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assessing the feasibility

Leasing Jurisdiction

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Explosive Detection:

the quest for traces and vapours

Smiths Detection's iLane

Traditionally, the airport security checkpoint has focused on the search for metallic items on the passengers themselves, by use of archway and hand-held metal detectors, and also a range of prohibited items in cabin baggage, through the use of X-ray technology. However, the nature of explosives – predominantly comprising of organic materials – makes them hard to detect using X-ray. As events over the past few years have shown, the need for better explosive detection technology is now of paramount importance. ***Siriol Haf Griffiths*** *reports.*

In recent years, there has been a steady deployment of explosive detection technologies that have resulted in bags being swabbed, sniffed and scanned for traces and vapours of explosives. The focus, to date, has been on detecting explosives in baggage (with the added recent complication of liquid explosive detection); yet the checkpoint of the future will have to be able to identify explosives carried on the person too.

Furthermore, as terrorists become more sophisticated, there will be a need to detect an increasing variety of threats, including new types of explosives, chemical and biological weapons and so forth. Meanwhile, the detection systems deployed will have to be sufficiently automated and simple enough for non-technical, non-scientific security personnel to use.

Sample Acquisition

Arguably, the most important part of explosive detection technology is how samples are gathered in the first place. Swipes or swabs are the most common method of sample acquisition. They are used to collect samples for Explosive Trace Detectors (ETDs) to later analyse. The technology is based on the belief, or hope, that in secreting an explosive device in a bag, the terrorist is bound to leave minute traces of the explosive material on parts of the bag with which they have had physical contact. As a result, screeners concentrate their swabbing efforts on handles, zips, locks and, for items like laptops, keyboards.

Sniffing is used primarily in hand-held detectors and explosives trace portals. The Explosive Trace Portals (ETPs) are based on using air jets to ruffle clothing and dislodge particles,

which are then collected, concentrated and analysed by the instrument. Sniffer dogs can also be deployed to hunt out vapours and particles.

Advantages & Disadvantages

Both swabbing and sniffing have their pros and cons. Swabbing is particularly effective at removing particles from small areas. However, there are numerous disadvantages to swabbing too. It is a manually intensive method, and involves rigorous contact. It is also subjective to each operator and thus is not reproducible. Swabbing does not probe the entire surface or interior of a suspect object, and only collects particulates.

Explosive vapours are not collected by swabbing, creating an unbalanced level of collection efficiency for the range of threat explosives screened for. Cloth swabs, for example, are good at collecting explosive particles; however, they do not easily allow for thermal desorption, the process used to remove these particles from the swab for further analysis and identification in an instrument.

Sniffing is advantaged in that it has the capability to collect both explosive vapours and particles. An elementary hand-held explosive detection system only collects vapour. However, advanced systems can collect particles from the human body. Systems that only collect vapours are generally unable to detect low vapour pressure explosives like RDX and HMX, which need particle collection to enable detection. In general, most vapour sniffing systems, only allow for minimal vapour collection and therefore, detection of a small list of volatile, explosive compounds, such as TNT.

Differing Technologies

Acro is a developer of explosive detection solutions and has developed two pen-like explosive detectors – the 'ACRO-P.E.T' (Peroxide Explosive Tester) and 'ACRO-N.E.T' (Nitro Explosive Tester). The devices work by touching the suspected surface or material with rubber tips from the device. By doing so, varying amounts can be collected, which also includes liquids. The device is very sensitive, down to amounts of 5µg; this is a quantity that's not visible to the naked eye. Both devices give an answer in about 30 seconds.

Professor Ehud Keinan is one of the world's foremost experts in the science of improvised explosives; he is a member of Acro's board of directors and the company's chief scientific advisor.

"It took more than 10 years to develop this technology and it's been designed to be idiot-proof, for want of a better phrase. We can detect TATP with the 'ACRO-P.E.T' and we have had to adapt to cope with the threat of liquid explosives. But the products that we have at the moment are not designed for the multiple-screenings of people. They are one-time detectors and disposable items. We are now developing something for multiple detections and testing, and also a sniffer. This is a device for the remote detection of peroxide-based explosives."

Sampling with the Mini-Nose™ from SDT

ACRO-N.E.T – Acro's Nitro Explosive Tester

The Israeli-developed Mini-Nose™, from Scent Detection Technologies, is a portable, hand-held, highly-sensitive ETD, which digitally recreates the mammalian olfactory processes for trace and particle detection. It is capable of detecting nanogram levels of explosive traces by particle swabbing and/or sniffing. The hand-held unit is swiped across the suspected surface and then transferred to an analyser for results in up to 15 seconds. On the surface of each sensor is a chemical coating which is sensitive to different families of explosives molecules.

The novel technology at the heart of this device is also simple to upgrade and can 'learn', so to speak, improvised substances; this means that it can adapt to any new threats.

The technology employed within the Mini-Nose™ is based on High-Frequency

Checking suspicious material with ACRO-P.E.T

Quartz Crystal Microbalance (HF-QCM). SDT says this technology offers the ability to sniff-out trace levels of explosives at greater accuracy and ease of use, something which is vital according to SDT's Vice President of Business Development Doron Shalom, "Just because something has performed well under laboratory conditions does not mean that it will be appropriate to be used in every day circumstances. And it's important to remember that security screeners at airports are not scientists. It's important for the technology developers to take that into account. Our novel technology has been successfully implemented into a portable, reliable and cost-effective ETD."

The TATP Challenge

Without doubt, the explosive that still poses a challenge for screeners is TATP (triacetone triperoxide). This is an organic peroxide that has been identified in explosive devices in a number of cases involving terrorists.

Richard Reid, the man who attempted to bring down American Airlines Flight 63 with a bomb hidden in his shoe, used a device containing a plastic explosive with a TATP trigger. It is also believed that TATP was used as the explosive in the 7th July 2005 London bombings. The participants in the August 2006 transatlantic plot may have planned to use TATP in liquid bombs that would destroy U.S. planes flying from London to the United States.

TATP's base ingredients - drain cleaner, bleach and acetone - can be bought easily and without attracting suspicion; its chemical composition is simple; and in its finished form it is almost undetectable by sniffer dogs or conventional bomb detection systems.

> "…TATP does not have any nitrogen in it, unlike compounds such as TNT, nitro-glycerine, PETN, HMX and Semtex. Most detectors are based on the presence of nitro groups in the explosives…"

Professor Ehud Keinan thinks that effective TATP detection is a huge ongoing conundrum:

"The bottom line is that TATP detection is an extremely difficult task. You need detection machines that are different to what is now available in airports. TATP does not have any nitrogen in it – unlike compounds such as TNT, nitro-glycerine, PETN, HMX, Semtex etc – and most detectors are based on the presence of nitro groups in the explosives.

"Furthermore, normal CTX machines are based on density. The density of conventional explosives is usually between 1.5 to 1.8 grams per cm^3. So if a terrorist had conventional explosives in his bag, the CTX machine would be able to identify that immediately. The reason for this is because out of all the other items in the bag, like books or clothes, the density is approximately 0.5 g/cm^3. So if you have something which is 1.5 to 1.8 g/cm^3, it is visible to the machine. But TATP is 0.5 g/cm^3, which is transparent to the CTX machine."

Chris McBee from Syagen Technology Inc. agrees with Prof. Keinan, "Most explosive detection systems have an area of strength allowing them to match up well with a limited range of

"…laptops, medical devices and digital cameras often have complex internal mechanisms which are difficult to open, requiring more sophisticated inspection mechanisms than those used to screen standard carry-on items…"

explosives, which are particularly suited to their technology and sample collection method. Unfortunately, if detection settings are employed for the widest range of explosive compounds, this increases the false alarm levels of commonly used IMS (ion mobility spectrometry) ETD to unacceptable levels for operational use. Therefore, in practice, a limited library of explosives is generally screened for.

"The list of terrorist threat compounds continues to grow, creating a misalignment of the screening technology to the full range of materials of interest to aviation security authorities. "The biggest detection challenges are TATP and the precursor material hydrogen peroxide. These can be detected by the application of high-level chemical analysis methods, like MS (mass spectrometry) and to a lesser extent by IMS. Currently almost all systems employed are IMS units.

"However, the challenge is in sample collection and delivery to the ETD. The big problem for IMS is that it is not capable of detecting many compounds simultaneously because of its poor resolving power, which leads to a high false positive rate. MS has 10-100x better resolution than IMS allowing it to screen for, essentially, an unlimited number of compounds simultaneously, with high sensitivity and low false positive rates. The trade off is cost and size, although recently introduced systems are solving these issues."

Liquid Detection

The main problem with liquid detection is collecting the sample, and its transfer to an ETD. However, several companies are meeting this challenge, and new technologies in the field are emerging.

For example, Traceguard have developed the CompactSafe – a machine that automatically extracts traces of explosives from compact items. Items such as laptops, medical devices and digital cameras often have complex internal mechanisms which are difficult to open, requiring more sophisticated inspection mechanisms than those used to screen standard carry-on items. CompactSafe enables complete extraction and sampling of substances from both the interior and

HI-SCAN 6040 aTiX X-ray system from Smiths Detection detects liquids in carry-on bags

exterior of the items it inspects. CompactSafe is able to extract any type of explosive trace, in both solid and liquid form. In October Traceguard completed a second successful pilot programme of the CompactSafe system Israel's Ben Gurion International Airport.

X-ray still has a role to play. In October, Smiths Detection won a contract worth $21million from the USA's Transportation Security Administration for their aTiX (Advanced Threat Identification X-ray) – the X-ray machine that can automatically detect explosives and liquids at passenger checkpoints. The company describe the aTiX as a, "next-generation advancement in security checkpoint X-ray systems". The contract follows successful trials run by the TSA at airports in the United States.

Meanwhile, in the UK, Smiths have secured a contract to supply aTiX to the BAA worth even more. In a programme already underway, Smiths are supplying the systems to equip Heathrow's new Terminal 5 (set to open on Thursday 27th March 2008) and replace all existing checkpoint X-ray machines in other terminals and at other BAA airports around the country.

Passenger Dignity

There are generally two different approaches being used today to safeguard the individual's liberty and dignity whilst at the same time effectively detecting the presence of explosives. The first is to sniff people for trace contamination of explosives, whilst the second is to image their bodies by visualisation methods that penetrate their clothing. The sniffing/trace portal method does not fundamentally violate personal privacy. However, the imaging portal method does face personal privacy issues.

Regarding the efficiency of both approaches, an explosive trace portal removes and concentrates samples off the body and clothes, then automatically analyses these, which removes the problem of human error. However, imaging requires a person to interpret images in order to identify a device by its shape. This is subjective and proven to be susceptible to human error and abuse.

As far as fooling the detectors; the whole body imaging system cannot see items placed underneath feet, under armpits, in the crotch area or inside body cavities. The use of privacy software to block private parts from view by screeners is sometimes used to alleviate privacy issues. The problem with this is that it then creates an additional area for concealment, around the groin.

Some consider the issue of privacy software to be a double-edged sword. There is an inherent contradiction in the argument for use of such 'privacy' software as a moderating factor in trying to win public acceptance of whole body imaging, when at the same time arguing that whole body imaging is needed to increase security levels.

Since 6 million passengers a day board aircraft around the world and on most days none of them are terrorists, a reasonable question is whether the probability of the threat, for any individual passenger, really merits going to the extreme of asking them to be viewed in the nude? The answer may be, only if there are no other options available and lives would be lost otherwise.

"…whole body imaging systems cannot see items placed underneath feet, under armpits, in the crotch area or inside body cavities…"

However, explosive trace portals overlap the capabilities of whole body imaging and address many of the detection loopholes present in whole body imaging. For example, it is possible for terrorist teams to subdivide bomb-making materials amongst several people, so the quantities are too small to be detected by imaging, but ETPs would detect traces from these small explosive quantities used in a team terrorist effort.

According to Syagen, its Guardian® explosives trace detection portal uses mass spectrometry to detect traces of explosives. The person enters the portal, and once the doors are closed, a five-second blast of air from up to 20 jets blow onto the person. There is then an intake at the bottom of the portal which sucks in air and concentrates particles and vapour. This concentrator has a heating source which subsequently vapourises the sample. It is then drawn into the MS analyser. The entire process from passenger entry to analysis takes around 16 seconds in total.

Syagen's Guardian® explosives trace detection portal

On the other hand, explosive detection portals, by definition, only detect explosives. Whole body imaging systems offer the screeners the ability to identify a range of prohibited or threatening items that neither metal detector nor explosive detection solution have the ability to do - ceramic, glass, plastic and wooden weapons can, today, only be detected by physical search or electronic strip searches.

Is our quest just to find explosives or to identify a whole host of potentially dangerous items? One can argue both cases.

The Future

The challenge within the industry has been and, for the foreseeable future, will continue to be the development of a system that can detect 95% or more of all existing explosives, in all categories. Such detection must be achieved whilst keeping the false alarms rate below 0.1%, even under the worst conditions of deception, concealment and encapsulation. As with designers of anti-virus software for computers, the explosive detection industry needs to maintain a pragmatic approach. The ability to adapt is paramount in order to stay one step ahead of terrorism.

The author is a freelance multi-media journalist based in Cardiff, Wales. She is an experienced radio and television reporter, having spent six years with the BBC during which she worked on numerous local, national and international stories, including 11th September, Election 2001 and the foot and mouth crisis.

Guardian® makes invisible traces of explosives extraordinarily clear

Precise screening of passengers for concealed explosives in seconds

In the war against terrorism, even the tiniest clues are critical and Syagen technology specializes in detecting them. Syagen has designed the Guardian® Explosives Trace Detection (ETD) Portal for people screening using the most accurate technology available. The patented mass spectrometry (MS) technology detects explosives contamination as small as one-millionth a grain of sand.

MS has a resolution that's 10 to 10,000-times greater than ion mobility spectrometry (IMS). This high resolving power enables MS to screen for more than 30 explosives simultaneously without compromising accuracy and precision. This advanced technology has been recommended by the National Academy of Sciences as the core technology for explosives trace detection for aviation security.[1]

Guardian Explosives Trace Detection Portal

Incorporating the most advanced pre-concentration technology,[2] Guardian produces performance levels unmatched in sensitivity, specificity and low false negative and false positive rates for the largest number of explosive compounds and is easily upgraded to search for new compounds should the threat scenario change.

Guardian offers a comfortable environment during the brief screening process, high screening throughput and occupies a small footprint. For more information, contact Syagen Technology at 714 258-4400 x28

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[1] National Research Council, "Opportunities to Improve Airport Passenger Screening with Mass Spectrometry," National Academies Press, Washington DC, 2003.
[2] Sandia National Laboratories (Albuquerque) "Hound" technology.