FAA Fights Back on Plastic Explosives

The Lockerbie disaster highlights a fast-growing and insidious threat, but technical safeguards may be possible nonetheless

PLIABLE, ODORLESS, twice as powerful as TNT, and invisible to conventional security devices, "plastic" explosives are fast becoming the terrorist's weapon of choice—as the world was reminded all too vividly this past 22 December when the mid-air detonation of a plastic bomb sent the wreckage of Pan American Flight 103 plunging into the town of Lockerbie, Scotland. A total of 270 people died that day. And the quest for ways to counter the plastics threat took on fresh urgency.

The challenge is a formidable one. But though the news will be of little comfort to the families and friends of the Lockerbie victims, the crash comes at a time when the technology for meeting that challenge is beginning to move out of the laboratory. The Federal Aviation Administration (FAA) has already demonstrated two new screening methods—one each for passengers and for baggage—that detect the plastic explosives quite reliably. Moreover, the agency is planning to deploy the devices at high-risk international airports within the next year.

"The airlines feel that this should be recognized as a breakthrough," says Richard Lally, security chief for the industry's Air Transport Association in Washington, D.C. "In the past year the FAA has succeeded where other governments, which have been working on the problem as long or longer, have *not* succeeded."

Plastic explosives are not "plastic" in the everyday sense, of course. The name comes from their pliability: the explosive ingredients are dispersed in a binder that is about the consistency of modeling clay. A compound denoted PETN, for example, is the basis of a sheet-like product sold by Du Pont for explosive welding and for explosive forming of metals. A similar compound denoted RDX is the basis for the putty-like C-4 explosives used by the U.S. military.

Nor are plastic explosives new. They were developed well before World War II, and were widely used in that conflict. But what *is* new is the rise of well-financed, international terrorist groups with ready access to plastic explosives. The type most commonly implicated in terrorist attacks to date has been SEMTEX, a bright orange, RDX/PETN combination manufactured in Czechoslovakia and extensively used by Eastern Bloc forces.

Terrorists, unfortunately, find plastic explosives attractive for many of the same reasons that legitimate users do. The material has a long shelf life. It is extremely powerful. Yet it is so safe to handle that U.S. soldiers in Vietnam reportedly used it for emergency cooking fuel. (It can only be set off with a special detonation device.) It can be molded into any shape, which means it can easily be hidden in, say, the walls of a suitcase. It contains nothing that would trigger any of the conventional airport security devices. And it has an extremely low vapor pressure, which means that it is undetectable even by dogs.

Couple all that with the fact that more than 1 billion people per year pass through security portals in U.S. airports alone, along with a similar quantity of checked baggage, and the dimensions of the security problem become all too clear. Indeed, the challenge of explosives detection has been well recognized for nearly two decades now, during which time the FAA's efforts have grown in rough proportion to the perceived magnitude of the threat. In 1975, for example, the FAA was designated as the federal government's lead agency for explosives detection research in the wake of a bombing at La Guardia Airport. And in 1985, the FAA greatly accelerated its efforts when the destruction of an Air India flight off the coast of Ireland made it apparent that the threat was escalating rapidly. Starting from about \$1 million per year in the early 1980s, funding for the explosives program peaked at \$13.5 million in 1987 as the agency went into a prototype demonstration phase for the most promising technologies, and now stands at just over \$8 million per year.

From the FAA's standpoint, explosives detection is actually two separate problems: baggage and people. Of the two, baggage is considered the more serious threat because it can be used to conceal larger quantities of explosives, and because it does not require finding a suicidal operative to smuggle the stuff on board. On the other hand, baggage is also easier to deal with, in the sense that it can be probed in ways that people would not appreciate.

A case in point is thermal neutron activation, which is by far the most mature technology for explosives detection in baggage, and which is being developed for airport use under an FAA contract with Science Applications International Corporation (SAIC) of Sunnyvale, California. The basic idea is to do a kind of hands-off chemical analysis by bathing the suitcase in a cloud of low-energy neutrons. Many of these neutrons will then be absorbed by atomic nuclei inside the suitcase. And as that happens, each neutron will trigger the emission of one or more gamma rays characteristic of its target nucleus. A measurement of the gamma rays will thus give a measure of the suitcase's contents, element by element.

"The phenomenon is almost as old as nuclear physics itself," says Tsahi Gozani, SAIC's chief scientist for nuclear projects. Indeed, SAIC first got into this area in the mid-1970s with a thermal neutron system for measuring the sulfur content of coal. But what makes neutron activation particularly attractive for this application, he says, is that all commercial and military explosives—especially all high explosives—are quite rich in nitrogen. And nitrogen happens to respond to activation more energetically than any other element. Its 10.8-million-electron-volt gamma ray is unmistakable. Also attractive, says Gozani—indeed, essential—is the fact that neutron activation produces no significant residual radioactivity. Add a neutron to any isotope likely to be found in a suitcase,

Wide World

The aftermath. *The nose section of Pan American Flight 103 lies in a field outside Lockerbie, Scotland.*

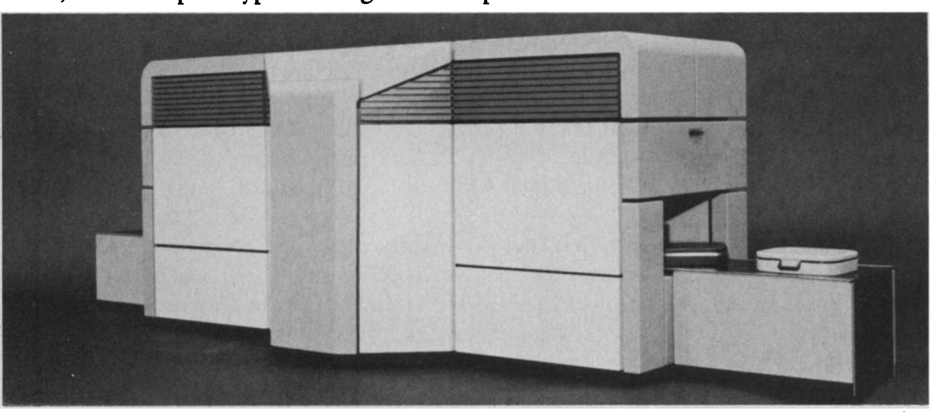
and the result is another stable isotope.

Putting this basic idea into practice, however, has been a long and arduous job. Any screening system intended for routine airport use has to be safe, reliable, fast, and above all, accurate. If it lets explosives through too often, it is useless; but if it cries wolf too often, it will be ignored. Much of the pioneering work on the technique was done in the late 1970s and early 1980s under an FAA contract with the Westinghouse Corporation. SAIC entered the picture in 1984 when the FAA sponsored both companies in an accelerated research and development effort. And in 1986, SAIC won the agency's contract to build a series of prototype units for field testing.

The surge of money after the Air India crash meant that the development program underwent tremendous acceleration, Gozani recalls. "Nine months after we got the go-ahead, we had a prototype standing in San Francisco airport," he says. Introduced with great fanfare by then Secretary of Transportation Elizabeth Dole on 15 June 1987, that first device was a big, heavy, clumsy thing. But it worked. A conveyor belt carried a mixture of domestic and international baggage into the interior of the unit, where each bag was bathed with neutrons from a sample of californium. The resulting gamma ray signal was then analyzed automatically by the unit's computer. Bags containing simulated explosives were also sent through. The final scorecard: more than 95% detection probability, with less than 5% false alarms. A second prototype, considerably streamlined and using a compact accelerator to produce the neutrons, gave similar results.

These tests also provided reassurance on another front. Of the 40,000 pieces of luggage examined, only one triggered the unit's automatic radiation detector when it came out the far end. And that alarm turned out to be due not to induced radioactivity, but to a piece of Mexican pottery made from clay having a naturally high content of thorium-237. The thermal neutron activation method has now been tested and approved for routine luggage examination by both the Nuclear Regulatory Commission and the California Radiological Survey.

Science Applications International Corporation



A new tool for security. *The first six of these thermal neutron activation units will be deployed within a year.*

The success of these prototype tests has now led the FAA to order six working units from SAIC to be installed in high-risk international airports, at a price of about $1 million apiece. The first is to be delivered in June 1989; the remainder by January 1990. These "post-prototype" units will be roughly the size of the existing concourse x-ray machines, says Gozani, and they will process bags at about the same rate that current metal detectors process passengers: ten per minute. This corresponds to screening roughly one jumbo jet load in an hour or so—slow, says Gozani, but presumably not intolerable.

Meanwhile, there is the problem of screening the passengers themselves for explosives. Thermal neutron activation is not an option, for obvious reasons. So the FAA has concentrated its efforts on the totally noninvasive technique of vapor detection, literally trying to detect the explosives by sniffing as a dog would—only much, much more acutely. The vapor pressure of the material found in plastic explosives is typically measured in parts per trillion.

As difficult as that challenge is, FAA officials say that they are very impressed with a technique being developed by Thermedics, Incorporated, of Woburn, Massachusetts. Thermedics president John Wood notes that the details of the method were classified early in the development process at the request of the State Department, which is funding the work jointly with the FAA out of concern for the security of its overseas embassies. In the most basic terms, however, the technique relies on the phenomenon of chemiluminescence, the emission of light during a chemical reaction.

"We've identified a common nitrogen-oxygen signature for the three major classes of explosives—dynamite, TNT, and plastics," says Wood. "And we're able to detect [vapors from] them in very small amounts: one part in 100 trillion."

The Thermedics system was given a field test this past October at Boston's Logan Airport. On a voluntary basis, passengers would step into a booth, where they would be swept by a current of warm air. When they stepped out again, the air would be pumped into an analyzing chamber. Of some 2000 passengers tested in this way, only one produced a false alarm, says Wood. He considers this pretty good, considering the competition from perfumes, shoe polish, deodorants, and all manner of other vapors.

Speed is a concern, of course. The system's current performance is two passengers per minute. But Wood maintains that the company is making good progress toward the FAA's goal of ten per minute. If things continue to go as expected, he says, "then in about 1 year we should have a next generation unit ready for testing in an airport. And about 6 months after that, we should start to see deployment."

Meanwhile, says Wood, Thermedics is also working on hand-held, battery-powered detectors for scanning airline baggage and for screening automobiles at embassy gates. "The device collects an air sample, and then you plug it into the analyzer, which is stationary," he says. Nor has it escaped the company's attention that this same technology could search for certain other substances with low vapor pressure: "We're also working on cocaine and heroin detectors," he says

So, what will all this mean for the air traveler? A slower boarding process, for one thing. The x-ray machines and metal detectors will still be there, checking what they have always checked. (Some 3000 handguns are confiscated in U.S. airports every year; the statistics on knives and other weapons are not even reported.) These new devices will simply add more steps. Indeed, security experts talk about the "multimode" approach, with advanced computer algorithms integrating data from multiple screening devices to produce more information than any one device could alone—and, not incidentally, presenting the would-be terrorist with a formidable obstacle course.

The new screening devices will also mean higher prices for airline tickets. According to FAA officials, for example, the agency is buying the first six thermal neutron units for much the same reason that it bought the first x-ray machines back in the 1970s: to provide seed money to get things started. Thereafter, if current practice is followed, security will be the legally mandated responsibility of the airlines—which is just another way of saying that it will be paid for by the passengers. ■ M. MITCHELL WALDROP