

**THE HIDDEN COST OF  
THE LACK OF  
ATC SAFETY REGULATION**

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# The Hidden Cost of the Lack of ATC Safety Regulation

## I. EXECUTIVE SUMMARY

FAA has no formal, structured safety regulation system for the air traffic control, unlike virtually all developed countries and the EC.

This absence has allowed bureaucratic empires and programs to emerge which are now known to be useless or duplicative in aviation. The wasted cost of these programs is now estimated at \$4 billion without a useful role yet certified.

Nearly all of the costs are borne by the taxes on air carriers to the Aviation Trust Fund. Additional, perhaps equal, costs of equipage lie ahead for air carriers.

## II. DISCLAIMER

Let me begin by spreading the blame. Like most aviation disasters, the WAAS/LAAS tangle is a result of the many mis-steps, some almost 20 years old, which have compounded the problem. The present management of FAA is not culpable and instead has the uphill task of straightening it all out.

Next, I do not believe that the WAAS/LAAS programs have suffered from technical mismanagement by FAA's staff nor by the contractors, although there has been much discussion on this point in the Congress and by the IG/GAO. The fact is that making a GPS signal safe for aviation precision approach is an immensely difficult task and is requiring much more time and money than originally, optimistically,

predicted. I have always thought that we would get there sooner or later.

There is, however, doubt that these systems will have much, if any, benefits to those who are paying for them - aviation users.

“Easy for you to say with the benefit of hindsight,” some may say. This paper will show that it was all foreseeable.

### III. SPONSORSHIP

Back in the late nineteen seventies and mid-nineteen eighties there was a pervasive belief that FAA’s R&D shop was launching a bunch of expensive, fascinating projects, which ultimately fizzled out because they didn’t produce any real world benefits. The MLS program, a technical success, was then thought of as a failure (more on this later) and was cited as an example.

So the practice of “sponsorship” began. Under this, an operating office of FAA - airports, safety, or air traffic - would endorse and adopt a development project because it would benefit its area of responsibility. The R&D office would run the contract, but the sponsoring office would do oversight, develop rationales (cost benefit studies), and defend the project against critics.

This made sense at the time and, in the absence of any recognizable long range planning, is as good a system as any. But it has gone out of control in respect to GPS augmentation.

### IV. THE ROMANCE OF SATELLITES

By the early nineteen nineties it was evident that the U.S. Defense Department's NAVSTAR program, later awkwardly named GPS - Global Positioning System - would have enormous potential for all sorts of civilian applications. The GPS satellites broadcast two positioning signals: an encrypted P code for military users and an open C code available to all, and meant for civil users. It is the civil C code that all public positioning and timing discussions concern.

The DOD realized from the outset that the civil signal was (a) very accurate and (b) available to hostile military and terrorist forces. The civil code could be used as a targeting system against the US and its allies. So the GPS birds incorporated a feature called "selective availability" (SA) which made the civil signal inaccurate for precise military targeting and too inaccurate for many civil uses, including precision approach for aviation as well. As civil uses of GPS multiplied, pressure on DOD increased to make the civil signal more accurate by turning off SA. President Clinton's 1996 Presidential Decision Directive, however, stated that SA would not be turned off until 2006.

The arrival of the civil GPS positioning signal opened new and exciting possibilities in navigation guidance for FAA's several offices. A culture arose in FAA that GPS was a disruptive, transforming technology that would revolutionize and modernize air traffic control and which would make obsolete the existing dense array of ground based navigation and surveillance systems - ILS, MLS, VOR, DME, NDB, LORAN, and even radar used by controllers.

A list of expensive GPS-based programs were launched that would replace the ground based systems. These would all be scrapped, saving lots of money to the government. Aircraft operators would discard their multiple avionics boxes and replace them with a small number of boxes based on a single signal—GPS. They would save lots of money.

V. A NEW ROLE FOR THE SAFETY OFFICE

One of the most important roles in the ATC system is that of instrument approach. The ground-based transmitters providing this service permit aircraft to approach and land safely in bad weather when the ceiling is very low or even when the runway cannot be seen by the pilot at all.

There are two generic types of instrument approach: non-precision and precision approach.

Non-precision approach (NPA) provides an accurate track over the ground but does not provide a stabilized, straight-line descent—continuous vertical guidance—to the runway threshold. NPA's are found at small, lightly used airports where the expense of an ILS is not justified, and on runways at airports where a single ILS is sufficient to handle the need. The bulk of NPA approaches are flown by smaller planes with less experienced pilots. The accident rates of NPA-equipped airports are higher than at ILS-equipped airports.

Precision approach provides a signal that guides an aircraft in a straight line through the clouds to the runway threshold. Continuous vertical guidance, as well as a direct track over the ground as the

aircraft descends, are the two main features of precision approaches. Precision approaches are of immense economic value because they permit scheduled operation in bad weather. They are also, in the hands of skilled pilots, very safe. Precision approaches are currently provided by Instrument Landing Systems (ILS) worldwide and by a growing number of Microwave Landing Systems (MLS) in Europe. There are now 1100 ILS-equipped runways in the US at the 700 busiest airports. Almost all the bad weather approaches by air carriers in the US are by ILS.

So: as the list of GPS-based services was developed it became necessary to parcel out the new projects to an appropriate sponsoring office in FAA.

Instrument approach by GPS presented a problem: it was an integral part of the ATC system, so perhaps the air traffic control office (ATC) should be the sponsor. On the other hand, instrument approach clearly had a safety dimension, so perhaps the safety regulatory office (AVR) should be the sponsor.

The selection decision was influenced by the air traffic office's lack of enthusiasm for GPS precision approach. The air traffic folks could see a useful role for GPS in the en route and terminal operations role, but could see no reason to discard a nationwide - indeed, worldwide - array of ILSs which were increasingly cheap, increasingly reliable, very safe, and in place.

So the safety office, AVR, was selected to sponsor WAAS and LAAS, the GPS-based replacements for ILS. This fateful decision led to a new role for AVR: spokesperson, advocate, supervisor of projects, designer

of cost-benefit studies, and coordinator of a continuing series of meetings and demonstrations by a new bureaucratic entity - the SOIT.

AVR's traditional role as an impartial judge of machines and practices was changed. AVR was now, in respect to GPS, a player.

## VI. IMPROVING THE GPS SIGNAL: WAAS & LAAS

The GPS, modified as it was then by SA, lacked the accuracy and integrity to guide an airplane safely to 200' above the runway in a Category I approach—the standard, garden-variety approach at 85% of the ILSs. Furthermore, the air carriers had announced a requirement for lower decision heights than Cat I. Cat II and Cat III would permit landing with 100' ceilings and would even permit autoland. Something had to be done to modify the basic GPS signal to meet these stringent standards.

The answer lay in augmentation systems—a complex system of permanently ground-mounted GPS receivers at monitoring stations which received the GPS signal, compared the signal to the known location of the monitoring station, and transmitted a correcting message to navigation receivers in aircraft. Two types of augmentation systems were undertaken, each for different roles. WAAS, the wide area augmentation systems, transmitted the corrective signals from geostationary satellites over the equator and could be received at virtually any US airport, large or small. Because WAAS messages are limited as to accuracy and integrity, WAAS would provide for Cat I approaches everywhere. LAAS, the "local" area augmentation system,

would be installed on a specific airport and would transmit corrections only to aircraft landing at that airport. LAAS corrective messages would be very accurate and would provide Cat II & III approaches, where needed.

## VII. THE BIRTH OF GPS SOLE MEANS

WAAS, LAAS, and the many other GPS-based technologies were obviously going to be very expensive. When added to the continuing expenses of operating and maintaining ground-based ATC equipment, they would bust the budget.

The Office of Management and Budget, noting that the GPS systems would be duplicative of the ground-based equipment, insisted that the ground-based equipment be turned off and removed. This would offset the cost of GPS systems and, hopefully, allow large cost savings to the government and to users.

Thus began the government's embrace of the principle of GPS Sole Means—that GPS would be the only nav system in the cockpit and the only service provided by the government. The blame for the adoption of this fallacy has been placed on OMB and, perhaps, on Vice President Gore's pro-technology movement in the White House. But this is not fair. It is the FAA's duty to decide what is safe and what is not. FAA failed to state to OMB that GPS sole means was not safe and that most of the ground-based nav aids had to be retained.

## VIII. THE EMERGENCE OF THE SOIT



In order to promote the US GPS programs domestically and abroad, the SOIT - the Satellite Operations Implementation Team, pronounced "soyt" - was formed, nominally within the safety office, AVR. The SOIT is co-chaired by a person from the Flight Standards office and a person from the Certification office. The membership of the team, a page and a half long, included someone from nearly every interested group - other FAA offices, DOD, ICAO, Nav Canada, EuroControl, etc. In practice, however, it was the sole province of its co-chairmen.

The SOIT gathered to itself virtual control of all policy and demonstrations of US civil GPS. Public statements about GPS to Congress, to ICAO, to nearly every audience - were first drafted by the SOIT. Worldwide GPS demonstrations were scheduled, if not actually conducted, by the SOIT. Twice a year the SOIT conducted public meetings, attended by a worldwide audience, devoted to promoting the use of GPS. These meetings, incidentally, were (and are) largely duplicative of biennial meetings of the CGSIC, the Civil GPS Service Interface Committee, run by the Office of the Secretary of Transportation.

Over time, the SOIT and its chairmen, have become the most powerful forces in civil GPS policy in the world.

The SOIT was established as a sort of SPO, a special program office, a matrix organization outside the typical bureaucratic hierarchy. The good news is that the SOIT is independent. The bad news is that it has no supervision and is out of control.

Control to the SOIT's self-generated theology is the principle that GPS sole means is safe—GPS needs no backup. When questioned on this point, the SOIT leaders said, "This question is not in our charter." Unfortunately, that question is in no one else's charter in FAA.

Neither the SOIT, nor the names of its chairmen, are in the FAA phone book.

#### IX. SECRETARY MINETA AND ATC SAFETY REGULATION

One of the first aviation pronouncements by new Secretary of Transportation Norman Mineta was that FAA should have a regularized ATC safety process. Work was immediately begun within the Administrator's office. A report was produced in June 2001 which included a survey of the practices in other developed countries and Eurocontrol, plus some options for FAA.

The obvious location for an ATC safety regulatory office is as a third branch in AVR, next to flight standards and certification. AVR wanted no part of it, however, and the issue became entangled in the languid discussions about establishing an ATO and hiring a Chief Operating Officer, and was then engulfed by the events of 9/11 and FAA change of command.

The proper solution to the ATC safety vacuum is simple: the function should be independent of ATC operations (just as it is independent of air carrier ops and air carrier manufacturing) and it should be in AVR. AVR should develop an ATC safety regulatory capability, which will take some time. And this solution is correct whether ATC remains as is, or

an ATO is established, or a new ATC Administration in DOT is established, or even a non-profit Nav Canada model is set up.

At present, however, within FAA the ATC office and the R&D shop oppose any overview, and the AVR safety office doesn't want to touch it. Leadership from the new Administrator will be required.

Meanwhile, the absence of ATC safety review has had costly consequences because GPS sole means was allowed to persist.

#### X. GPS AUGMENTATION: THE OFFSPRING OF SOLE MEANS

The requirement that all current nav aids be scrapped to make way for GPS gave rise to the development of a replacement for ILS systems.

The proposed solution for this was WAAS and LAAS. WAAS was for Cat I approaches and LAAS for Cat II and III. No other significant roles were originally proposed for these technologies. They were both dependent on continued credibility of the doctrine of GPS sole means: if the ILS's were to be retained, WAAS and LAAS would be duplicative and un-needed.

The doctrine of GPS sole means was subject to constant criticism from outside experts and institutions. Internal FAA reviews, a top level White House Commission, DOD practices, Eurocontrol policies, and numerous professional, award-winning papers, all characterized sole means as deeply flawed and unsafe.

FAA fought back to protect its programs. A trade association was paid to hire a university to write a pro-sole means study: the study has since been discredited. The FAA Administrator, supported by her chief

safety officer, argued the sole means case before a deeply skeptical ICAO Council.

## XI. THE DEATH OF SOLE MEANS

The end finally came on September 10, 2001, with the GPS Vulnerability Report from DOT's Volpe Center in Cambridge, MA.

The Volpe Report was actually mandated by a White House group, the Presidential Commission on Critical Infrastructure Protection (PCCIP) which designated GPS dependency as a national weakness and directed the DOT Secretary to take a close look. The study was handed to the tiny navigation staff at the Volpe Center.

By now the details of the Volpe Center Report are well known. The report demolished the sole means doctrine and was, to his credit, immediately read in full, published, and endorsed by DOT Secretary Norm Mineta. There is no turning back.

The report is also a humiliation of some of the FAA's professional officers and of its past leadership. It also reflects no credit on past OST leadership, which passively accepted FAA's flawed rationale.

## XII. WHERE WE ARE NOW

The requirement to carry a secure, backup ground-based positioning source to complement GPS is actually not that hard to achieve, nor does it impeach the potentially useful GPS roles, such as ADS-B, which are planned for oceanic, domestic en route, and terminal flight.

But the need for the ILS replacement augmentations, WAAS and LAAS, is largely eliminated. The continuation of the ILS transmitters,

and the continued ILS receivers (including Cat II & III boxes) on aircraft, means that the 1000 busiest runways in the US will not use a GPS approach aid. Nor will the ILS-equipped runways in the rest of the world. One thing is clear: if FAA had done its safety work from the first, neither WAAS nor LAAS would have been undertaken.

FAA must now deal with the world as it is. The WAAS program, having consumed nearly a billion dollars, and with a total program cost estimated at nearly three billion dollars, is a reality. Its remaining aviation roles are minor but not non-existent. Small airports without an ILS precision approach (because the demand for one is so low) may now have a glide slope added to their NPA. It is hard to envision a market for WAAS among air carriers, especially since US and European air carriers have said that all along. There are lots of users of WAAS today, of course, but not in aviation, and the number is increasing. Agricultural users owe a debt of thanks to FAA for paying for WAAS with taxes on air carriers.

The situation with LAAS is more optimistic: the program is in its infancy and can be stopped. LAAS is a very short-range replacement for ILS at busy airports which will now keep their array of ILSs. There are no benefits to small airports or to general aviation. FAA is now searching for a role for LAAS and is proposing that LAAS can be used to fly high accuracy tracks and curved final approaches via LAAS in re-designed terminal airspace. This is true but unpersuasive. FMS's with basic GPS can fly any high accuracy track and intercept an ILS. Most air carriers have figured this out and will not equip with LAAS.

### XIII. THE NEXT STEPS

It is now evident that much of FAA's furious and expensive GPS augmentation development would have added little to ATC capacity even if GPS sole means were a viable concept, which it is not.

However, basic, unaugmented GPS is a superb, high accuracy positioning signal in space - now that SA has been turned off six years early - which will find its way into every navigation suite in aircraft, large and small.

The real revolution in navigation comes from the flying computer—modern avionics on the airplane. If any improvement in ATC capacity, efficiency, and delay are to be realized they will come from avionics and air space redesign. Fortunately, this work is proceeding.

Meanwhile, four steps should be taken to set a better path for the future:

- (1) Establish an ATC safety regulatory office in AVR, whether they like it or not.
- (2) Continue WAAS development: it can't be stopped now. Maybe the agriculture department will chip in.
- (3) Kill LAAS. In the words of a skeptical OMB Director in the Nixon Administration, "Now you guys have done it. You've created a program with no benefits at all."
- (4) Stop AVR from "sponsoring" projects. Abolish the SOIT. The research shop and air traffic are perfectly capable of implementing ATC technology and have done so since 1938.

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