it takes to physically reach and pull a riser.
- 7) **Device Response Time** – time it takes for a device to respond after the movement has been applied.
 - e.g. The time it takes the canopy to turn and change direction after the riser has been pulled.

Dr. Green notes that reaction times can also vary greatly under different conditions.

- Expectation vs Surprise – Why it's better to anticipate problems.
- Urgency – high-speed vs low-speed malfunction?
- Response Complexity – a horseshoe or a 2-out, versus a clean cutaway?
- Cognitive Load – other issues/problems/distractions at the same time.
- Fatigue
- ...and more.

In reading Dr. Green's article, Dr. Kallend's "minimum 3 second" reaction time sounds reasonable (perhaps if anything, maybe even short).

Appendix E - Resources

E.1 Books and On-line Resources

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E.2 Bigway Camps

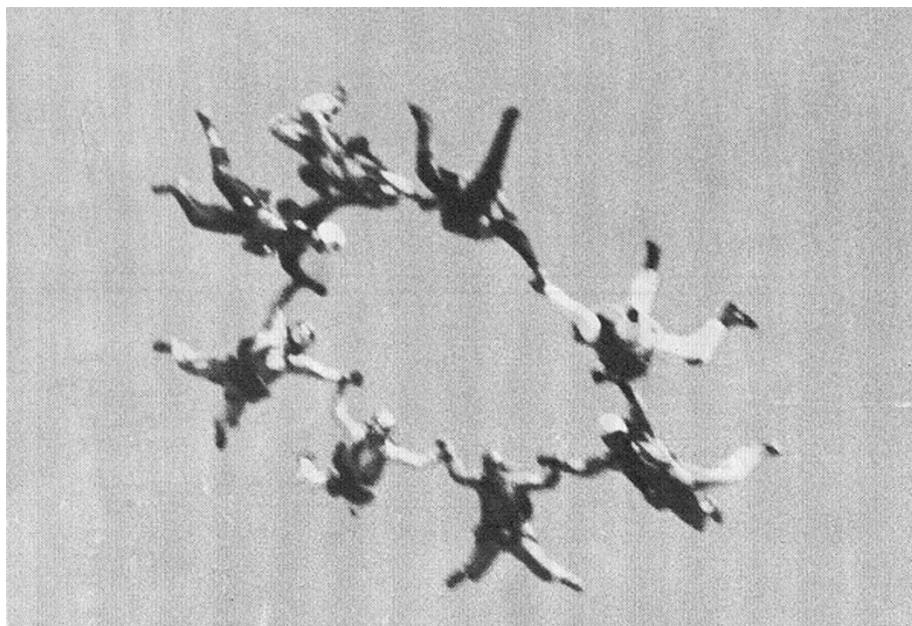
P3 Skydiving / Perris Performance Plus – www.p3skydiving.com
Skydive Perris (Perris, CA 92570)
Facebook: <https://www.facebook.com/P3Skydiving>

GoBig Skydiving – www.GoBigSkydiving.com
SkydiveCT (Ellington, CT 06929) and JumpTown (Orange, MA 01364)
Facebook: <https://www.facebook.com/groups/287952401260013/>

Masters Skills Camp – www.MastersSkillsCamp.com
Skydive Elsinore (Lake Elsinore, CA 92350)
Facebook: <https://www.facebook.com/pages/Masters-Skills-Camp/362581203771729>

APF – Aussie Bigways – www.AussieBigways.com
(Australia, various locations)
Facebook: <https://www.facebook.com/Aussiebigways/>

Appendix F - Star Crest Recipient Memorial



First 8-Way Star – October 17, 1965 *photo by Bob Buquor*

First 8-way Star Crest Recipients: 1. Gary Young, 2. Al Paradouski, 3. Bill Newell,
4. Mitch Poteet, 5. Bill Stage, 6. Jim Dann, 7. Don Henderson, and 8. Brian Williams

Of course broad credit for Star Crest skydiving goes to the early pioneers and originators of group relative work skydiving. In 1967 Bill Newell created the Star Crest Recipient (SCR) awards program to honor his close friend and mentor, [Bob Buquor](#). Both Bill and Bob played major roles in the early evolution of star formation relative work. Bob was also an early pioneer in freefall photography which had launched his career as a commercial freefall cameraman. In 1966 Bob unfortunately drowned near Malibu while filming sequences for the MGM movie "[Don't Make Waves](#)". [Bill Newell](#) created the [Star Crest Recipient Award](#) in recognition and memory of Bob Buquor's driving enthusiasm in relative-work skydiving. Bill Newell aptly described the goals of the Bob Buquor Memorial Star Crest.

"We are striving to keep the original ideals on which we were founded alive for today's skydivers as well as for the pioneers of yesterday. It is to Bob Buquor's driving enthusiasm for

Star Crest Skydiver's Guide

relative work skydiving that the SCR membership is dedicated. We hope that recipients of our awards will carry on Bob Buquor's love for the art of flying by helping other jumpers, especially those less experienced, enjoy relative work skydiving as much as they do."

Beginning with the first 8-way star in 1965, as of 2012 over 26,000 skydivers have earned the Star Crest Recipient award, making it one of the oldest and most popular skydiving awards. The spirit of the Star Crest Recipient Award was recognized by the National Skydiving Museum by a plaque and dedication.



NATIONAL
SKYDIVING
MUSEUM

**In Recognition of
45 YEARS
BOB BUQUOR
MEMORIAL
STAR CREST
AWARDS
& BILL NEWELL**

**THE BIRTH OF
FORMATION SKYDIVING**

(National Skydiving Museum, 2012)

More information and photos from the early days of RW group skydiving can be found at the [Star Crest Awards web site](#) (Star Crest Awards, 2015).

F.1 Credits: Star Crest Skydiver's Guide Star Crest Jump Start

This guide was organized for use with Star Crest and small-way relative work group skydives. The information provided is a compilation from coaches, instructors, jumpers, organizers, [books and web resources](#), along with the author's own experience.

Particular thanks goes to reviewers including Samantha Oldfield, Mark Brown, Tony Albano, Rick Poplinger, Randy Forbes, Rachael Newell, Marilyn and Doug Wuest, Tim Long, Dennis Sattler, Roger Worthington, Deb and Dave Correia, Vladimir Ursachii, John Kallend, Mary Todd, John

Garr, Pat Chapman, Ron Hensley, and Nikko Mamallo (plus many others who I apologize for missing). A big “thank you” to everyone who has helped in contributing to put this together.

Photo credits and permissions for pictures and illustrations in the *Star Crest Jump Start* and this *Star Crest Skydiver's Guide* go to Randy Forbes, Nikko Mamallo, and Jack Davis.

And lastly a huge “thanks” and “love you” to my wife, Carol, for both letting me “go play in the sky”, and for putting up with me while I put this together – Love’ya so much! ☺

Keep it safe up there, *smile*, and don’t forget to have fun!

- - Jack Davis, July 2016

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Author Bio



Jack Davis started leaping out of airplanes many years ago and was one of the early adventurers with a four-digit USPA skydivers' license. After a respite for kids, career, and mortgages he returned to skydiving and for recent years has been once again flying high.

In the *Star Crest Skydiver's Guide*, Jack shifts focus from the tech industry to the passion and fun of "small-way" formation skydives. The book builds on the inputs from experienced jumpers, organizers, his own experience, along with a selection of written and web resources. The book illustrates techniques, answers questions, and organizes resources for skydivers looking to build skills on their way to even larger "bigway skydiving".

Jack lives near Seattle, WA with his wife (and best friend) Carol, along with their mellow* tuxedo polydactyl cat, MacGyver.

* "MacGyver is the only cat that actually *comes running to you* when he hears the vacuum. The only thing he loves better than getting brushed *and vacuumed* is real people food."

Please forward comments and suggestions for improvement to Jack at:

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Early days – Jack flying his *Delta II Parawing*