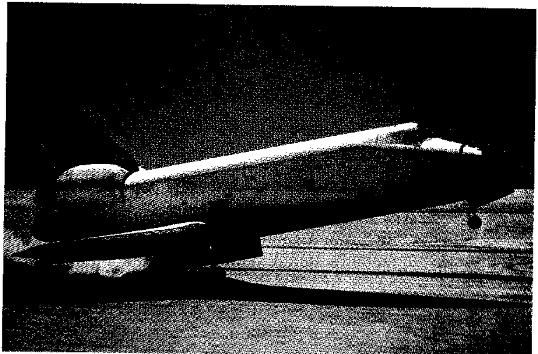
Rope Breaks: Lessons Learned from the Space Shuttle



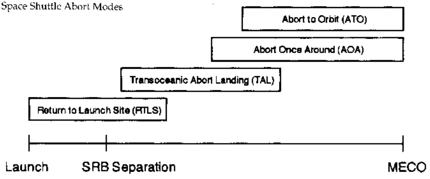
by Joe Parrish

I have long been fascinated by one of the world's lowest performance self-launching gliders. NASA's Space Shuttle (subsonic L/D of approximately 3:1) is a complex machine that does one thing very well – transporting humans and cargo to Earth orbit and back. Some aspects of this motorglider's flight profile may be of direct interest to Earth-bound glider pilots. The engineless landing phase is an obvious one, but let's also consider the launch phase.

The Space Shuttle has well thought-out and rehearsed emergency procedures, called "abort modes," for coping with an engine failure or other major emergency between launch and orbit. While watching a Shuttle launch on television, you may have heard Mission Control making voice calls such as "Two-engine prime TAL," "Negative return," and "Press to ATO" to the crew. These voice calls help the crew understand when boundaries between abort modes are crossed. The boundaries between the various abort phases are computed before the mission, and vary with launch mass, orbit parameters, atmospheric conditions, and the type of failure. The launch trajectory profile is chosen such that no less than one abort mode is always available to the crew (Figure 1).

The Space Shuttle flight crew practices before the mission in the simulator, running through all of the potential

Figure 1: Space Shuttle Abort Modes



contingencies, and is well-prepared for any possible situation. As glider pilots, we can emulate the advance preparation and flight procedures the Shuttle pilots use. Let's strap in to the flight deck of the Orbiter and run through a typical Shuttle launch, and compare it to a glider launch:

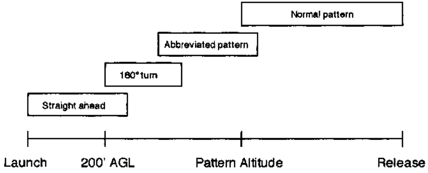
After several hours of pre-takeoff checklists, all of the stillness disappears as the three main engines and the two solid rocket boosters are fired, and we are committed to flight. Soon after we are airborne and clear of the launch tower, a slow roll is initiated to put us head-down and able to see the landing strip at the Cape. ***(Please don't try this in your Nimbus!)*** At any point during the first four minutes and 20 seconds of flight, a malfunction of the main propulsion system will initiate the Return to Launch Site (RTLS) abort. This is much like our 200' rope break practice in the glider. Soon thereafter, Mission Control calls to tell us that we have reached the Transoceanic Abort Landing (TAL) point, which means that we are too far away to RTLS and must execute a sub-orbital trajectory culminating in a runway landing in Europe or Africa. A similar abort mode would be used in our glider if we were towed too far away from the field or encountered adverse winds or heavy sink after the rope broke. Mission Control then calls the transition to the next abort mode, Abort Once Around (AOA), which involves making a single orbit and then a more standard entry and landing. This is analogous to a rope break at approximately pattern altitude for our glider. Finally, if a propulsion system failure occurs late in the ascent phase, we will use the Abort to Orbit (ATO) mode to achieve a lower-than-planned orbit, but still perform some of the mission. Similarly, a rope break between pattern altitude and release altitude means only that we have less opportunity to find lift, but we are still able to perform a normal pattern and landing.

Glider pilots may also emulate the verbal calls made to indicate the transition between abort mode boundaries. Typically, Mission Control will not be available to relay these voice calls to you in the glider, so do the next best thing—talk to yourself! On dual flights, this has the added benefit of keeping your instructor or passenger from falling asleep.

As soon as the ground roll begins, the glider pilot should be thinking about options (abort modes) available in case of a rope break or some other premature termination of the tow. Always know when you transition from landing straight ahead, to turning slightly into the adjacent landing area, to turning back to the departure runway, etc. (Figure 2). Use your cranial flight computer to adjust these boundaries as conditions change during the launch. The important point is to have an abort plan worked out in advance. Sometimes, the term "in advance" may only mean a few seconds, but this is far superior to having to formulate your plan after the rope breaks.

Many glider pilots in the United States are taught to

Figure 2: Glider Abort Modes



monitor their altitude during the initial phase of launch and announce "200 feet." This practice has undoubtedly saved a number of pilots from demise, but it is important to realize that the rope will almost certainly not break at this particular altitude. To put it another way, the 200 foot minimum altitude mark is merely a boundary between abort modes; it is not the boundary between danger and safety. Many factors such as density altitude, tow plane climb rate, and glider performance will affect the minimum safe altitude for a 180 degree turn. I prefer saying out loud "decision point" to "200 feet." The 200 foot AGL mark is, however, a good minimum altitude for beginning pilots in typical training sailplanes in benign conditions.

Pre-solo student pilots are usually very well aware of the prospect of a simulated rope break at 200 feet AGL. The instructor can almost see the tension drain out of the student's shoulders if we climb through this altitude without drama. One of my favorite Stupid Instructor Tricks is to prearrange with the tow pilot to rock the wings of the tow plane at approximately 600-700 feet AGL on the downwind leg of the launch pattern – the point at which a completely nominal landing pattern can be executed. Very few students will do this, though! Most take several seconds to recognize the "rock off" signal (even if it is briefed immediately before takeoff), and precious seconds are again wasted after the release while the student figures out that a landing is imminent. Most students will fly directly toward the intended touchdown point, resulting in a much too high arrival over the runway threshold – requiring the instructor to work a slip-to-landing lesson into the mix.

The lesson here is that pilot diligence is required throughout the tow, and the pilot can only begin to relax after achieving an altitude similar to the ATO mode in the Space Shuttle.

In summary, always have a plan in mind until you reach a suitable altitude for soaring flight. As a famous astronaut once said, "It ain't over 'til it's over!" Be conscious of the launch as a progression of options, and verbalize your decision points aloud to help you maintain your plan. When the rope does break – and it surely will someday – you'll be able to handle it with the Right Stuff.

Safe soaring!

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