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Fogbusters

Aviators have tried dozens of ways to get rid of airport fog—from sand to laser beams—and have never had much success

by Jeffrey W. Miller

VIEWED FROM A COCKPIT UP ABOVE, THE LAYER OF FOG over the Arcata airport in Northern California was a churning mass of gray and black in a field of rolling white. As the plane descended, the black portion rose like a mushroom cloud, suckare and more white fog into its vortex. es Grimes and Byron Clark, fresh from World War II service (Clark as a bomber pilot i Europe, Grimes flying transports in Alaska), pointed the nose of their C-47 toward the nearest edge of the turbulence and began their descent. Fierce air currents buffeted the plane as it came in for landing. Visibility was "zero-zero"—nothing but white ahead and above. Suddenly they were surrounded by smoke, and then just as suddenly they were clear. The runway was in sight—and what a sight it was.

A hundred plumes of fire, each twelve feet tall, reached skyward like giant blowtorches. Fed by diesel fuel through underground pipes, the blue-white blast evaporated the fog with startling efficiency. In less than five minutes the flames had bored a hole three hundred feet high and almost a mile long for Grimes and Clark to land in.

Over the next three years, from 1946 to 1949, Grimes and Clark would make hundreds of flights at Arcata to test various fog-fighting schemes. Many of them used this flamepowered system, which was known as FIDO (variously reported to stand for Fog, Intensive, Dispersal Of and Fog Investigation Dispersal Operations) —"the seeing-eye dog of blind flying," as one magazine writer called it. Commercial, Navy, and Marine pilots, even a jet pilot or two, did likewise in one of the longest chapters in modern aviation's constant war against fog. Yet, as in many of the battles before and since, fog eventually prevailed. The reason is a complicated mix of physics, missed opportunities, and simple economics.

The FIDO system "sounded and smelled like a hundred blowtorches."

The physics is the easiest to understand and perhaps the hardest to combat. Fog consists of tiny droplets of water vapor suspended in the air (in other words, a cloud), hanging near the ground. There are several ways to get rid of the droplets: condense them into macroscopic drops of water or crystals of ice, which will then fall to the ground; evaporate them; or disperse them.

For aviation purposes there are two main types of fog. Warm fogs—those above the freezing point—are stable, even-temperatured masses. When sitting over a runway, they require a lot of energy and brute-force methods to clear. Cold, or supercooled, fogs—those below the freezing point—are much less stable and can be seeded and cleared fairly easily. They will freeze spontaneously if given suitable nuclei to form crystals around. Vincent Schaefer, a General Electric scientist, proved that in 1946 when he dropped dry ice into his laboratory freezer box and made it snow. To

underscore his point, he later carved the GE logo into a cloud over Schenectady, New York.

Silver iodide dust and liquid propane or liquid carbon dioxide (both of which draw heat from their surroundings, thus causing ice crystals to form) are the seeding agents of choice today for cold fogs. But unfortunately, cold fogs account for only 5 percent of the total in the United States. What is good news for airline travelers in places like Reno, Nevada, and Salt Lake City, Utah, where cold fogs prevail, has been no help to those in the rest of the country 95 percent of the foggy time. These warm-fog travelers have been left to stare at their watches, or land hundreds of miles from their destinations, and question why nothing can be done.

They are not alone. Commercial airlines, the military, NASA, and the Federal Aviation Administration (FAA) have all had good reasons for wanting to master warm fog at least long enough to provide the quarter-mile or more of runway visual range most planes need to land. Two of the biggest reasons for this are safety and money. According to the National Transportation Safety Board, fog is a factor in as many as 15 percent of all fatal air crashes. Perhaps the most horrific example was the 1977 collision of two jumbo jets in the Canary Islands, which killed 583 people. Besides the cost in lives, it has been estimated that delayed, diverted, and canceled flights cost the airlines $25 million to $100 million annually.

In the last fifty years various parties, from Air Force meteorologists to back-yard inventors, have tried almost everything to rid themselves and us of this aviation albatross. Electronic landing systems have been in use since World War II. In the earliest version, Ground Controlled Approach (GCA), a radar operator on the ground would observe the approach of a fighter or bomber and give the pilot instructions over a radio link. Airline pilots hated this system, preferring to land their planes themselves, and so the postwar emergence of Instrument Landing System (ILS) was welcomed. ILS used narrow beams from ground transmitters to mark an approach path, which pilots could pick up using onboard receivers. Early versions of ILS were somewhat inaccurate, but recent improvements have made it possible to land in virtually any sort of weather.

However, the most precise systems are expensive, and at most airports the weather is only bad enough to make them necessary a few days a year. Except for eternally misty places like London, it is not cost-effective to install ILS good enough to work in the worst fogs. This ensures that fog will continue to be as big a menace as it was in the 1920s and 1930s, when early aviators dumped electrified sand from planes—a solution that would eventually have turned landing strips into sand dunes.

By 1935 the approach had become more scientific. MIT's Henry Houghton sprayed an advection fog—the kind formed when warm, moist air passes over cold water or land— with a calcium chloride solution. The idea was that a hygroscopic (water-attracting) salt solution would draw moisture from the fog and form large droplets, which would fall harmlessly to the ground. Houghton did manage to dry out an area six hundred by three hundred yards, but the line of sprayers on the ground was too unwieldy and the salt too corrosive for the system to be practical.

By the late 1960s the most popular seeding ingredient for warm fogs was urea. It worked fairly well, but the huge amounts needed to keep horizontal visibility above one-half mile—eighty thousand pounds per hour—guaranteed that it would stay in fertilizers and not the skies.

Moreover, as a 1969 Navy technical paper explained, hygroscopic seeding worked well only with perfect meteorological conditions—when fogs were relatively unpolluted, slow to re-form, and unaccompanied by any wind that would sweep the newly opened hole off the runway. Worse, if the size of the seeding particles was not exactly right (the right size depending on the nature of the fog), or if too much was dumped at once, the result could be no change or even a heavier fog.

Undaunted by the failure of hygroscopic seeding to work consistently, weather modifiers have continued to send out new fogbusters like knights at a joust. Laser beams, electric heaters, corona dischargers, ultrasound, sieves, even helicopters have all been tested, with mixed results. Helicopters reportedly were able to clear their own landing spots on a number of rescue missions in Vietnam. In 1978 the Air Force tried a sweeping microwave beam. It worked, but only at unsafe and prohibitively expensive power levels. Despite all this gadgetry, the most effective methods through the years have been the most elemental: fire, wind, and water.

The British first learned this during World War II when they installed a heat-operated fog-clearing system, the first to be called FIDO, at fifteen military airfields. Open trenches, sometimes in double rows, were dug along runways. When planes had to land in heavy fog, aviation fuel was released into the trenches through perforated pipes and ignited. Estimates are that 15,000 men in 2,500 planes, often American bombers returning from missions over Europe, landed safely with FIDO's help.

This was not lost on two American naval observers, Commander John P. Lunger and Lieutenant Commander Robert Champion. In the spring and summer of 1944 they oversaw a battalion of Seabees, who drained lakes and grassy bogs to build a FIDO installation on the Army air base at Amchitka in the Aleutians, off the foggy southern

coast of Alaska. The Amchitka system could reportedly cut mile-long holes in fogs 4,000 feet deep.

FIDO was useful during the war but an easy target in peacetime. The reason: It consumed huge amounts of fuel —in one case 200,000 gallons per hour, or up to $5,000 per landing in 1945 dollars. As Wesley Price later wrote in *The Saturday Evening Post*, “Airline men who wanted a fog cutter for peacetime flying thought FIDO would be a good dog, until they heard about the bite.”

But the U.S. Navy was not yet ready to call it quits. Instead it ordered further research at one of its foggiest air stations, located on a coastal bluff near Arcata, California. By 1946 the Air Force and various civil-aviation groups had joined the Navy to test a series of landing aids for weatherblinded pilots. The Landing Aids Experiment Station (LAES) was born.

Leading the fog force was Robert Champion, fresh from Alaska. He was joined by a team of pilots and technicians who, in addition to refining FIDO, were testing GCA and ILS. Batteries of fog-piercing approach and runway lights, lit in four colors and four patterns to signal the pilots home, rounded out the bad-weather arsenal.

In keeping with the freewheeling experimental spirit of the station, LAES researchers even tried to knock the fog droplets senseless with sound waves by blasting twelve air-raid sirens simultaneously. The result was a twelvefoot-long hole in the fog and an outraged farmer who complained that his turkeys were becoming psychotic. Super-sonic noisemakers didn’t work either—and this time cows wouldn’t give milk and chickens stopped laying eggs.

But these were only the side shows. It was FIDO that demanded the most attention and eventually elicited the most support. The first problem was to reduce fuel consumption. The Navy, proposing to substitute a cheaper grade and burn it more efficiently, developed a high-pressure system that combined a pumping station, a network of underground pipes, and high-pressure burners, each consisting of three nozzles arranged in fan formation. When the fuel reached the nozzles, it was ejected as a fine spray and then torched by an electric igniter. The system, run from the control tower, released large amounts of radiant energy that could dry out the fog in five minutes or less.

“It sounded and smelled like a hundred blowtorches going on at once,” remembers George Davis, who was an airfield technician at LAES. “And you could really feel the heat.” No wonder, then, that after Southwest Airlines successfully used the system in 1946, “HDO for the common man seemed right around the corner, waiting only for the bigwigs of aviation to strike a match,” in Price’s words. So what happened?

For one thing, the cost problem refused to disappear. Cheap diesel oil simply didn’t do the job, and FIDO testers had to go back to high-octane gasoline. Fuel costs averaged $250 per landing (2,300 gallons consumed) and $173 per takeoff (1,600 gallons consumed). Wages and maintenance pushed the total bill five or six times higher.

What really put the system on the back burner, however, was a series of poor field tests at Los Angeles Airport (which gets morning fog at certain times of the year, since it is near the ocean) in the early 1950s. The Los Angeles system, which cost more than a million dollars to install, tended to smoke, probably because it burned diesel oil instead of gasoline. When used on dense fogs, it produced a chimney effect that pulled in fresh fog from either side of the burner lines. Then there was the psychological effect on passengers as their plane slanted down for landing amidst towering flames, and the safety hazard if the plane should skid off the runway. (In Arcata an ambulance and a registered nurse were always on standby.) By 1953 FIDO was finished—or so it seemed.

Twenty years later the FAA looked at FIDO again and decided that refinements and the use of clean-burning natural gas would make it feasible at Los Angeles International Airport. The agency also tested the thermokinetic method—essentially a series of jet engines placed in pits alongside a runway. The engines created a hot wind that could evaporate fog in minutes, not to mention a sound that one American pilot compared to a squadron of F-100s.

Neither system was cheap. The new FIDO would have cost $11 million to install and $1 million a year to operate, the jet-engine system about half as much. The cost-benefit ratios still looked good on paper, but whether by choice or circumstance (the report was completed in the waning days of the Ford administration), neither system was deployed in the United States.

That was not true in France, where a thermokinetic powerhouse called Turboclair made its debut in 1974 at Orly and soon after at Charles de Gaulle Airport, both outside Paris. But after early successes the system needed too much maintenance and became too expensive to operate. In 1987 jumbo jets had to pay $7,500 to use the system. French airport authorities, putting their faith in new, sophisticated electronic landing systems, shut down Turboclair in 1988.

Here in America the fog beaters press on. In 1984, at the Marshall Space Flight Center in Huntsville, Alabama, NASA successfully used fire hoses equipped with high-

capacity nozzles to propel huge amounts of water 250 feet up into the foggy air. This water coalesced with fog droplets, fell to the ground, and was recirculated. The fog-washer method used a tenth of the energy of thermokinetic methods, but unfortunately for the designer, Vernon Keller, it was intended for space shuttle landings at Vandenberg Air Force Base in California, where warm fog is so common that even sea gulls sometimes get lost. Plans changed after the *Challenger* disaster put space shuttles low on NASA's priority list. Since then, only the Japanese industrial giant Sumitomo has shown even a fleeting interest.

In 1986 Federal Express, the U.S. Department of Energy, and the Los Angeles airport authorities put up $500,000 to test the electrogas dynamic system of Meredith Gourdine, a New Jersey inventor, at the Elmira-Corning airport in upstate New York. Bad luck struck that effort as well: there was not enough fog during the test periods. The fifty generator boxes and their special nozzles, which sprayed electrically charged droplets into the mist, could not be judged a failure or success. Many observers remain skeptical.

Even if tests prove successful, it's no guarantee that the warm-fog menace will be over. In the last half-century, after all, we have burned, seeded, blown, washed, and electrified this natural foe but never whipped it completely.

Jeffrey W Miller is a history and science writer in San Francisco.

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