SOIA: Boon or Bust?

By Captain Ross Sagun

It's a beautiful day at Denver International Airport as you release the brakes of your DC-10 for pushback. Today you are heading home; non-stop service to SFO with 284 passengers on board. The sun is so bright that its rays are heating up the cockpit, that is, until the copilot gets the call:

"United sixty-one heavy, we've just started a flow program for San Francisco, expect wheels-up at 2130."

2130? You do the quick math and its ugly. That is one hour and fifteen minutes past your scheduled departure. Not only will your passengers be delayed, possibly missing their connections, but even worse, you are now going to be smack in the middle of Bay Area rush hour traffic. Bay Area weather strikes again.

At about the same time, another fellow aviator is getting the news.

"Northwest 3 heavy, SFO is going into holding. Advise when ready to copy holding instructions."

Only one small problem. Tailwinds across the Pacific today were less than expected and the flight was held down longer than expected, resulting in higher fuel consumption. The captain thinks to himself, "I hope this hold is a short one because we can't hold for very long." Bay Area weather strikes again.

At LAX, all United Shuttle flights are holding at the gate for a slot time. Crews are getting tired of waiting for pushback clearance on a totally jammed ground control frequency and are starting to run into legality problems. Gate control is pulling its hair out with too many airplanes and too few gates and ramp space. Customer service is getting hammered as passengers' risk missing connections and tempers flare. Flights are starting to cancel like dominos. Bay Area weather strikes again.

All over the country, and to some extent internationally, when the weather changes in the San Francisco Bay Area, bad things begin to happen.

The cause:

What the heck is going on, you ask. The weather is reported as beautiful VFR…2500 scattered, 57 degrees, wind from the west, as usual. What no one told you was that, while the weather at the airport is still with scattered clouds, over the San Mateo Bridge the scattered layer just gelled into a broken layer precluding pilots from seeing the airport suitable for parallel visual approaches. This has forced Bay TRACON to switch to their only alternative, single-stream ILS approaches to 28R. The airport's acceptance rate just went from a healthy 63 per hour to about 30, just about a 50% decrease. Bay is now scrambling to resequence two runways worth of traffic into one big daisy chain. Holding was inevitable and a ground stop may be in the cards if the controllers become saturated. From pilots to controllers to passengers, everyone is being taxed to the limit today. Its going to be a long afternoon at SFO.

The ATC "experts" would tell you that holding shouldn't pose a problem for you, at least for 15 minutes, because you have planned for that 15 minute hold per the MAR (managed arrival reservoir) program being conducted at 13 West Coast airports. You did put on that additional 15 minutes of hold fuel didn't you, Captain? Probably not, because you have never heard of the MAR program. The FAA's MAR program assumes that all aircraft bound for a MAR airport will hold for up to 15 minutes and is based upon the premise that, if and when the weather breaks, there should be a reservoir of airplanes in holding ready to be cleared for the approach. This helps ATC by eliminating the natural slack period, which usually follows a break in the weather. You wish you would have known about this tidbit since it amounts to about 4,000 pounds of kerosene that you didn't board. Your ALPA ATC Committee took issue with the FAA on the MAR program, stating that industry had not adequately informed their pilots of the planned 15-minute hold and its fuel ramifications.

SFO LDA

The problem with SFO, and some other airports around the country, is that the runways are just too close together to allow simultaneous parallel instrument approaches. Standard separation is 5000 feet between centerlines. Using special procedures, called simultaneous closely spaced parallel instrument approaches, ATC can go down to 4300 feet using conventional ASR-9 radar. ASR-9 sweeps at approximately 4.8 seconds per sweep.

Using Precision Runway Monitor (PRM) sweeping once per second, ATC can further reduce centerline spacing to 3400 feet for parallel approaches, and down to 3000 feet for 2.5 to 3 degree offset approaches.

Since SFO runways are only 750 feet apart, ATC managers have long tried to fix the SFO problem, where literally one cloud can cut airport capacity by 50%, using procedures rather than technology. One of the more creative solutions was the infamous SFO LDA. Literally conceptualized on a cocktail napkin in the late 1980's, this ill-fated approach suffered from a whole host of problems. Officially coined as a point-in-space approach, it led the pilot using an offset localizer located off of the airport to a missed approach point offset from the runway centerline by, you guessed it, 4300 feet . After the pilot would reach the MAP with the runway and parallel traffic in sight, he/she would visually initiate a "rejoin" maneuver, align with the centerline and land.

One problem was an unacceptably high pilot workload. The LDA approach was a non-precision dive-and-drive approach with numerous step-downs and with no glideslope. Also, the required descent angle to stay on the approach profile was excessively steep. Actual pilot reports as well as simulations showed that the steep angle contributed to approach destabilization.

ALPA was concerned about other problems as well. The original missed approach from the LDA led right into the runway 1R departure corridor, introducing a midair collision risk. Controllers could apply tower-provided visual separation between two aircraft within 750 feet of each other, at night, using a rudimentary BRITE radar display. Passing was not only allowed, it was encouraged, to preclude the need for controllers to sort aircraft types. Pilots of smaller aircraft could pass larger ones to stay out of wake turbulence. Unfortunately, without the no-passing rule, heavies and 757's would pass smaller, lighter aircraft, placing them at risk.

Probably the biggest nail in the LDA coffin was the data gathered from several simulations, conducted by both FAA and ALPA with industry support, that showed a high probability for the aircraft on the LDA approach to overshoot the 28R final and encroach into the parallel traffic's course. Approximately 1 in 5 approaches were shown to deviate more than 200 feet into the runway 28L final approach course, a totally unacceptable number by anyone's standard.

A "new" LDA approach

After years of attempting in vain to negotiate with the FAA to change the SFO LDA approach to alleviate these and other safety concerns, ALPA launched a vigorous campaign to discourage pilots from accepting the approach. Many pilots agreed and declined the LDA clearance, forcing the FAA back to the safety-negotiating table. Fortunately, the founding fathers of the FAR's saw wisdom in granting the pilot-in-command the final authority as to the operation of the flight (FAR 91.3). As a result, the FAA agreed to twenty-eight changes to the original design and a new and improved LDA approach was implemented in the form of an "operational evaluation".

Pilot questionnaires gathered during the evaluation period revealed that ALPA, working with FAA and industry, had successfully fixed many of the original problems with the approach. However, one problem continued to dog the concept; descent angle. Although we had designed in what we thought was an acceptable angle, it was revealed that ATC was not adhering to the published procedure. Instead, ATC would clear aircraft to intercept the final approach course 1000 or more feet higher than allowed by the design criteria, citing sector saturation as the reason. ALPA received several pilot reports stating that the practice was contributing to destabilized approaches. Some pilots emphatically told the FAA and ALPA that they would never fly the approach again. The ATC Committee immediately notified the FAA that we would withdraw our support of the SFO LDA if they did not cease this unacceptable practice at once. Shortly thereafter, the FAA, unilaterally and without discussion with ALPA, withdrew the approach completely. The LDA was dead on arrival, killed by those that had originally conceptualized it, the FAA themselves.

SOIA is born

FAA and industry continued to seek solutions to the SFO problem as the impact of air traffic control delays hit crisis proportions. In 1997, FTI, Inc., an aviation consulting company out of St. Louis, Missouri hired by United Airlines, approached the ALPA ATC Committee. FTI had taken on the charge to reinvigorate the LDA concept. ALPA agreed to meet with FTI to discuss the possibilities. We emerged from the meeting with a firm agreement in writing that incorporated over 20 requirements. Those included:

- Protections for wake turbulence
- No passing
- No tower-provided visual approach
- Deconflicted missed approach
- Spacing requirements to prevent side by side formation flight
- Requirement for TCAS to be in TA/RA
- Use of PRM radar to allow 3000 feet between approach courses, versus 4300, thus shallowing the rejoin maneuver
- Adequate training required
- Required testing by simulation

Buoyed by a seemingly cooperative effort, ALPA's ATC Committee went to work with industry to design a "new" approach. This new approach concept would be called SOIA, for Simultaneous Offset Instrument Approach. Our goal was to completely redesign the SFO approach to ALPA specifications, a goal that we wholeheartedly embraced. Our design team consisted of most of the pilots and staff that were involved in the LDA effort which helped to preserve the "corporate memory". Difficult lessons are not readily forgotten.

Why San Francisco? After all, SOIA approaches were being envisioned for over 20 airports around the country. The simple answer is what we call runway criticality; that is, the distance between runway centerlines. SFO represents the worst-case scenario with only 750 feet. If SOIA could be made to work at SFO, it could presumably work anywhere.

While the ATC Committee had headed the LDA effort for ALPA and was now in charge of the new SOIA effort, many of ALPA's other safety volunteers were also involved. Some of the more notable participants were Captain Tom Young and Captain Wally Roberts (CHIPS support), Captain Dave Smith (OPSCOMM, providing the team guidance from the Centrals), Captain Jim Arthur (Western Region – North), Captain Dick Deeds (DAL, now retired), our resident engineer and number cruncher and Captain Ray Brice (UAL MEC CASC) rallying the support of United's 1200 SFO pilots. Captain Dave Haase (ECASC) provided us a guiding light as we navigated our way through an LDA quagmire filled with alligators. Somewhat akin to making it through a particularly difficult PC, we emerged relatively unscathed and the safety of the system had been preserved, at least for the time being. Now, the challenge to design a totally new approach concept was before us.

The New Design

Based upon our earlier experiences with the LDA, our primary objective was to develop a design that would be flyable and keep the 28R aircraft from encroaching into the 28L final, protect aircraft from wake turbulence hazards, and allow for a stabilized approach. Now, with the aid of PRM radar and closer approach spacing, we had what we thought were the tools to design a truly safe and flyable approach.

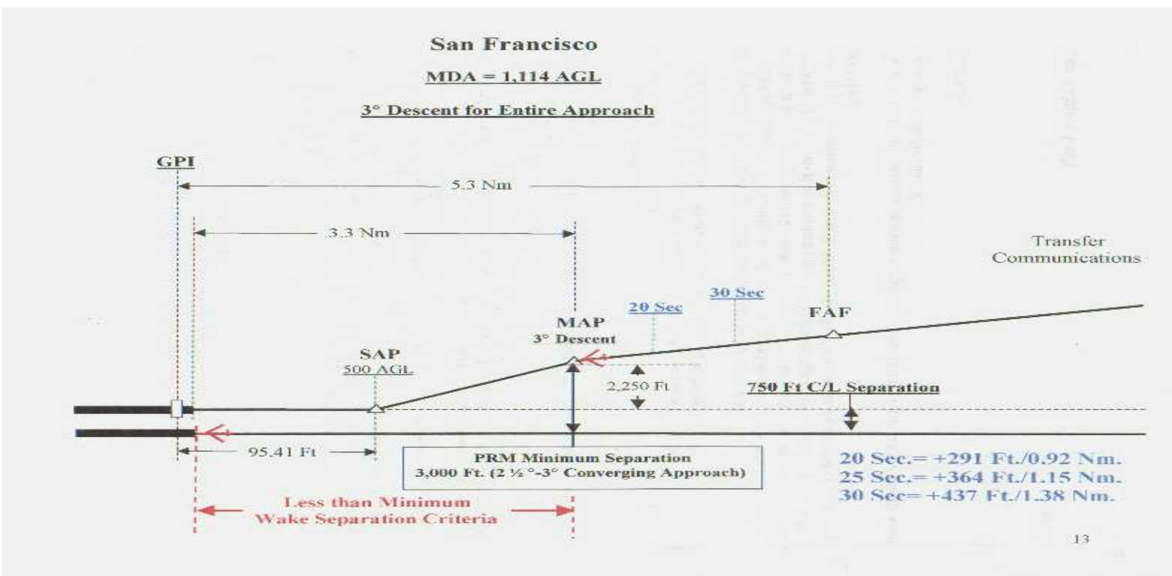
Within weeks, ALPA had suggested a project management structure which was adopted by industry and the FAA. The structure would consist of a project management team (PMT) comprised of members representing FAA, ATA, UAL, Continental, NATCA, and ALPA. Each member would have full veto power. Under the PMT would be three work groups: air traffic control issues WG, simulation issues WG, and implementation issues WG. We were on the proverbial roll.

After putting our collective minds to work, we came up with what we thought was a novel concept with these assumptions to quantitatively determine a safe intercept angle for the rejoin maneuver:

- An aircraft on a SOIA approach should fly a stabilized approach and be completely stabilized wings level, and on centerline at the 500 foot AGL point on final. We call this point on final the SAP (Stabilized Approach Point).
- The 28R aircraft approaches the centerline at a certain angle (x)
- the aircraft fails to turn onto the 28R centerline.
- Passing through the 28R centerline, we assume that the pilot will recognize his/her error since he is in visual conditions and begin an aggressive corrective maneuver
- We assume this maneuver to be a 25 degree bank back to the 28R centerline
- We require that the 28R aircraft stay completely clear of a 200 foot bubble surrounding the 28L aircraft on the straight in approach.

- Based upon the above, we calculate the maximum, zero-wind, intercept angle (x) from the MAP to the SAP.

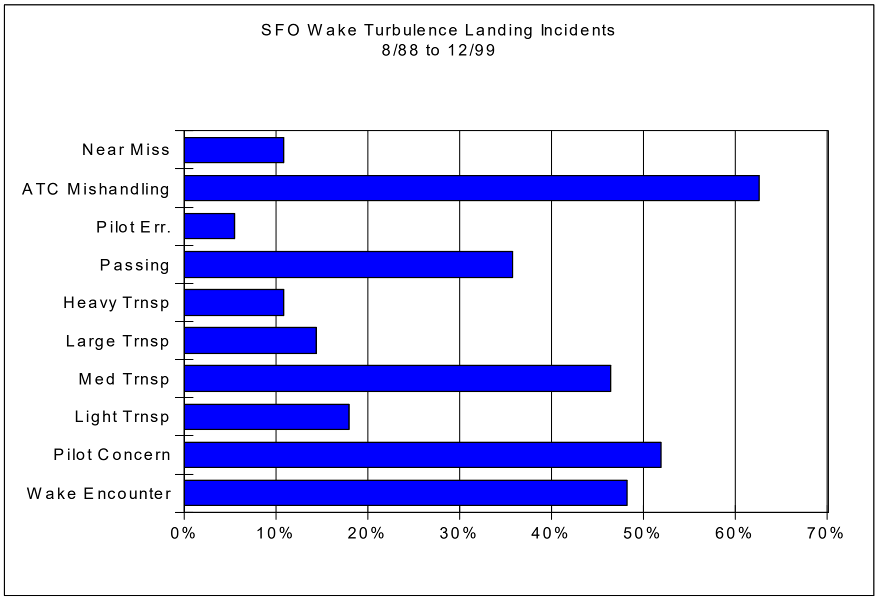
Dick Deeds took the idea and wrote thousands of lines of software code to do the math. The result was what we theorized to be the proper angle to prevent overshoots. I remember calling Dick at all hours of the day and night to find him glued to his computer debugging the code. It was a tremendously difficult and time-consuming task. The result of hundreds of hours of hours of work was a computer program which could design a “SOIA-spec” approach to any runway configuration, given the runway coordinates and spacing. We were now able to generate the approach in seconds with all of the required angles, minimums and gradients. It was, and is, a thing of beauty that is the envy of even the FAA.



The SOIA concept takes shape

Wake Turbulence Concerns

Now that we had the angle, our next challenge was to figure out how to minimize wake turbulence risks. The FAA’s solution was to leave it up to the pilot-in-command. After all, wake hazards are most prevalent in the visual segment where visual separation is being applied. During visual separation, the PIC is solely responsible for wake turbulence separation. We performed an analysis of SFO wake turbulence incidents that revealed some interesting points. The study revealed 56 reports including 27 wake encounters. 26 of the reports indicated that, even though no wake was encountered, the reporter was concerned about the *possibility* of encountering wake turbulence. ALPA responded that we believe that pilot acceptance of a SOIA approach will depend greatly on how the wake turbulence risks are addressed, and for good reason.



Data derived from NASA Aviation Safety Reporting System (ASRS) Search Request No. 5805 November 2, 1999

ALPA's response was not well received. FAA and industry argued that during truly visual conditions with unrestricted ceilings and visibility, the PIC can adequately assume the responsibility for wake avoidance. After all, he can see the subject aircraft well before being asked to follow it, and can adjust his vertical and horizontal profile accordingly. We responded that, in the case of SOIA, with ceilings as low as 1600 and visibility as low as 4 miles, under an overcast over the bay at night while performing a sideways-L vertigo inducing scan pattern, its not so simple. There isn't adequate distance or time to adjust either horizontally or vertically. The FAA was compelled to listen, since their own rules require ATC to provide wake turbulence separation to aircraft utilizing runways separated by less than 2500 feet. Furthermore, the NTSB had just issued a special study of wake turbulence events, strengthening our case.

ALPA's position is that ATC should not place anyone in a wake-unfriendly environment by design. SOIA must incorporate a wake-friendly final. They would have to sequence arrivals so that wake generators (the heavier of the two aircraft, or 757's) would be the in-trail aircraft and would not pass the leader. After all, ATC's function is to sequence aircraft. This requirement, while not an easy fix, is being explored by ATC and involves a major adjustment of arrival flows so that heavies and 757's are routed to 28R and others to 28L. Will the increased capacity afforded justify the cost and difficulty in achieving a wake-friendly final? It has been estimated that SOIA would provide up to 38 aircraft per hour versus 30 per hour without it.

A Possible Solution

FTI's Joe Linsenich came up with a novel idea to deliver the aircraft at 170 knots indicated, 2 miles apart, at the FAF (ROSSI). As the first aircraft crosses either ROSSI or BRIJJ, it slows to final approach speed, thus creating a compression as the trailing aircraft maintains speed to its FAF. Calculations and preliminary simulations showed that this scenario would result in the vast majority of aircraft crossing the 28L and 28R thresholds with anywhere from 0.5 to 2.0 miles in-trail. ATC had indicated that they could tolerate up to a 1-mile gap between arrivals and still maintain departure capacity. ATC system designers need to remember that gains do not come without cost. The alternative is to build another runway, a costly proposition as well, both financially as well as environmentally.

Another applicable axiom is that you get what you pay for. In the case of SOIA, its relatively inexpensive but its potential is also limited. SOIA will not work with weather much lower than 1600/4 due to the design requirement to acquire the other aircraft prior to reaching the MAP. If a trailing aircraft reaches the 28R MAP (DICKI) and has not visually acquired the 28L lead aircraft, ATC must issue a go-around since to proceed further breaches the 3000 foot separation standard. Go-arounds/missed approaches are a controller nightmare, as their goal is to handle an aircraft once and unload it, not to have it as a rogue wandering around trying to find a place to fit into an already crowded flow.

No side-by-side formation flight

The FAA and industry would like us to fly in side-by-side formation flight to maintain departure capacity and increase the arrival rate to 45 per hour. ALPA's position is that there be no side-by-side formation flight or passing during the visual segment. Simulation showed an unacceptable increase in workload if the aircraft on the adjacent final is not in the forward field of vision. Curiously enough, even the management pilots that flew the simulation agreed on this issue. A picture is, indeed, worth a thousand words.

Approach minimums

The SOIA concept incorporates the use of an 11 million dollar PRM fast-update radar to allow for a reduction in separation from 4300 to 3000 feet at the MAP. This is very significant since the narrower spacing shallows out the realignment maneuver making the approach much easier to fly. SOIA weather minimums are based not only on the ability of the pilot to see the landing runway but also on the ability of the pilot to acquire and follow the aircraft on the other approach course.

We accommodate the latter by the use of a required ceiling. At SFO, the CEILING REQUIRED must be at least 1600, while the actual DH is 1104 msl. This gives the pilot approximately 500 vertical feet and 30 seconds of acquisition time to spot the other aircraft prior to reaching DH. Remember, visual separation must be applied before the aircraft on the LDA approach reaches the MAP (DICKI). Otherwise, ATC must issue a missed approach to one of the aircraft to avoid losing standard separation.

This brings up a very important point. Normally, once a pilot sees the runway and is in a position to land, the pilot may maneuver his aircraft accordingly. This is not the case with a SOIA approach. Separation is based upon the presumption that the pilot will remain on the localizer course until reaching the MAP. If you leave the LDA course prior to reaching the MAP, it is possible that ATC may have to issue a PRM breakout to the other aircraft or send you around.

Training

SOIA is a procedural enhancement of PRM. PRM, in and of itself, requires that special training be accomplished. A thorough understanding of normal and emergency PRM procedures is essential to ensure a safe procedure. Therefore, training for SOIA would have to include PRM training as well as specific SOIA procedures. How this training will be accomplished is still being discussed and will most certainly require close coordination with ALPA's Pilot Training Committee. While FAA and industry believe that a training bulletin and "ATTENTION ALL USERS" page would suffice, the ATC Committee does not believe that paper training alone will suffice for SOIA.

Dual communications capability required

Just like in PRM, the ability of the controller to have a clear communications channel to issue a breakout, should it become necessary, is fundamental to SOIA. SFO poses some additional difficulties in this regard. Unlike at MSP, where each runway has its own local (tower) controller, SFO has only one local controller. A breakout issued by the final controller, with override capability over local control, would be heard by both SOIA aircraft, and the ability to attempt to simultaneously deconflict both aircraft would be difficult, if not impossible.

The FAA has continuously lobbied for the removal of the dual communication requirement, arguing that ABD (anti-blocking device technology) could serve as a suitable alternative. The problem with this is that ABD merely advises, with an audio tone, that the channel is blocked. It does nothing to clear the channel.

Testing

In 1999, the new SOIA approach was tested for flyability in United's 747-400 simulator using active line pilots. The results were impressive, with minimum overshoots and good approach stabilization. We had succeeded in designing a flyable approach, or so it seemed. What we didn't realize at the time was that the FAA was planning to run the approach in a way that would reintroduce many of the problems that we had worked so hard to solve and abrogating our written agreement, such as:

- Leaving wake turbulence avoidance totally up to the pilots
- Giving no regard to faster in-trail aircraft overtaking the lead aircraft
- Encouraging side-by-side formation flight
- Sequencing smaller aircraft closely in trail or wing-tip to wing-tip to larger, wake generating aircraft (for example, a commuter turboprop behind a heavy B-747-400)
- Requiring TCAS to be placed in the TA-only mode, essentially disabling the pilot's collision avoidance protection

The last issue mentioned above was especially egregious to ALPA. Our analysis showed that, if the final approach speed differential between the two aircraft were to exceed as little as 20 knots, the slower smaller aircraft would drift back into the wake turbulence danger zone sometime prior to touchdown and, presumably, at a very low altitude (see graphic).

Dist. ILS		1.29	1.18	1.07	0.97	0.86	0.75	0.64	0.54	0.43	0.32	Drift
Distance	Time	Velocity (Knots)										Distance
Feet	Secs.	115	120	125	130	135	140	145	150	155	160	165 Kt
650	25.67	WAKE	WAKE	0.10	0.21	0.32	0.43	0.53	0.64	0.75	0.85	1.18
600	23.70	WAKE	WAKE	0.01	0.12	0.23	0.34	0.44	0.55	0.66	0.76	1.09
550	21.72	WAKE	WAKE	WAKE	0.03	0.14	0.25	0.35	0.46	0.57	0.67	1.00
500	19.75	WAKE	WAKE	WAKE	WAKE	0.05	0.15	0.26	0.37	0.48	0.58	0.91
450	17.77	WAKE	WAKE	WAKE	WAKE	WAKE	0.06	0.17	0.28	0.39	0.49	0.81
400	15.80	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	0.08	0.19	0.29	0.40	0.72
350	13.82	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	0.10	0.20	0.31	0.63
300	11.85	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	0.01	0.11	0.22	0.54
250	9.87	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	0.02	0.13	0.45
200	7.90	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	0.04	0.36
150	5.92	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	0.27
100	3.95	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	0.18
50	1.97	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	WAKE	0.09

The graph shows that aircraft with final approach speed of 135 kts or less will encounter wake turbulence inside of the FAF using the FAA's plan. (450 foot line to account for 50 foot wingspans and nominal 100 foot lateral centerline displacement. Graph assumes the in-trail aircraft to be at maximum category D approach speed - 165 knots)

Pilots know that wake turbulence demands the utmost respect. A recent incident drives that point home. Two B-737's executing parallel visual approaches to SFO were within approximately 0.5 nm of each other on a beautiful, clear day. At 1300 feet AGL, the B-737 on the 28L final experienced a 42-degree roll (confirmed by the DFDR) as it encountered the lead 737's wake. Fortunately, all that resulted were some frayed nerves. What could have happened if the lead was a 747-400 and the victim aircraft a Jetstream? ALPA does not want to find out the hard way.

Safety and Politics

So, where are we in the SOIA saga? That is a very difficult question to answer. It seems at times like we are flying through a volcanic ash cloud. The further we progress, the more clouded the view. Progress has slowed as meeting schedules slowed to a glacial pace. Data that was readily shared between FAA, industry, and ALPA now seems to be buried somewhere within the bureaucracy. One good example was a flyability simulation mentioned above which was performed in July 1999. Six months later and despite repeated requests, the ALPA ATC Committee has yet to receive a copy of the pilot questionnaires from the FAA. Why the secrecy? The management structure that the entire group settled upon in 1998 seems to have been abandoned and overall management of the project returned to FAA Headquarters. Everyone on ALPA's SOIA design team wonder if our SOIA engines will eventually flameout. Meanwhile, SFO airport delays continue to be among the worst in the nation.

What does the future hold for SOIA? The ball rests in the FAA's court. If they choose to proceed with their plans to run side-by-side flights with little or no consideration for the risks of wake turbulence, ALPA will have little choice except to withdraw our support. We are hoping that the FAA makes the decision to honor our concerns and implement a safe SOIA approach procedure. Only time will tell. One thing is certain…safety has always been, and will continue to be, our primary objective.

Captain Ross Sagun is the Chairman of ALPA's Air Traffic Services Group (formerly known as the ATC Committee) and a SFO-based DC-10 pilot for United Airlines.