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Playing It Safe — How Much Inconvenience Will Passengers Tolerate to Reduce Terrorist Threats?

A U.S. National Research Council report recommends improving the effectiveness of current systems through better operator training and motivation, and providing new threat-detection technologies in response to specific threats.

Robert L. Koenig
Aviation Writer

Heightened concern about the threat of international terrorism has intensified debate about the adequacy of some current airport-security screening systems, and raised privacy and legal questions related to new high-technology passenger-screening devices.

There have been recent, rapid developments in the areas of both baggage and passenger screening. In the United States, the federal government recently increased security rules and agreed to pay for new explosives-detection technology at many U.S. airports following the destruction in flight of TWA Flight 800. [On July 17, 1996, the Boeing 747-100 exploded at 13,700 feet and plunged into the Atlantic Ocean shortly after takeoff from John F. Kennedy International Airport (JFK), New York, New York, U.S. All 230 passengers and crew members were killed. The cause of the explosion remains under investigation.]

A new report by the U.S. National Research Council (NRC), *Airline Passenger Security Screening: New Technologies and Implementation Issues*, has recommended that the U.S. Federal Aviation Administration (FAA) carefully assess public response to prototype screening systems with regard to privacy, convenience and comfort. The NRC report, commissioned by the FAA, also suggested possible improvements to existing metal-detection screening portals and ways to improve the training, performance and morale of screening-device operators.

In preparing the NRC report, a 10-member panel of experts collected and analyzed information on current and prospective passenger-screening systems, inspected airport screening facilities and methods, and hosted a workshop. The panel was particularly concerned with technology to counter a perceived new threat: Explosives smuggled aboard an aircraft hidden under a passenger's clothing.

For nearly a quarter century, since a December 1972 FAA ruling following a wave of aircraft hijackings, the FAA has required the screening of passengers and carry-on baggage on all certified, scheduled passenger aircraft.

A passenger places her carry-on baggage on a conveyor belt for X-ray inspection, then walks through a portal that detects any metallic objects being carried by the passenger. If the portal sounds an alarm, security-screening personnel use either a hand-wand metal detector or a physical patdown to determine if the passenger is carrying a weapon or an explosive device.

Today's screening technology functions well in detecting metallic objects, but the equipment does not detect nonmetallic weapons or plastic explosives.

Although the NRC report noted potential advantages of the new-generation surveillance systems in detecting explosives and nonmetallic weapons, it predicted that passengers will endorse the more invasive new security technologies only if they believe that terrorism poses a strong threat. "The reactions of passengers, air carriers and airport operators to any new screening technology will be strongly influenced by the perceived level of threat ... ," the NRC report said. "If the threat is high, more invasive technologies that may inconvenience passengers are likely to be more acceptable than when the threat is perceived to be low."

A report prepared by the U.S. General Accounting Office (GAO)[1] concluded that:

- "The experts believe that aviation is likely to remain an attractive target for terrorists well into the foreseeable future;
- "Explosives-detection devices can substantially improve airlines' ability to detect concealed explosives before they are brought aboard aircraft. While most of these technologies are still in development, a number of devices are now commercially available. For example, some devices are in use in [non-U.S.] countries, such as the United Kingdom, Belgium and Israel. None of the commercially available devices, however, is without shortcomings; [and,]
- "Aviation security rests on a careful mix of intelligence information, procedures, technology and security personnel. New explosives-detection technology will play an important part in improving security, but it is not the panacea."

FAA testing of conventional X-ray baggage screening in May 1994 "showed that there is a low probability of detecting a moderately sophisticated explosive device," the GAO report said.

With those limitations in mind, the FAA has worked to improve existing screening systems and to assess new technologies for detecting such weapons and devices. Promising new screening systems include:

- Imaging technologies (Table 1), which produce images of the person being screened to show the presence of nonmetallic weapons, explosive devices or other suspicious items concealed under multiple layers of clothing;
- Chemical trace–detection technologies (Table 2), which involve collecting minute samples from a person's skin or clothing — or, in some cases, the air around the person — to detect the person's exposure to explosive materials; and,
- Nonimaging electromagnetic technologies, some of which use microwave energy to detect metallic or nonmetallic objects on the passenger being screened.

Table 1
Passenger Screening Based on Imaging Technologies

Detection Technology	Uses	Comments
Millimeter waves	Portals	Requires more than a single view.
	Wall units	Requires more than a single view.
	Enclosed spaces	Could get a 360° view.
X-rays	Portals	Requires more than a single view.
	Enclosed spaces	Could get a 360° view.

Source: Jankowski[2]

Table 2
Passenger Screening Based on Chemical Trace–detection Technologies

Implemented as …	Comments
Portal screening — noncontact	High-volume airflow gathers vapors or dislodges particles adhering to surface.
Portal screening — contact	Passenger opens "saloon"-type doors with hands.
Portal screening — contact	Passenger passes through a portal lined with brushes or fronds, and brushes against them.
Hand-wand device — noncontact	High-volume airflow gathers vapors or dislodges particles adhering to surfaces.
Canine screening — noncontact	Currently are in use.
Boarding-card scanning — contact	Boarding card is scanned after handling by passenger for particles of explosive material.

Source: Jankowski[2]

The NRC panel suggested possible improvements to existing metal-detection screening portals and ways to improve the performance of screening-device operators. For each of the new screening technologies, the panel offered a critique and recommended strategies to ease the acceptance of the proposed new systems by airports, air carriers, and passengers.

For imaging technologies — which can display graphic images of screened passengers — the report recommended that the subjects' privacy be protected by masking parts of the image, limiting the number of persons who see the image, ensuring that the images are viewed only by operators of the same sex and offering alternative screening procedures to persons who object to imaging.

The report noted that such steps would "require large investments from air carriers and airports," a cost concern that led the NRC panel to conclude that "imaging technologies, as they exist today, are not suitable as primary screening procedures" that every passenger must undergo. Instead, the report suggested that imaging be used only after a person "has been identified as posing a high risk" by other means.

For chemical trace–detection technologies — which require samples from passengers' clothing, belongings or the air around them — the panel concluded that "concerns about initiating physical contact may prove to be a significant hurdle" to using such systems (Table 3). Although passengers would be more likely to accept chemical trace–detection approaches that collect samples without direct contact, the report said that noncontact systems probably would not be as effective.

If contact methods must be used for chemical trace–detection systems, the NRC panel recommended "techniques that collect *secondary* samples from something a person has touched," or samples that can be collected easily from, for example, a touch of the subject's hand.

Table 3
Principal Health and Privacy Concerns, New Passenger-screening Technologies

		Concerns				
		Health			Privacy	
Screening Technology	**Passenger-system Interface**	**Harmful effects of radiant energy on the body**	**Risk of communicable disease transmission**	**Displeasure at being touched by sampling devices**	**Reluctance to permit body image to be displayed to a human inspector**	**Possible unlawful search and seizure, if other-than-threatening objects are detected and acted on**
Imaging	A human inspector views an image of the passenger's body under layers of clothing to detect firearms or explosives.	▲	N/A	N/A	▲	▲
Chemical Trace Detection	A human inspector moves a hand-held wand over the clothed body of the passenger, touching the passenger, to detect traces of explosives.	N/A	▲	N/A	N/A	▲
Chemical Trace Detection	Passengers pass through a portal that touches part of their bodies to detect traces of explosives.	N/A	▲	▲	N/A	▲
Chemical Trace Detection	Passengers pass through a portal that blows air past their bodies to detect traces or vapors of explosives.	N/A	N/A	N/A	N/A	▲
Electromagnetic	Passengers pass through a portal that uses electromagnetic energy to detect metal objects.	N/A	N/A	N/A	N/A	▲
Electromagnetic	A human inspector moves a hand-held wand over the clothed body of the passenger, without touching the passenger, to detect metal objects.	N/A	N/A	N/A	N/A	▲

▲ = Concern applicable to this technology.
N/A = Concern not applicable to this technology.

Source: U.S. National Research Council

Finally, for nonimaging electromagnetic technologies — specifically, dielectric portal technology, which uses microwave energy to detect both metallic and nonmetallic items — the panel suggested that such systems be modified to focus on threatening objects. Some passengers may express concern about radiation exposure, but the report suggested that such technology could "improve the detection of nonmetallic objects without raising concerns about image projection and without requiring that an operator interpret the image."

Even the most sophisticated screening systems are vulnerable to mistakes or inattention by their operators. According to the NRC report, "poor operator performance is a principal weakness of existing passenger-screening systems and a potential weakness of future systems."

Experts say that the performance of airport personnel who operate the current metal-detector portal systems is often weakened by their lack of integration into the overall security system. In addition, many operators are poorly paid, treated rudely by some airline passengers and work under cramped conditions with equipment that was not designed according to ergonomic principles.

"The resolution of issues related to ergonomics will be critical to the success of new passenger-screening systems," the NRC report said. "In an apparent paradox, as screening systems become more automated, human factors are likely to become even more critical to success." In future systems, human operators will perform difficult and complex tasks that cannot be fully automated.

Even the most sophisticated screening systems are vulnerable to mistakes or inattention by their operators.

Besides screening systems designed for operators' comfort, the NRC panel recommended:

- Intense efforts to select operators with the highest job aptitude;
- More thorough training for operators; and,
- Steps to better motivate and evaluate operators.

To use the new imaging technologies, operators must be trained to detect suspicious patterns in the images, and maintaining the chemical-identification systems used in trace-detection technology requires highly skilled operators.

"Improved personnel selection, training and motivation methods will complement the effective design of systems and procedures and will assure acceptable levels of operator performance," the report said.

Although the NRC panel focused on next-generation screening technologies, the report also recommended steps to improve the detection portals currently used at most airports.

The panel said that the goal of such improvements should be to "increase screening efficiency by decreasing the number of false alarms and by allowing the screening personnel to resolve these alarms more quickly by providing information about the specific type and location of the object that triggered the alarm." As examples of "technical ways to improve the metal-detection portals," the panel suggested the possible use of:

- Parallel algorithms to simultaneously detect different metals, alloys and structures; and,
- Detector arrays to enable present-generation screening portals to locate contraband.

The NRC panel found that each new screening technology, from advanced imaging systems to chemical trace–detection techniques, has strengths and weaknesses, which the panel evaluated without recommending any one system.

"Ultimately, the performance capability and quality of a passenger-screening technology is unlikely to be the limiting factor in its implementation or application," the report said. "Limitations on the technology will instead be imposed as a result of passenger intolerance for invasion of privacy, delays or discomfort."

The capabilities and limitations of the new screening technologies were described and summarized by the panel as follows:

Imaging technologies. Several imaging systems can detect metallic and nonmetallic weapons, explosives and other contraband concealed under multiple layers of clothing. Some of those systems already are in use, particularly in screening prison visitors.

The two main types of imaging systems are passive millimeter-wave imaging, which scans subjects for natural radiation emitted by the body, and active imaging, which projects radiation onto subjects.

One advantage of passive imaging is that passengers need not be concerned about exposure to radiation; a disadvantage is that analysis of the images can be complicated by keys, wallets, belt buckles and other common items.

"Image-analysis software is being developed to facilitate interpretation, but current technology requires interpretation by human operators," the NRC panel found.

Active imaging systems include millimeter-wave imaging, through which a beam of millimeter-wavelength energy is projected against a target and the reflected rays are detected; and active X-ray imaging, which uses low-energy, low-intensity X-rays reflected from the subject to create an image.

Photo: Nicolet Imaging Systems

Person being scanned by the SECURE 1000 active X-ray imaging system. (The resulting image is shown on page 6.)

Both types of active imaging systems have the disadvantage of subject exposure to microwave radiation or X-rays, even though researchers believe the exposure levels pose no health risks. Also, the images of common items such as keys and wallets can be difficult to evaluate. "As in passive imaging systems, the presence of these nonthreat[ening] items makes images produced by X-ray imaging systems difficult to analyze and interpret," the report said.

The NRC panel expressed concerns about the difficulty of evaluating some images and the time that image interpretation can take. "All current imaging technologies require operators to view the images because humans can interpret complex images and identify anomalous objects more efficiently than available software," the report says.

Chemical trace–detection technologies. Although they cannot be used to screen for metallic weapons, chemical trace–detection systems effectively detect explosive materials.

The challenge of such technology is to find an unobtrusive way to collect minute samples from a person's skin, clothing or, in some cases, the air around them, to detect the presence of, or recent exposure to, explosive materials.

There are two steps in chemical trace detection: collecting samples and identifying chemicals.

Sampling can be focused on the air around the person or baggage (vapor technology) or on solid particles found on skin or clothing (particulate technology). Vapor technologies are more effective for detecting explosive materials with high vapor pressures; particulate technologies are better for finding explosive materials with low vapor pressure, such as military plastic explosives.

Samples can be collected by having the subject walk through a portal or by passing a hand-wand device over the person. Depending on the design, the system can use:

- Contact sampling, in which the wand makes physical contact with the subject, or the person is required to push open a door, be touched by brushes in the portal or hand over a boarding card; or,

- Noncontact sampling, such as hand-wands that do not touch subjects or systems that collect vapor samples by sending an air stream around persons walking through the portals.

"Because it is difficult to extract explosive vapors from large volumes of air or to gather particulates of explosive materials from the great variety of materials on which particles of explosives might be found, it is not surprising that no sampling technique that is universally adoptable has been identified," the NRC report said.

Another challenge in all chemical trace–detection systems is clearing vapors or explosives particles from the sample-collection mechanism so a positive reading does not influence later samples.

"Aside from dealing with problems related to lingering contamination, manufacturers also have to address the tendency of [chemical] trace–detection systems to react to the presence of materials, particularly certain medications, that are chemically similar to explosive materials," the report said. "This tendency leads to false positives, which are likely to be more common than the detection of true threat[ening] materials ... ."

Once samples are collected, the screening system can use any of a number of chemical-identification systems, some small enough to be used in hand-held instruments, to detect explosive materials.

Nonimaging electromagnetic technologies. Such systems, which use electromagnetic energy to detect questionable

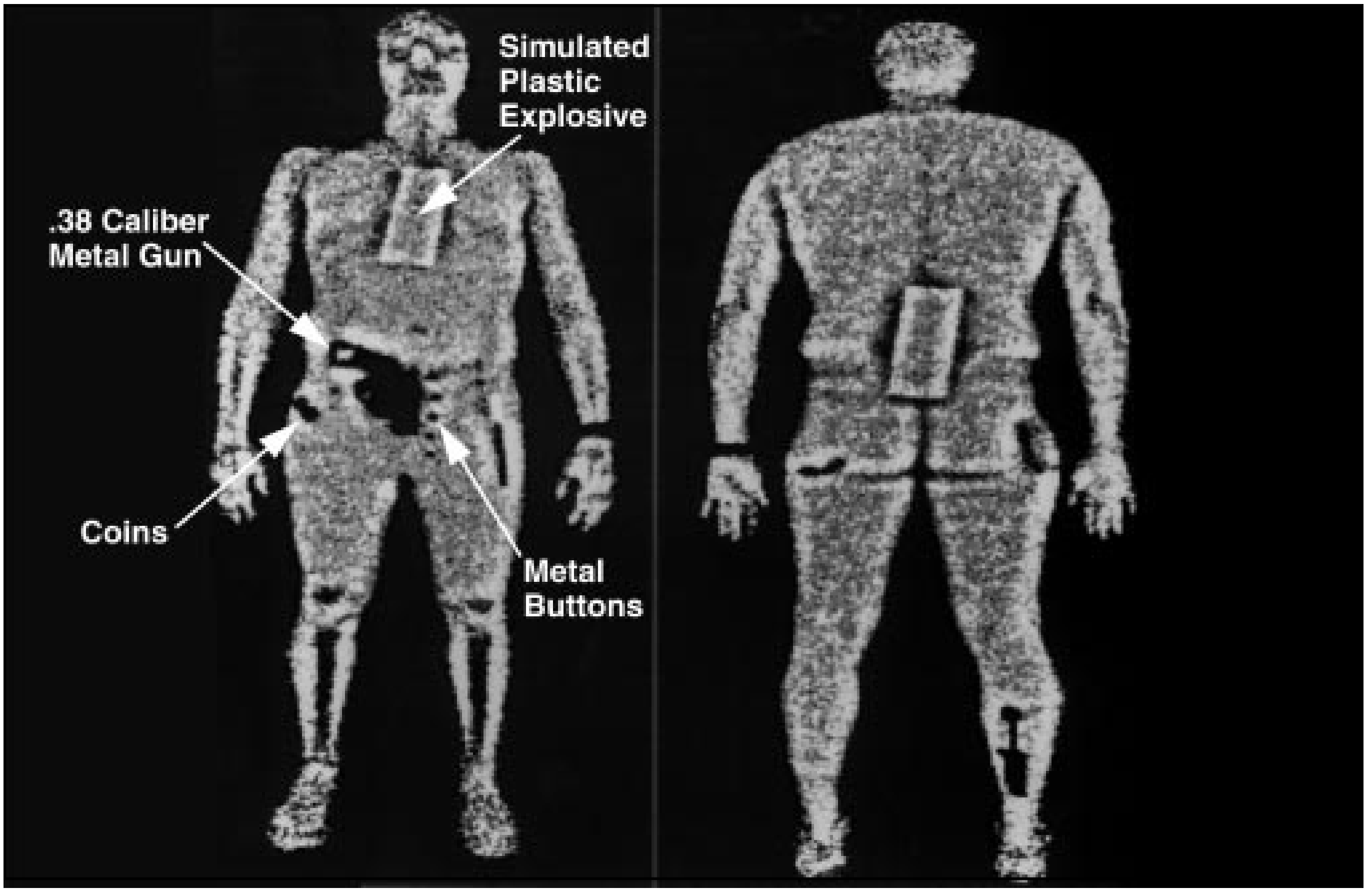

Photo: Nicolet Imaging Systems

Image created by the SECURE 1000, showing .38 caliber handgun, simulated plastic explosive and other objects.

objects on the passenger being screened, already are used in some public places, including libraries and courthouses.

In one form, the machines can detect only metallic objects. But the report said that improvements can reduce the number of false alarms by making the detectors less sensitive to everyday items such as belt buckles, keys or coins.

Metal detectors also can be made more versatile in detecting alloys; more specific in pinpointing suspected threatening items; and more tolerant of electrical interference from fluorescent lights, video terminals or other nearby sources.

Another nonimaging screening system uses microwave radiation and a transmitter/receiver pair to detect nonmetallic objects that may pose threats. In one such system, the subject steps through a nonimaging, dielectric portal and is scanned from head to toe to reveal both metallic and nonmetallic objects.

Passenger-profiling systems. Several airlines, including El Al Israel Airlines, have extensive security programs that include passenger profiling (which tries to identify passengers who might pose a threat through analysis of passenger characteristics) and face-to-face questioning of all passengers. Such a system can be time-consuming, and in the United States, where the terrorist threat is generally perceived to be lower on domestic flights than on international flights, profiling and questioning are likely to raise passenger objections. "However, the El Al screening system could serve as a model for a passenger-profiling method to help air carriers identify passengers who require more extensive screening," the report said.

Air carriers, although they often hire independent firms to operate security checkpoints, are ultimately responsible for maintaining air travel security. In general, they want quick, effective and relatively inexpensive screening of passengers and carry-on baggage.

Although the new security technologies may be effective and quick, they will not be inexpensive. The NRC panel found that "new security-screening equipment based on the technologies discussed in this report will be more expensive" than the current screening equipment. Nevertheless, making cost projections is complicated because some new systems will require fewer checkpoints or fewer, but better-trained, operators than others.

The NRC report made no cost projections. The GAO report cited preliminary FAA estimates indicating that buying and

Photo: AS&E Inc.

Person being scanned by the AS&E BodySearch™ system.

installing one new explosives-detection system for baggage screening at the 75 busiest U.S. airports could cost between US$400 million and $2.2 billion, depending on the technologies and procedures used.

Airport operators are closely involved in security issues, mainly to "provide a secure environment" in which air carriers operate. For example, airports provide law-enforcement support to air carriers (or their security contractors) when threatening objects are found.

For many airports, the space requirements of screening systems — the size of detection equipment, as well as the space for passengers to stand in line — are important considerations. New airport terminals often are designed with future security-screening needs in mind, but "older airport facilities designed and built before hub operations or passenger screening are often strained to meet current space requirements ... ."

Delays also add to costs for carriers and passengers. The report says that "air travel becomes significantly less convenient and more expensive, in terms of direct costs to business travelers, when passengers have to arrive earlier at the airport to accommodate additional passenger-screening procedures."

Although the NRC panel offered no solutions to the cost and operational problems, the report suggested that, before implementing new screening technologies, "both airport operators and air carriers will demand well-supported data showing that the new technologies will add significantly to existing security-screening capabilities.

"Airports and air carriers will also have to consider carefully whether the [equipment costs of the] new technologies will [be] offset ... by lowering costs for other factors, such as the number of personnel or checkpoints."

The NRC panel concluded that radiation from passenger screening devices "does not harm the individuals undergoing screening or operating the equipment." The panel found that radiation levels and electromagnetic fields from such devices "are very low and are well below the levels known to have harmful effects." For example, "a passenger would have to go through a screening portal approximately 1,000 times to receive the same radiation dose as would be received from cosmic ray

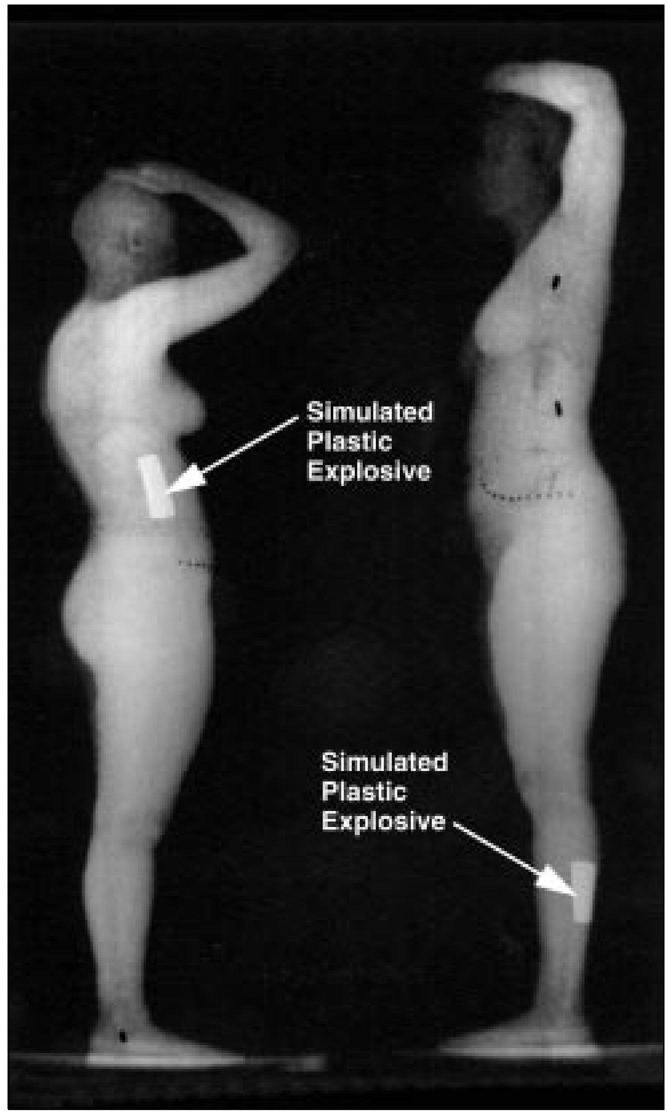

Photo: AS&E Inc.

Side views of a fully dressed female subject. Note the simulated plastic explosive concealed in right torso area and on the back left calf. .22 caliber bullets are concealed under the left underarm, in the waist area and inside the right shoe. (Both images are of the same subject; apparent difference in height is an artifact of the scanning process.)

exposure at high altitude during one transcontinental flight from New York to Los Angeles."

In addition, the panel found that "these technologies are not expected to cause adverse effects to developing embryos or fetuses" and will pose no problems for wearers of heart pacemakers.

Despite the lack of evidence of adverse health effects, some individuals and groups are deemed likely to express concern (Table 3, page 3). The NRC panel found that "the health issue is primarily a *perception of risk* rather than an actual health threat."

Radiation emitted by the new scanning technologies does not pose significant health risks, the report said. But it warned that "air carriers and their contracting screening companies must be prepared to demonstrate that their equipment operates within the radiation dose range specified by the manufacturer and that these levels are safe for all people."

Because health concerns "may still affect public acceptance of imaging and nonimaging electromagnetic radiation technologies," the panel suggests that, where such systems are used, air carriers should inform passengers about the relatively low exposure levels.

The report also found that the risk of microbial diseases (from bacteria, fungi or viruses) being transmitted through personal contact in chemical trace–detection screening systems is insignificant. Nevertheless, the NRC recommended that, to ease passenger fears, the operators of chemical trace–detection systems keep themselves and the equipment extremely clean.

Passenger-screening technologies currently in use have survived numerous court challenges in the United States.

The NRC panel workshop, with participants from airports, air carriers and other interested groups, concluded that "privacy concerns about displaying images of bodies and initiating physical contact may prove to be significant hurdles to implementation."

The experts also found that chemical trace–detection systems that involve physical contact or confining airflow are the most likely to cause passenger discomfort (Table 4, page 9).

Delays at airports may be another problem when new screening systems begin operations. "Convenience in the form of avoiding time delays appears to be a highly important factor in public acceptance, as well as in the overall successful functioning of the system."

The panel's benchmark figure for screening time is six seconds per passenger, the average processing time of current security systems. "Technologies that take more than six seconds to screen each person are likely to encounter significant public resistance," the NRC report said.

Most imaging technologies are relatively fast, but the report said that it is unclear whether images can be created and assessed within six seconds. Chemical trace–detection technologies may take longer than imaging technologies.

Even though the NRC panel raised doubts about passenger acceptance, it also suggested initiatives to alleviate passenger concerns about privacy in imaging technology, including:

- Masking the private parts of the displayed body image or distorting the image to make it look less realistic;
- Allowing only operators of the same sex as the subject to view the scanned images;
- Displaying the images so that only the screening personnel can see them;
- Guaranteeing passengers that weapons-free images will not be preserved; and,
- Allowing passengers who so desire to undergo an alternative screening procedure.

The panel suggested that solving the discomfort problems in chemical trace–detection screening may be more difficult, because of "the aversion of some people to being touched, either with an inanimate object, such as a bar or frond, or by a person wielding a hand-wand device.

"For technologies requiring people to touch a piece of equipment, passenger acceptance may be enhanced by allowing subjects to control the area to be touched (e.g., letting them push doors open with their hands), instead of having them walk through a portal lined with fronds that brush against the entire body," the report suggested.

Passenger-screening technologies currently in use have survived numerous court challenges in the United States, mostly relating to U.S. constitutional guarantees against unreasonable searches and seizures. In general, courts have ruled that the screening technologies constitute reasonable searches, under the Fourth Amendment "administrative search exemption."

But experts warn that new imaging technologies displaying increasingly graphic representations of screened passengers are likely to spark new courtroom challenges. Meanwhile, systems that focus mainly on detecting threatening objects, rather than depicting the whole individual, may be less vulnerable to legal challenges.

Table 4
Principal Comfort and Convenience Concerns, New Passenger-screening Technologies

Screening Technology	Passenger-system Interface	Concerns: Comfort — Discomfort from being enclosed in a small space	Concerns: Comfort — Displeasure and discomfort from the blasts of air used to obtain samples	Concerns: Convenience — Delays imposed by inspection and system-processing time	Concerns: Convenience — Delays encountered during high-traffic or high-detection periods
Imaging	A human inspector views an image of the passenger's body under layers of clothing to detect firearms or explosives.	N/A	N/A	▲	N/A
Chemical Trace Detection	A human inspector moves a hand-held wand over the clothed body of the passenger, touching the passenger, to detect traces of explosives.	N/A	N/A	▲	N/A
Chemical Trace Detection	Passengers pass through a portal that touches part of their bodies to detect traces of explosives.	N/A	N/A	▲	N/A
Chemical Trace Detection	Passengers pass through a portal that blows air past their bodies to detect traces or vapors of explosives.	▲	▲	▲	N/A
Electromagnetic	Passengers pass through a portal that uses electromagnetic energy to detect metal objects.	N/A	N/A	N/A	▲
Electromagnetic	A human inspector moves a hand-held wand over the clothed body of the passenger, without touching the passenger, to detect metal objects.	N/A	N/A	N/A	▲

▲ = Concern applicable to this technology.
N/A = Concern not applicable to this technology.

Source: U.S. National Research Council

Although NRC experts believe that the new screening technologies are likely to survive legal challenges, they predict that courts will scrutinize "the degree of intrusiveness of the search procedure, the magnitude and frequency of the threat and the sufficiency of alternatives to the search or screening procedure." The NRC panel said that "[legal] challenges based on illegal search or an improperly carried-out search must be expected."

If air carriers and/or security-contracting companies were to print scanned images or store image data for future reconstruction, the report predicted legal challenges to those practices. "The archiving of personal data on innocent persons probably would open the air carrier and its security contracting company to legal action, based on the invasion of privacy," the report said.

In general, the NRC panel concluded that chemical trace–detection and nonimaging electromagnetic screening — because they are more focused on finding threatening objects — are less vulnerable to legal challenge. Nevertheless, because chemical trace–detection screening may reveal certain medicines or illegal drugs, the report said that air carriers "must be careful to ensure that their equipment is not designed or modified to detect materials that are not considered threat items" for flight safety.

"The trade-off between technology performance and public acceptance is an issue for all technological improvements in airport security screening," the NRC report said. "Any changes to the now-familiar metal-detection portals will cause concerns over health effects, the invasion of privacy and passenger convenience."

The NRC report was issued in June 1996, shortly before airports around the world tightened security measures in response to heightened concern about terrorism that resulted,

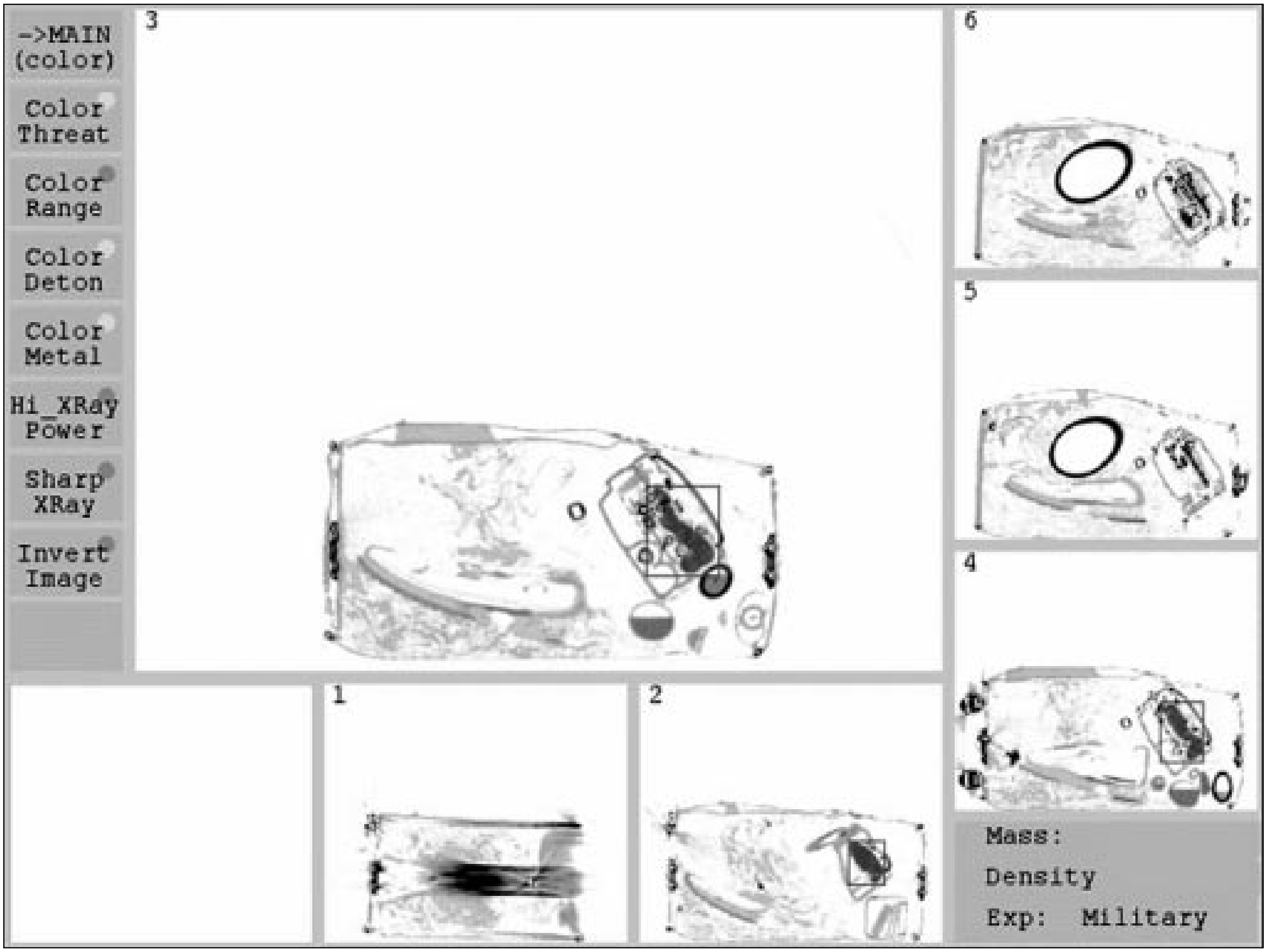

Photo: InVision Technologies Inc.

Montage of images created by CTX 5000 and viewed on a monitor. Military explosive Semtex is concealed in radio. CTX 5000 detects the radio bomb's explosive and highlights its detonator and electronics. CTX 5000 automatically alerts the operator and identifies the threat concealed behind the circuit board. Without CTX 5000 the bomb could be detected only by opening the radio.

in part, from suspicions about the source of the TWA Flight 800 explosion.

On July 25, the FAA announced that it would "begin increasing security levels at U.S. airports, with a special focus on international flights." The heightened security included more intensive screening of passengers on international flights and closer scrutiny of carry-on baggage on both domestic and international flights.

The GAO report also examined developments in several aspects of explosives-detection technology:

Checked-bag screening. "Four explosives-detection devices with automatic alarms are commercially available for checked bags, but only one has met FAA's certification standard ... ," the report said. That device, the CTX 5000 manufactured by InVision Technologies Inc., was certified by the FAA in December 1994. With the unit priced at about US$1 million, acquisition and installation of the CTX 5000 for the 75 busiest airports in the United States would cost between $400 million and $2.2 billion, the report said.

CTX 5000, based on the principle of computer-assisted tomography (CAT) used in medical scanning, is being operationally tested at two U.S. airports: San Francisco (California) International and Hartsfield International, Atlanta, Georgia. It is already in use at Manchester (England) International Airport, Brussels (Belgium) Zaventem Airport and Ben Gurion International Airport, Tel Aviv, Israel.

On Sept. 3, 1996, InVision Technologies announced that it was shipping a CTX 5000 unit to JFK. The explosives-detection equipment will be installed in the El Al Israel Airlines check-in area, and will be used to screen carry-on and checked baggage. The British Airports Authority has bought three additional CTX 5000 units, to be used at Heathrow International Airport Terminal 3.

According to a security manager at Manchester International Airport, "CTX is widely accepted in terms of explosive detection. There is nothing yet that will even come near it."[3] Despite acknowledging capacity problems and difficulties with integrating the CTX 5000 into the existing baggage system, a Belgian airports authority said, "It is a very expensive machine but worth it. The images are extraordinarily clear and give the operator tremendous flexibility in terms of taking additional slices [sectional views] if there is doubt over a particular item."[4]

The GAO report noted other possibilities under development: Two X-ray devices that have lower detection capability but are faster and less expensive than presently available models; and a device using electromagnetic radiation, also less expensive but offering only chemical-specific detection ability for only some of the explosives specified in its explosives detection–system certification standard issued in September 1993.

Carry-on items. The GAO report noted that "explosives-detection devices are commercially available for carry-on bags, electronics and other items but not yet for screening bottles or containers that could hold liquid explosives."

Cargo and mail. "Screening cargo and mail at airports is difficult because individual packages or pieces of mail are usually batched into larger shipments that are more difficult to screen," the GAO report said. "Although not yet commercially available, two different systems for detecting explosives in large containers are being developed by the FAA and [the U.S. Department of Defense]. Each system draws vapor and particle samples and uses trace technology to analyze them. One system is scheduled for testing in 1977."

Blast-resistant containers. FAA tests have demonstrated that it is feasible to design an aircraft cargo container to withstand an internal explosion, the GAO report said. But because of their size, blast-resistant containers will fit only into the cargo compartments of wide-body airplanes. The FAA plans to test prototype containers in 1996 and place some in airliners to determine how they fare in practical use.

At least one of the barriers to widespread installation at U.S. airports of latest-generation explosives-screening hardware — the high cost — may be eased by federal action. On September 5, President Clinton announced that the federal government would assume responsibility for buying and installing advanced explosives-detection equipment at major U.S. airports.♦

Editorial note: This article was adapted from the U.S. General Accounting Office report, *Aviation Security: Immediate Action Needed to Improve Security*, Report no. GAO/T-RCED/NSIAD-96-237; and the National Research Council report, *Airline Passenger Security Screening: New Technologies and Implementation Issues*, Publication no. NMAB-482-1 of the National Academy Press, Washington, D.C., U.S., 1996. The NRC report was also published as *New Technologies for Airline Passenger Security Screening: Implementation Issues*, Report no. DOT/FAA/AR-96/52. The 74-page NRC report includes tables, photographs, charts, an extensive reference list and an appendix discussing U.S. court cases related to aviation security.

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