Getting the Stomach for Upsets

The view from the rear seat of the Siai-Marchetti S211 over the Arizona desert.

PHOTOS: MATT THURBER

AIN senior editor spends a day in all-attitude jet upset training at Aviation Performance Solutions.

by Matt Thurber

We're at almost 40,000 feet, and I'm pulling back on the beefy stick of a two-seat Douglas TA-4J Skyhawk single-engine jet trainer, about to make the airplane stall. "Keep pulling," says Phillip "OP" Oppenheimer, Aviation Performance Solutions (APS) instructor and Top Aces chief pilot, over the intercom as the airspeed bleeds off and the outside world tilts up further–"pull, pull, pull," just like a pilot might mistakenly try to stay level as airspeed decays during a high-altitude upset. Finally, as the angle-of-attack needle crawls to the maximum AOA (at that altitude) of about 12 to 14 units and the jet's nose points well above the horizon, the airframe shudders and it's time for the recovery procedure: push to reduce AOA, roll wings level, add thrust and…wait, wait, wait.

The flight in the TA-4J was the second sortie during a busy day of jet upset prevention and recovery training (UPRT) at APS headquarters at Arizona's Phoenix-Mesa Gateway Airport in mid-December. APS offers UPRT courses in a variety of aircraft as well as advanced simulators, starting in the Extra 300L aerobatic piston single, then progressing in advanced training to

After rolling the S211 nearly upside down, APS president and CEO and instructor BJ Ransbury said, "Recover," and Thurber implemented the baseline APS strategy: push, roll, power, stabilize. The S211 is equipped with Garmin's G3X display with synthetic vision, and angle-of-attack indicator.

the Siai-Marchetti S211, Dornier Alpha Jet or TA-4J. I had previously flown with APS in the Extra 300L, and this time I was invited for a day of jet upset training in the S211 and TA-4J.

APS has expanded beyond Phoenix and opened a wholly owned UPRT location in Dallas and a joint venture in the Netherlands with the Test and Training Center; it also has licensed training facilities in Riyadh, Saudi Arabia, and Johannesburg, South Africa. In partnership with CAE, APS also contracts with the U.S. Army to provide UPRT in Dothan, Ala., in CAE's fleet of Grob G120TP single-engine all-attitude turboprop trainers and C-12 (King Air 200) full-flight simulators. The APS Advanced Jet Pilot Integrated Upset Training program is part of a four-day course that begins in APS's Extra 300Ls and provides time in an advanced simulator culminating in a day in one of the three jets.

The S211s are owned by APS and the Alpha Jet and TA-4J are owned by Top Aces USA, a U.S. division of Canadian company Discovery Air, which provides air combat training to the U.S. military and allies worldwide. When APS customers are flying in the Alpha Jet or TA-4J, it is always under an APS UPRT program flown with an APS-certified UPRT instructor pilot under contract with Top Aces.

The live jet training adds another dimension to UPRT, expanding APS's all-attitude training envelope into real-world regimes closer to those in which corporate pilots typically fly. While APS does train in advanced full-flight simulators, those sessions are less an exploration of human factors and the limits of jet flight envelopes and more an exercise in upset recognition and crew resource management techniques. UPRT in real airplanes is one of APS's specialties, and it helps customers experience and overcome the all-important startle factor that happens during an upset. More important, learning how to recover from developing upset events, some of them extreme, helps embed the proper recovery techniques in pilots, so that even when put into an upside-down and nose-low but high AOA predicament, the pilot knows that the first move must be—counterintuitively—to push the stick forward and reduce AOA before trying to roll upright.

The APS upset recovery processes are directly aligned with the industry- and ICAO-sanctioned Airplane Upset Recovery Training Aid, which can be downloaded from the Flight Safety Foundation or APS website. According to APS president and CEO Paul "BJ" Ransbury, "As does APS, modern UPRT providers must similarly align with, and integrate, ICAO's 2014 Manual on Aeroplane Upset Prevention and Recovery Training."

The APS All-Attitude Upset Recovery Strategy is seemingly simple and expressed as Push-Roll-Power-Stabilize, he explained, "yet it requires in-depth academic and practical training for pilots to truly be able to integrate it into their skills." However, he added, "As opposed to thinking of it as specific control movements, it's primarily an aid to enhance mental organization and discipline in a crisis: the pilot must manage angle-of-attack, then manage lift vector, make an energy decision then stabilize the flight path divergence while considering secondary flight controls and type-specific considerations."

Loss-of-control in flight remains the cause of the highest number of fatalities in business aviation and airline operations. Ultimately what UPRT does is help pilots not only recognize and prevent an airplane upset but also learn how to handle the recovery, if necessary, in a consistent fashion. This means, he said, "After APS UPRT, pilots have 'been there, seen that,' felt the adrenaline, felt their tendency to lock up from a psycho-physiological standpoint and developed the ability to reliably push through. They have a plan and implemented it. It's the consistency and reliability of these skills more than anything else in a life-threatening crisis that makes APS UPRT unique." Ultimately, he explained, the goal of UPRT "is to get the airplane safely back into the heart of the flight envelope."

Briefing for the S211

All jet training at APS is conducted by military pilots and, like any such operation, it begins with detailed briefings. My first flight was with Ransbury, a former Canadian Armed Forces F/A-18 Hornet, airline A320 and airshow pilot.

The all-attitude S211 is powered by a single 2,500-pound-thrust Pratt & Whitney Canada JT15D, an engine familiar to many corporate pilots. With a maximum takeoff weight of 6,063 pounds, the jet maxes out at 400 kias (Mach 0.8) and can reach 40,000 feet. Clean stall speed is 90 knots, and it is approved for upright spins. Primary flight controls are mechanical push-pull rods, although the ailerons are boosted hydraulically. While the S211 can be equipped with ejection seats, APS chose to fly this jet with pilots strapped into seat-back parachutes, and thus we briefed the manual bailout technique as well as other emergency procedures and the important positive exchange of controls process.

To make the S211 cockpit a little more familiar for modern corporate pilots flying glass cockpits, APS equipped the S211 with a Garmin GTN 650 com/navigator and G3X touchscreen display with synthetic vision backed up with a Mid-Continent Standby Attitude Module. The G3X also displays AOA right next to the airspeed tape. Although

Thurber (right) with APS president and CEO BJ Ransbury after the S211 flight.

APS does high-altitude training in the S211, it wasn't necessary to fly with oxygen masks in the S211's pressurized cockpit on this particular flight as we weren't going to fly too high. In the TA-4J, however, oxygen masks were mandatory.

What is important to understand when flying the S211 and TA-4J and any jet in an upset is that events happen more slowly: pitch rates at a given load factor are less at higher jet speeds; and because of higher inertia, an unload on the flight controls doesn't instantaneously reduce AOA as it does in the piston trainer. Application of power isn't instantaneous as it is in a piston-powered airplane, especially at high altitudes where air is thinner and turbine engines develop far less power than at lower altitudes. High altitudes also mean that control forces are heavier and stall speeds higher. While both the S211 and TA-4J can be used for low- and high-altitude training, the S211 UPRT profiles top out in the low 30,000s, while the TA-4J UPRT program goes into the high 40,000s.

S211 in Flight

After strapping into the S211 (I sat in the rear seat), we taxied to Mesa's Runway 12R. As is typical in upset training courses, the instructor (in this case Ransbury) did the takeoff. The S211 is relatively light, with a power-to-weight ratio of 0.413:1—about the same as an early Lear—and the low-bypass Pratt gave us a good punch of acceleration during the liftoff.

Ransbury handed me the controls, and I climbed toward the practice area, leveling off at 9,500 feet to remain below a cloud layer; the S211 profiles are typically flown between 10,000 and 18,000 feet. The S211 is responsive and well harmonized, with consistent and not-too-heavy control forces throughout most of the flight envelope.

I started with some steep turns to get a feel for the airplane. Ransbury then demonstrated a power-on stall and the APS baseline UPRT strategy. During the maneuver, he gave a step-by-step description of what he was doing and the indications on the AOA gauge, also underscoring how AOA and pitch are not related. For the stall recovery, he said the strategy out loud—push, roll, power, stabilize—and this helped cement it in my brain. After pointing out the slow power response, he finished the maneuver with the critical final step: stabilize. "Now I bring the nose up, power set, waiting for the positive rate, gear is up, flaps up, speed brakes in, trim set, recovery is complete. Now I can take my brain out of recovery mode and start troubleshooting the situation."

Then it was my turn. I pulled the power back to

65 percent and popped the speedbrakes to slow down, then pulled the nose up into the stall. As the nose tilted up and the speed dropped below 100 knots, we could feel the airframe buffet gently, then the nose dropped and the jet rolled slightly to the left. I unloaded the wings by pushing forward on the stick, rolled back to wings level, added power then stabilized by leveling the pitch attitude first then establishing a positive rate of climb. After retracting the speed brakes and checking that the gear and flaps were up, recovery was complete (although Ransbury had to remind me to say those last words as the final step in the process).

We did the same with more power added, then entered the sustained stall exercise at 10,500 feet. In this exercise, the point is to learn how it's necessary to overcome the swept-wing jet's inertia and keep the forward push on the stick even if the nose is already below the horizon. When the S211 stalled, the nose pulled to the left and dropped 20 to 30 degrees below the horizon, and I had to use right rudder to keep from entering an incipient spin. The sink rate reached 3,000 fpm. I pushed forward, then rolled wings level as the lift returned to the wings, added power, then stabilized back into a climb. "We have to recognize that we have to push," Ransbury said. "The airplane's dynamically unstable; we have to push in a stall even with the nose low."

During cross-control turning stalls in the landing configuration, we lost about 600 feet and the nose rolled sharply to about 90 degrees of bank. Ransbury pointed out that in the real world, the idea is not to stall during a base-to-final turn and recover 50 feet above the ground but to prevent the stall from occurring in the first place. In the cross-control stall, the AOA gauge does not always accurately show the actual stall—the stall in this case can happen suddenly before the gauge goes all the way red—but it still gives warning that a stall is coming. The cross-control stall, with proper training, feels wrong, and should be a strong cue to the pilot to recognize the situation and intervene before entering full stall, he added.

Next was one of the most dramatic exercises, the overbank nose-low recovery, where Ransbury rolled the Marchetti 120 degrees to the left and about 30 degrees nose down, then said, "Recover." Pilots without this training typically tend to pull back in a startling overbank situation because the ground is rushing up quickly and their non-UPRT instincts tell them pulling means up, he explained. Even though the nose was pointed down and we were nearly inverted, I had to push on the stick first to unload the wings, roll back to the right to level the wings, pop the speedbrakes, then try to keep the g load below 2.5, which is a typical maximum load for a business jet and also a key somatosensory feel that APS tries to inculcate in business jet and transport category UPRT customers.

"The concept of 'muscle memory' or 'control feel' in UPRT is generally misapplied as the amount of control column pressure to effectively unload the airplane can vary dramatically as a function of trim, speed and configuration," he had explained during the briefing. "The only truly reliable muscle memory in upset training is the sense of load factor on the seat of your pants."

I ended up pulling 2.4 g, lost about 2,000 feet and sped up to more than 300 kias. After I said I had completed the recovery, Ransbury showed me that I forgot to advance the throttle and that airspeed was dropping as I tried to maintain a positive climb rate. My error highlighted the importance of completing the "stabilize" step properly, by making sure pitch and power were at the desired settings. "You must be just as disciplined with stabilizing the aircraft as you are with pushing to reduce AOA," Ransbury said. "It all matters in ensuring a comprehensive solution to an airplane upset."

We tried the same maneuver with the S211's aileron boost switched off, which makes the roll handling much heavier. This conditions the pilot in training to be ready to use whatever control force is necessary to achieve the desired result.

"Just because the controls feel different doesn't change the overall strategy for recovery," he said.

In the nose-high unusual attitude, I had to use bank to get the nose down. With the nose up to 38 degrees, I banked left about 90 degrees, too much as it turned out, then recovered by pulling too hard in pitch, about 1.5 g. The goal should be 45 to no more than 60 degrees to avoid creating a new unusual attitude, if any bank is used at all; also, I didn't unload the wings properly. Ransbury demonstrated a shallower bank and using pitch to about half a g, which helps prevent the onset of the stall, maintains more energy and controllability throughout the maneuver and assists in getting the nose down safely. As Ransbury reminded me, "Airplanes don't stall at zero g and the desired half-g unload is a best compromise between maintaining a margin of safety from the stall and keeping light positive g on the aircraft to ensure fuel and hydraulic operability not to mention the safety of crew and cargo not latched to the floor behind the cockpit."

The wake turbulence encounter was another dramatic event, simulating departing from the airport in clean configuration at 180 kias and nose up about 10 degrees. Ransbury took the controls and by rapidly augmenting the control inputs propelled the swept-wing jet to 150 degrees of bank to induce startle/surprise factor then said, "Recover." I pushed then rolled left and stabilized, losing about 200 feet, but I inappropriately used some rudder, too, which he pointed out can quickly cause unintended consequences in commercial jets. "If we get into a situation where we start dancing on the rudder and guessing what to do haphazardly, especially in a swept-wing airplane, we could really get ourselves into harm's way pretty quickly," he said.

To simulate IMC, APS uses a full curtain system in the rear cockpit of the S211 for glass-cockpit UPRT. "This is very popular with professional jet pilots," he said. During my flight, we tried two unusual attitudes while I wore a view-limiting device

The training manuevers require a strong stomach. After an upside-down mock wake-turbulence encounter at high altitude, Thurber was feeling the effects. Fortunately, the g loading during the demonstration of a Split S sorted him out and he was ready for more maneuvers.

over my glasses, to simulate IMC and using the Garmin G3X ADI to recover. One was a 20-degree nose-low left 120-degree roll, and I recovered pulling just 1.5 g. The other was a takeoff-configured stall at 65-percent power, with cross-control rudder and ailerons. At the stall, the nose rolled sharply left to nearly 90 degrees, then I pushed, rolled level and stabilized; we lost 700 feet of altitude.

After I had flown back to Mesa Gateway and entered downwind for Runway 12R, Ransbury took over and landed the S211. After the flight, customers are given a copy of a video of the UPRT session overlaid with flight data captured with a Garmin VIRB video/audio camera interfaced with the onboard Garmin avionics via Bluetooth.

Fighter-trainer Time

After lunch, Oppenheimer briefed me on the TA-4J. Oppenheimer is a retired Air Force lieutenant colonel who flew the A-10, A/OA-37 and F-16, and served as F-16 squadron commander of the 309th Fighter Squadron. He is also type rated in the Beechjet 400A and has flown as a firefighter in single-engine aircraft and as a corporate pilot in the King Air 200 and Citation Excel and X.

The S211 flight was an excellent introduction to the APS jet UPRT, getting me started with the low-altitude work and prepped for the high-altitude session. The clouds had cleared by the time we were ready to fly the TA-4J, so we'd be able to explore its full envelope.

Before climbing into the Douglas jet, Oppenheimer gave a detailed briefing on our mission and high-altitude upsets, as well as detailed instructions on how to use the Escapac IG-3 zero/zero ejection seat. The source of the material we covered on high-altitude upset training is found in Supplement #1 to the Airplane Upset Recovery Training Aid–Revision 2, and he explained the concepts in an easily understandable and uncomplicated fashion.

The key takeaway differences between low-altitude and high-altitude upsets are the lower air density at high altitudes, reduced available thrust and decreasing stall AOA as Mach increases. The high-altitude upset-training regime is defined as above FL250 and Mach 0.70. "The recovery is the same," he explained, "but because of the environment and what's happening, life is going to get very interesting. The big thing is don't overcontrol. Nothing is a panic mode; slow, smooth and deliberate is the way."

The TA-4J was another step up on the excitement curve, as close as I'll probably ever come to flying a real fighter jet. This was the real deal, ejection seat, oxygen mask, the works. Adding to the enjoyment was the thoroughly professional and military-style environment on the Top Aces ramp, with a dedicated crew chief helping strap me in, as also occurred in the S211, and an entire ground crew helping get the TA-4J's 9,300-pound-thrust Pratt & Whitney J52-P8B started and sending us off to taxi to Runway 12R.

Thrust to weight ratio is about .7:1, and the Skyhawk can fly to 50,000 feet and 600 knots or Mach 1.2 (downhill, said Oppenheimer). The Top Aces TA-4J is mostly original, with no modern avionics or instruments in the back cockpit and a Garmin GNS 530W in the front. Top Aces is outfitting another TA-4J with glass-cockpit avionics.

Oppenheimer did the takeoff, and then he handed over the controls. The TA-4J quickly accelerated to 250 kias, then I let it speed up to 300 kias as we passed 10,000 feet. He had warned me that this jet is "a little bit longitudinally sensitive," and he wasn't kidding. Compared to the S211's, the TA-4J's pitch control is much more touchy, and I had to pay a lot more attention to pitch attitude. As we continued the climb at Mach 0.72 and passed 30,000 feet, Oppenheimer introduced an exercise to re-emphasize the disassociation between pitch angle and AOA. While holding pitch at lift-over-drag (L/D) max as represented by a small triangle on the AOA gauge, I banked 15 degrees and watched as the vertical speed dropped and the altimeter stopped climbing. With bank at 30 degrees, the two gauges dropped further, and at 45 degrees the jet started descending. "The pitch angle has changed completely, but the AOA is still the same," he noted.

Before climbing too high, we did a runaway trim exercise, where even though I pushed the stick all the way forward, the nose kept climbing. I banked at 60 degrees to drop the nose, and got the jet stabilized, but going in circles. Oppenheimer asked me to carefully add some gentle top rudder, and this way I was able to gain more directional control. "Do you think you can land out of this?" he asked. "It might not be pretty, but I think you'll walk away from it."

The stall at low altitude was fairly benign, with some wing rock and gentle nose oscillations and some more robust buffet but altitude loss of just about 200 feet. This was nothing like the high-altitude stall.

We further explored the pitch-AOA disassociation climbing through 35,000 feet, still with the AOA at L/D max, but then after noting the pitch angle, I pulled the nose higher and slowed to Mach 0.67 then returned to the previous pitch angle. The AOA at this point remained higher than before and airspeed and VSI dropped; we

Phillip "OP" Oppenheimer, APS instructor and Top Aces chief pilot, left, took Thurber through the high-altitude training in the Top Aces Douglas TA-4J. The key, he said, is to keep in mind "slow, smooth and deliberate" is the way to recover from an upset.

were behind the power curve. I had to push the nose down to recover, and we lost more than 1,000 feet to get back to the Mach 0.72 climb.

We couldn't make it all the way to 40,000 feet because of the warm air and available mission time, but did get to about 39,000 feet. Here we simulated a congested-area slowdown, where ATC asks us to hold at a high altitude before descending. I started at a 15-degree bank, a typical half-bank angle used at high altitude, and here it already felt like there wasn't much stall margin left. Increasing the bank to 30 degrees, I could start to feel what Oppenheimer calls the "tickle" of the stall buffet, where the boundary layer starts separating from the wing, much earlier than at lower altitudes as evidenced by the AOA gauge showing 12 to 14 units at high Mach instead of 22 to 24 down below. I was unable to keep us level at that bank angle.

The best lesson of the day, in my opinion, was the full stall at high-altitude. When the buffet started and the wing dropped, I pushed the nose down, leveled the wings and added full military power. The nose was about 20 degrees low, and I kept pushing on the stick, waiting for the airflow to reattach to the wings. Here is where patience is mandatory, because nothing happens quickly at high altitudes. We descended from 39,000 feet, and finally at about 33,000 feet I was able to recover with confidence to a stabilized flight condition.

If I pulled back too soon, the jet would simply resume stalling, Oppenheimer had explained during the briefing. "At 20 degrees nose low and no power [because the thin air doesn't allow the engine to develop much power] going down from 40,000 feet, most pilots when they try to pull back, they're right back into the stall buffet because airflow is separated." This exercise highlights how the 2009 Air France 447 accident pilots might not have waited long enough when they tried—twice—pushing the stick forward during the stall in the Airbus A330. They didn't keep holding the stick forward long enough to allow the trimmed horizontal stabilizer to assist with the commanded unload until the airflow reattached. "You're going to have to go to 15 to 20 degrees nose low, or whatever it takes to reduce AOA below critical; it is the most insane thing," he told me before we took off.

Oppenheimer rocked the jet and flipped us upside down and nose low in a mock wake turbulence encounter at high altitude, to demonstrate more of the thin-air effects. During the recovery, speed builds quickly, and by the time I pushed forward on the stick and rolled wings level, speed had climbed Mach 0.15 to about Mach 0.87, and it took some time to slow down because the tools for reducing speed are much less effective in the thin air. With the power at idle and speed brakes out, nothing happened. And pulling back on the stick just kept the airflow separated, so again it was a matter of patience and accepting the loss of altitude until I could milk the stick to halt the descent rate.

We did a similar maneuver, rolling inverted and then recovering normally so Oppenheimer could show me how that recovery is far safer than just letting the nose drop and letting the jet swoop into a Split S (what not to do), where instead of rolling back upright the jet would zoom straight down and lose about 10,000 feet before pulling out. "That's assuming a business jet in the same condition didn't come apart because of high g and extreme speeds," Ransbury explained after the flight.

It was at this point that I could feel my stomach starting to try to disassociate itself from my body, and some sweat erupted on my forehead—just in time for the next maneuver, a demonstration of the Split S, which Oppenheimer would fly because APS wants to avoid negative transfer and doesn't want students to think this is a valid escape maneuver. "Without question, the all-attitude and expanded g capabilities of both the S211 and TA-4J provide critically important margins of safety to ensure participating pilots maximize their training experience by allowing mistakes to play out," Ransbury said.

Inverted Flight

At about 30,000 feet, Oppenheimer rolled inverted then allowed the nose to drop until we were pointed straight at the desert floor. While in this attitude, he pulled back on the stick to show me what a stall looks and feels like while racing toward the ground. "The airplane doesn't care what attitude it is in," he said. The recovery started with the standard push, which seems greatly unintuitive in such a radical attitude, but of course it worked. Staying below 2.5 g, he pulled the nose up and when the recovery was complete I looked at the altimeter, and we were down to about 19,000 feet. Describing the Split S during the briefing, he had said, "You'll see that that's not the correct way to get back to the horizon." Thankfully, the g load during the Split S sorted my stomach out and didn't worsen my slight nausea.

The final maneuver was a downhill speed run to feel how the pitch control changes as the TA-4J goes transonic. With Oppenheimer on the controls and me following through, he lowered the nose and added power. As the jet accelerated through Mach 0.85 then 0.90, he had me feel that the roll and pitch control was still normal, but after about Mach 0.91 the elevators started getting extremely heavy. "It will still move but it's like driving a ten-wheel dump truck," he had warned during the briefing. We stopped accelerating at Mach 0.95, and the elevators were indeed much heavier because of the supersonic shockwave, which was not only forming over the wing but also over the empennage, removing some of the elevators' authority, he explained.

Oppenheimer had me roll into a 60-degree bank and pull back on the stick to about 2.5 g, which required a strong pull, then as I held that attitude, he pulled the power back and suddenly the elevator control returned to normal and the load jumped by nearly one g. "It's just something to be aware of," he had explained in the briefing. "If you get into a high-speed dive of

The instructor returns the Douglas TA-4J to Mesa's Runway 12C after guiding Thurber through a series of maneuvers aimed at preventing and recovering from an upset.

some kind and you're at MMO or beyond, past the barber pole [speed], be careful on the pull-back, because as you come from transonic to subsonic, there is potential for an over-g. As you get rid of the supersonic shockwave, the elevator controls become very effective again."

We returned to Mesa Gateway, this time ending the flight with a 360-overhead pattern and landing on Runway 12C.

The APS all-attitude jet training adds a new dimension to UPRT, reinforcing what students learn in the Extra 300L and advanced simulators, while greatly expanding a flight envelope that most pilots never get to experience, and also helping them learn how to return to the heart of the normal flight envelope consistently and safely while dealing with the potentially incapacitating startle and fear factors. The initial course typically starts with three days of classroom training and developing the UPRT discipline in the Extra 300L and an advanced transport-category simulator session, then finishes with a day flying either of the three jets.

APS recommends that pilots return every two to three years for a day of recurrent training that can be done in any of the APS aircraft, including the S211, Alpha Jet and TA-4J. APS has found that many flight departments are opting to complete the entire four-flight on-aircraft program in the S211, yet Ransbury said that APS and its customers still find that the Extra 300L remains the best aircraft in which to develop initial UPRT skills before transitioning to the all-attitude jets.

"At the end of the program APS puts the training in perspective," he said. "The ultimate goal of APS UPRT is upset prevention through enhanced awareness, knowledge and skill. Hopefully the upset recovery is never needed. However, should an APS graduate be put into an airplane upset requiring recovery—and statistics show that to be possible and often fatal—they have the knowledge, skill and discipline to live to fly another day."

"I've not had a single pilot who didn't get something out of this," Oppenheimer concluded. "And usually, that something is critical to their safety as a professional pilot."

The cost of the APS course varies with each jet and is offered as an enhancement to the core program. Customers typically fly just one jet type: S211 from $3,695; Alpha Jet from $7,250; and TA-4J from $8,965. ❑