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Airport Testing an Explosives Detection Portal

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Abstract

At the direction of the US Congress, following the Pan Am 103 and TWA 800 crashes, the Federal Aviation Administration funded development of non-invasive techniques to screen airline passengers for explosives. Such an explosives detection portal, developed at Sandia National Laboratories, was field tested at the Albuquerque International airport in September 1997. During the 2-week field trial, 2400 passengers were screened and 500 surveyed. Throughput, reliability, maintenance and sensitivity were studied. Follow-up testing at Sandia and at Idaho National Engineering and Environmental Laboratory was conducted.

A passenger stands in the portal for five seconds while overhead fans blow air over his body. Any explosive vapors or dislodged particles are collected in vents at the feet. Explosives are removed from the air in a preconcentrator and subsequently directed into an ion mobility spectrometer for detection. Throughput measured 300 passengers per hour. The non-invasive portal can detect sub-fingerprint levels of explosives residue on clothing.

A survey of 500 passengers showed a 97% approval rating, with 99% stating that such portals, if effective, should be installed in airports to improve security. Results of the airport test, as well as operational issues, will be discussed.

Introduction and Concept

The continued use of explosives by terrorists has prompted the Federal Aviation Administration (FAA) to invest in the development of various explosives detection systems for the screening of both personnel and baggage. In the case of personnel screening, trace detection systems are of particular interest because they avoid the significant privacy and public health concerns associated with bulk detection systems like traditional x-ray. In this paper, we describe airport trials of such a trace detection system for personnel, Sandia's explosives detection portal. This portal has been developed at Sandia National Laboratories (SNL) under contract to the FAA. The FAA requested and funded the airport field trials. The preconcentrator used in the portal was developed at Sandia over the last decade with funding from the Department of Energy (DOE) Office of Safeguards and Security.

A metal detector environment, high throughput (10 seconds or less per person), detection of common high explosives, specification of type and amount of explosives detected, and non-invasive screening are goals of the SNL portal design. Upon entering the portal, a test subject turns ninety degrees and stands for five seconds while being screened. Air is blown down from the top of the portal and along the person's body at 7 ft / sec, and is sucked into two slots located near the feet.

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The volume of air collected by each of those slots is 160 liters/sec. During this collection time, a brief, one-half second pulse of air is directed at the subject from nozzles in the portal walls. These nozzles ruffle the person's clothing to aid in removal of residual explosives. After passing through the slot, the air passes through the preconcentrator. A preconcentrator is essentially a molecular filter, which allows air to pass through to an exhaust line while collecting heavy organic molecules such as explosives onto a screen. The preconcentrator was developed and fabricated by Sandia. When the air collection cycle is finished, this screen is heated to desorb the collected explosives back into the gas phase, and the resulting explosives-enriched vapor is pulsed into an ion mobility spectrometer (IMS) for detection. The IMS used is a side-flow PCP-110, manufactured by PCP, Inc. in West Palm Beach, Florida. For the airport field trials, the portal had two preconcentrators and two IMS detectors. Hardware costs for the single prototype portal are about \$200k, with the two IMS detectors contributing \$130k of that cost. Except for the preconcentrators and the control and data acquisition software, written at Sandia, most of the hardware is commercial off the shelf (COTS). Significant savings could be achieved if this portal design was commercially manufactured in significant numbers.

Airport Methods and Results

Airport field trials of the SNL portal were requested and funded by the FAA in 1997. The portal was installed in the Albuquerque International airport and operated by Sandia engineers for two weeks in September of 1997. Max Aero security staff were hired by Sandia to solicit volunteers to be screened in the portal. Because of the experimental nature of the portal prototype, passengers had to consent before being screened. The portal was located inside the secure terminal of the airport, immediately behind the security checkpoint. A photo of the portal during September 1997 at the Albuquerque airport is displayed in Fig. 1.



Fig.1. Max Aero employees, Jerome Sigur and Carol Murray, demonstrate operation of the Sandia explosives detection portal during its field trials at the Albuquerque International airport in September 1997.

During nine days of portal operations, 2400 passengers volunteered for screening. The security checkpoint staff solicited passengers after they had passed the metal detector and x-ray machine. Posters were displayed that described the portal's overall operation and the steps in the screening process. Since consent was required, no minors were allowed through the portal. However, there is no technical reason why children cannot be screened with this technology. During the first two days of screening, 491 volunteers were verbally surveyed upon exiting the portal. They were asked three questions. The results are displayed in Table 1.

Table 1. Survey results of volunteers screened at Albuquerque International airport.

Question	Yes (N=491)
1. Should this portal be used in airports?	99.4% (488)
2. Would you go through the portal again?	99.4% (488)
3. Is your overall impression favorable?	96.5% (474)

The survey results are very favorable. Only three volunteers responded 'No' to questions 1 and 2. In question #3, the volunteers were also asked for any criticism of the portal. Of the 17 (out of 491) volunteers with negative comments, most complained that the portal's nozzles were startling or that the portal was noisy (almost 80dB). Some complained of plastic or "hair dryer" smells. A few commented that this kind of screening was too "Big Brother." Many of the "No" responses came from pilots.

A false alarm rate of less than one percent (about 20/2400) was observed. Many of these alarms were very small, only slightly exceeding the portal's threshold for automatic alarm. In most cases, no alarm was detected when the subject passed through the portal a second time. There was, of course, no reason to believe that a terrorist with a bomb would volunteer to be screened for explosives. No known substance was responsible for the false alarms.

A nuisance alarm did sound for one volunteer. A nuisance alarm means an explosive was detected, but it is caused by explosives residue and not by an actual bomb carried by the passenger. This nuisance alarm was recorded on passenger #255 on the second Monday of testing. This passenger had visited a site that handled and detonated explosives during the previous week. A plot of the portal record for passengers #175-275 from that day is displayed in Fig. 2.

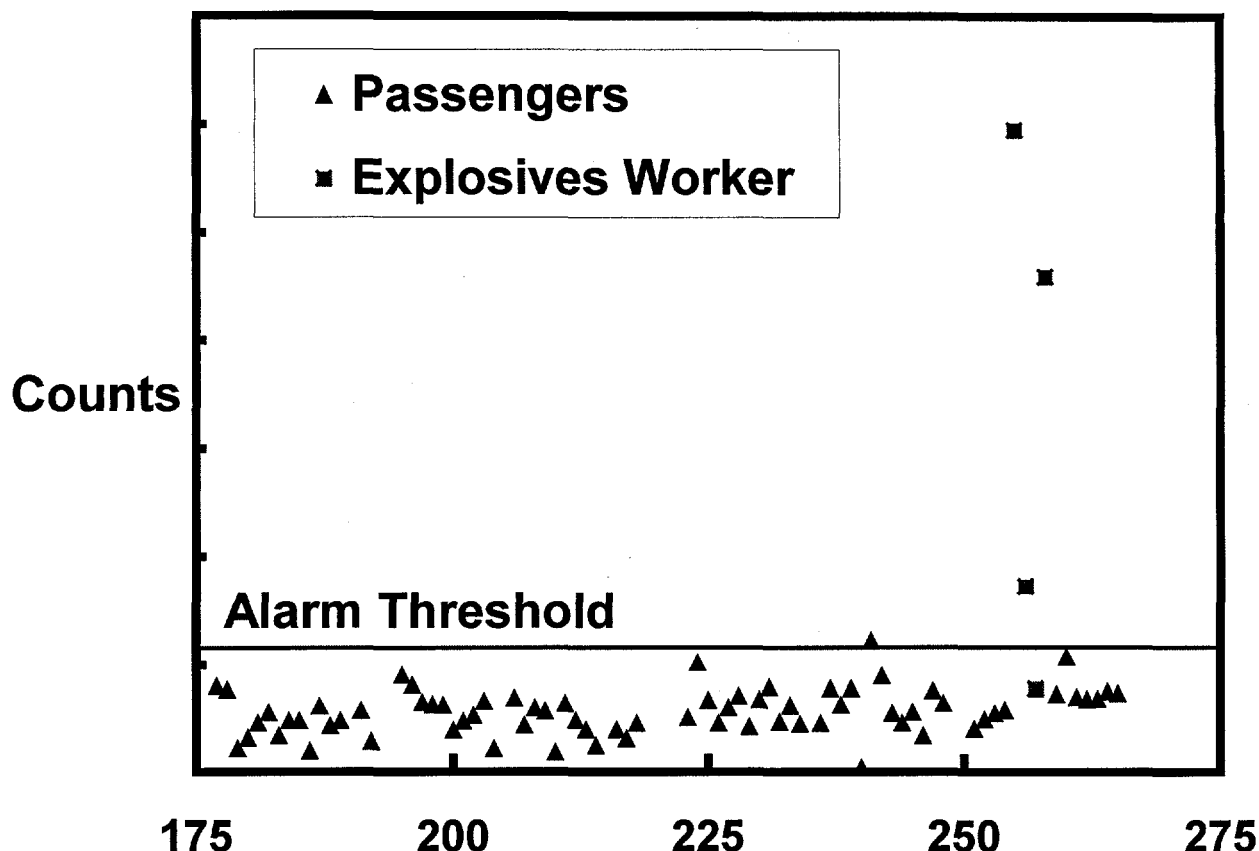


Fig. 2. Portal record of counts for one explosives channel showing a nuisance alarm (red squares at right) for passengers #175-275.

The elevated points (red squares) to the right side of Fig. 2 show the elevated explosives signature from this passenger. Any point above the alarm threshold (blue solid line) results in an alarm. He passed through the portal four times, alarming three of the four times. It is interesting that the fourth of those passages was the second strongest detection, indicating that there is enough explosives material on this passenger for many detections.

During the airport trials, standard tests were performed to calibrate the portal and to confirm proper operation and sensitivity. Sub-fingerprint amounts of explosives were detectable for several common high explosives. The use of commercial off the shelf hardware in the portal makes the portal easy to maintain, and kept downtime low. The portal operates reliably for a first prototype. Maintenance procedures included daily calibration of peak locations, daily addition of a carrier fluid for the IMS detectors, and cleaning of the preconcentrator after every 400 passengers. The preconcentrators collect hair and lint from the passengers, and eventually need to be flushed out. Such cleaning is quickly performed with compressed air.

Further Development and Commercialization

The airport field trials in September 1997 were the pinnacle of a three-year, 1.8 million-dollar effort funded by the FAA. Further development and testing is planned. In November-December 1997, after the airport tests, the portal was returned to Sandia National Laboratories, where screening of explosives handlers and other testing was performed. From April-June 1998, the portal was moved to Idaho National Engineering and Environmental Laboratory (INEEL), where the FAA has funded a portal test facility. The INEEL staff performed many tests on the portal before it was shipped to the FAA's William J. Hughes Technical Center in July 1998 for further evaluation.

In parallel with the development efforts, Sandia is pursuing commercialization of this technology through the technology transfer process. A Commerce Business Daily advertisement was placed in January 1998 searching for companies that might want to manufacture and market the portal. Meetings are ongoing with those companies, and an industrial partner may be selected by the fall of 1998. It is hoped that portals could be available for the market as early as the spring of 1999.

Conclusions

A prototype explosives detection portal has been field tested at the Albuquerque International airport by Sandia National Laboratories. A verbal survey on the first two days of airport operation resulted in 491 responses. The results of the survey show that the public accepts the sample collection method employed in the Sandia design (although the survey is biased by only questioning volunteers). A false alarm rate of less than one percent was observed. One nuisance alarm was recorded from the 2400 volunteers screened during the nine-day trial.

After the airport trials, further tests of the portal at Sandia and INEEL have been conducted. The portal is currently undergoing tests at the FAA Technical Center in Atlantic City, NJ. Sandia is searching for an industrial partner to commercialize the portal through the technology transfer process. It is hoped that such a partner will be chosen in 1998, and that portals of this design may be marketed in 1999.

Sandia continues to study improved designs including better nozzles for ruffling the passengers, a one-sided design (which could halve the hardware costs and required floor space), and a more sensitive detector.