Advanced passenger screening technologies: ‘It’s not just about the passenger’

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Abstract
The world of the security screening checkpoint has changed dramatically due to the events of 25th December, 2009 when Umar Farouk Mutallab, or infamously known as ‘The Underwear Bomber’, successfully carried explosives stitched in his underwear through the security screening checkpoint (SSCP) undetected. As the deployment and implementation of advanced technologies at airport passenger SSCPs are accelerated to detect these items, what does it mean to the airport operator? Terminal facilities will be affected in a number of ways including spatial impacts, structural impacts and passenger wait times. The airport operator needs to be prepared to handle these concerns before they come to their facility.

Keywords
safety and security, design and construction, security screening checkpoint (SSCP), walk-through metal detector (WTMD), advanced imaging technologies (AIT), whole body imaging (WBI), explosive detection systems (EDS)

INTRODUCTION
Advanced technologies at airport passenger security screening checkpoints: everyone has read about them in the newspapers, heard about them on the radio and on the morning news. Airport operators have heard about them through the Transportation Security Administration (TSA), with discussions about the deployment of new advanced screening technologies at passenger security screening checkpoints (SSCPs), with internet discussions, conference discussion groups and planning guidelines. Some of the coverage and discussions have been positive, with the focus on improved safety for the travelling public. Some of the coverage has not been as favourable, with regards to concerns over perceived health-related issues as a result of the advanced technologies as well as privacy concerns. But what does all of this mean to the airport operator? What is not typically discussed in these forums are the impacts for terminal facilities, such as spatial impacts, structural impacts and passenger wait times. Operators hear that they are going to receive these technologies with new screening equipment being deployed at their airport, but do they...
know how they can accommodate them? The airport operator needs to be prepared to handle these concerns before they come to their facility. How airport operators got here is one thing, but where they are going is another.

BACKGROUND

On 25th December, 2009, Umar Farouk Mutallab, or infamously known as ‘The Underwear Bomber’, successfully carried explosives stitched in his underwear through the SSCP undetected. The technologies in place, a walk-through metal detector (WTMD), were unable to detect the explosives as the equipment detects metal objects on a person, not other contraband materials. Mr Mutallab was unsuccessful in detonating these explosives, but federal mandates to deploy more advanced technologies were again put upon the airport as a response to these events. Similar to the deployment of explosive detection systems (EDS) and explosive trace detection (ETD) technologies in response to the events of 11th September, 2001, the TSA has again embarked on the deployment of improved technologies at the SSCP to identify objects that could pass through the checkpoint undetected. While critics have expressed concerns about whether this new advanced equipment could have detected the explosives on Mr Mutallab, the TSA and other industry experts believe differently.

The new advanced technologies to be deployed will focus on passenger screening as well as carry-on items destined for the aircraft cabin. For screening of passengers, advanced imaging technologies (AIT) portals are the current focus for detecting items on a person that may normally go undetected through a WTMD. For the screening of carry-on items, advanced technology (AT) is the technology focus for providing high-definition images allowing for multiple screener views as well as the capability for automatic threat detection, utilising computer algorithms similar to those used in EDS equipment. In comparison, the current dual-energy x-ray equipment still in use at many airports today allows for a static, single image of carry-on items, requiring manual reviews of suspect items.

The adage ‘10 lbs of stuff in a 5 lb sack’, portrays the impacts of the deployment of the advanced technologies at SCSPs, similar to when it became a federally mandated requirement for 100 per cent screening of checked baggage in 2002. Not all existing facilities were capable of handling the deployment of this new screening technology, at least not easily. Some of the machines found their way into public circulation in front of the check-in counters. Some check-in counters were pushed out to place the equipment behind the counters. That, coupled with possible structural modifications to the facility to handle increased equipment loading requirements or building of new space to accommodate the equipment, all with a goal to improve customer service and airline operations, were a result of this equipment deployment. As a result, facility circulation and customer service were greatly affected. Airport operators need to prepare for the same types of facility modifications related to the deployment of both AIT and AT technologies at the security screening checkpoint.

THE TECHNOLOGIES

Advanced imaging technology

The highest-profile and most publically discussed equipment to be deployed is the AIT, better known as the ‘whole body...
imager’. This technology allows for a TSA screener to look at the image of a passenger to detect anomalies that would otherwise go undetected in a WTMD. The two basic technologies used in AIT portals are backscatter and millimetre-wave imaging technologies.

Backscatter imaging projects low-level x-ray beams over the body to create a reflection of the body displayed on a viewing monitor. The passenger stands with their arms elevated in a single body pose in front of the device, similar to a standard x-ray. The resulting image is similar to an x-ray image, capable of showing images of the human body, highlighting anomalies, or contraband, which can be cleared by the screener or identified as requiring further screening. The low levels of radiation exposure utilised by this equipment are equivalent to approximately the same levels of exposure from spending two minutes in an aeroplane during flight.

Millimetre-wave imaging technology bounces harmless electromagnetic waves off the passenger’s body to create a black-and-white, three-dimensional image of the body. The passenger stands in a single pose with arms raised and the screening panels rotate around the passenger to create the image. Both metallic and non-metallic threat items are identified, to be cleared by the screener or signalled for further screening for items that cannot be cleared. The radio frequency energy used for creating the images that are emitted is thousands of times lower than that emitted by a cellphone.

Currently, the TSA has certified two manufacturers for equipment deployment. Rapiscan Systems’ ‘Rapiscan Secure 1000 AIT Single Pose’ equipment utilises backscatter technology, while L3 Communications’ ‘L3 Provision 100’ equipment utilises millimetre-wave technology.

**Advanced technology (AT)**

Less frequently discussed, and not receiving the public’s attention, are the developing technologies being deployed for the screening of carry-on items. Current dual-energy x-ray equipment provides the screener with a static, two-dimensional, single image view of a carry-on item, making identification of threat items more difficult and requiring a more timely review by the screener. The newer AT x-ray technology provides the viewer with dual high-definition images of an item, which can be viewed at different angles. The AT x-ray also provides automatic threat detection capabilities, using algorithms to identify threat objects by mass, atomic number and size. This allows the screener to identify threat objects more efficiently and clear potential threat items in a timely manner. The TSA has certified two manufacturers for providing AT equipment, the Rapiscan Systems’ ‘620DV’ and Smiths Detection’s ‘Hi-Scan 6040a’.

**FACILITY IMPACTS**

The AT equipment described above gives a basic overview of their differences, benefits and to some degree an indication of health concerns with respect to AIT portals. While the technology is advanced in its capability, it does come with constraints. In this case, size does really matter. While all public, and some private, discussions have focused on the technology, similar to EDS equipment, how will its deployment affect a facility?

**Spatial impacts**

With any new technology, there are growing pains. The first generation of deployed equipment is typically the starting point for improvement. The new AT equipment being deployed has a larger
footprint than older technologies and requires maintenance clearances that are larger than current equipment. This all equates to more space needed in an existing SSCP to lay out the new checkpoint lanes adequately.

For AIT portals, the footprints range from 13–30 m wide and 12–31 m deep, compared with a typical WTMD, where the widths range from 10–11 m and depths range from 7–8 m. Width is the more critical of the dimensions when discussing spatial impacts and there is a 19 m difference between the two technologies. Width, coupled with maintenance clearances, will have a substantial impact on the existing SSCP layout.

The same comparisons between dual-energy x-ray and AT x-ray, while not as significant as AIT dimensional impacts, still have an impact, especially considering when both AIT and AT are utilised, where the sum of differences equals a significant spatial impact. AT equipment footprint widths range from 15.7–17.2 m wide and 27.6–27.9 m in length. When compared with dual-energy x-ray equipment with widths of 10–13 m and lengths of 24–33 m. The difference of approximately 330 mm width, while not significant, does not take into account maintenance clearances.

To better understand the overall impacts of these footprint impacts, they are best realised in a direct comparison utilising TSA SSCP design guidelines. Utilising a standard two to one design layout, which includes two lanes utilising one passenger screening portal and two carry-on x-ray devices:

- **Standard technology SSCP footprint:**
  - One WTMD portal;
  - Two dual-energy x-rays;
  - One holding station;
  - Footprint: 6 m × 13 m deep.

- **AT SSCP footprint:**
  - One AIT portal;
  - Two AT x-rays;
  - One holding station;
  - Footprint — 8.8 m wide × 17.2 m deep;
  - Note: Does not include enclosed AIT operator station.

While it can be seen that the difference in width requirements is approximately 1 m for a two to one layout, the depth difference of approximately 4 m is not to be overlooked. The AT SSCP footprint is deeper than the standard equipment layout, but it does not account for the operator station. The operator station houses the lane control unit (LCU). The LCU contains a workstation with computer and monitor used by the AIT operator to view AIT images. The LCU also needs to be enclosed in a private space to prevent anyone outside of the enclosure from seeing any AIT images. The approximate size of a typical operator station is 1.5 m × 2 m which houses one LCU. While technology allows for more than one LCU to be co-located in the station, current protocol calls for one LCU per station, but this requirement can be modified on a case by case basis. The operator station proximity to the AIT portal(s) is recommended to be within 91 m of the equipment. This recommendation is based on the limits of single, continuous data copper wiring lengths, such as CAT5 and CAT6, where signal strength is the consideration, but the distance can be increased through the use of boosters and multiple data cables. While the distance of 91 m can be exceeded, any further distances affect TSA staffing shift changes due to the lack of an operator station immediately adjacent to the SSCP. These screening devices, either individually or in combination in the SSCP, can adversely affect the terminal facility, necessitating such modifications as...
widening and deepening existing SSCP space, adjusting valuable passenger circulation space and relocating tenants adjacent to the SSCP to accommodate the increased spatial needs.

Structural impacts
The new AT equipment, as described above, has an impact on the existing terminal facility due to being larger than earlier generation equipment. While the equipment footprints have increased, a lesser discussed and potentially larger impact is weight. It is easier to visualise numerous possibilities for the configuration of the SSCP and related architectural impacts because this is visually apparent, especially with graphical templates made available to lay out a checkpoint. What is more difficult to comprehend are the impacts of these layouts relative to the building’s structure.

Without delving too deep into the world of structural engineering, the two basic structural systems commonly used for terminal facilities are slab-on-grade, structurally supported elevated slabs, or a combination of both. If the SSCP is located on a slab-on-grade structure, the weights of the equipment are easily accepted with minor, if any, structural modifications required. The loads of the new equipment are evenly distributed across the slab. If the structure beneath the SSCP is a supported or elevated slab, the impacts of the additional weight become a major consideration. In today’s existing terminal facility, evidence of expansion, relocation of existing spaces and ever-changing locations of equipment can be seen with the amount of cores and holes evident throughout the elevated slabs. The capacity of the slab may have been altered based on the amount of slab cored as well as the location of the cores. More densely placed cores will affect slab capacity more than cores spaced further apart.

Now that the significance of understanding the type of structure that is supporting the SSCP has been established, following is the reason to care.

Equipment weight comparison
• Portals
  — Walk through metal detector: 45–65 kg;
  — Advanced imaging technology: 680–975 kg;
  — Factor of weight increase: 1,500–2,100 per cent increase.

• Carry-on x-ray
  — Dual-energy x-ray: 408–635 kg;
  — AT x-ray: 952–1,587 kg;
  — Factor of weight increase: 2,300–2,500 per cent increase.

Following a quick review of equipment weights, one can begin to see where weight is a concern, and it becomes more critical that the airport operator understands their facility structure and its limitations. For example, and again using the two to one lane configuration, by swapping out equipment with one AIT and two AT x-rays, effectively 1,723 kg of additional weight has been added. As more lanes are added to the equation, it is easily imagined that weight becomes a concern. The following descriptions look at the most common structural systems encountered and how they can be dealt with when adding AT equipment to an SSCP.

Slab-on-grade
If the terminal structure supporting the SSCP is slab-on-grade, it is recommended
that trenches are cut in the slab to locate utilities and the removed concrete is replaced. A walker duct can also be utilised, which makes adjustment or relocation of equipment easier. A walker duct, similar to a trench drain in concept, provides a continuous trench in the slab in which utilities are placed. A cover is placed over the trench with openings to allow utilities to penetrate the trench to the equipment. In the event that equipment needs to be relocated, the duct cover can be removed, allowing for easy movement or relocation of utilities. If cutting of the existing slab is prohibitive or not desired, all power and data wiring can be located on the floor surface of the SSCP, but would require wire moulding to be placed over all wires within circulation areas to reduce tripping hazards.

Supported or elevated slab
If the SSCP supporting structure is a suspended or elevated slab, typically utilities are fed to the equipment through the slab from below. The locations are determined where utilities are required to feed the equipment. A core or hole is drilled through the slab at these predetermined points and the utilities are fed to the equipment through the hole. The current equipment manufacturers will make this information available to assist in coordination of these utility locations. For existing elevated slabs, structural capacity becomes a potential issue. Not only is the weight of the SSCP a concern, but another contributing factor in determining the slab capacity is what, if anything, is hanging off it below. If it is determined that the existing structural capacity is close to being or is exceeded, then structural modifications will be required to ensure a safe structure. Regardless of the structural system, each will need to be modified to some extent, if only to allow it to be modified to add required utilities to the new equipment. While this is a cost to the project, the TSA is currently providing funding for necessary facility infrastructure modifications to accommodate the deployed AT equipment.

Infrastructure considerations
The structural concerns and modifications are not the only infrastructure modifications that will need to be addressed to accept the new AT equipment at the SSCP. Power and data requirements also need to be considered for both AIT and AT equipment. All of the AT equipment either operates on 110V AC\10A or 230V AC\5A, so an understanding the excess power availability within the existing facility infrastructure needs to be determined so the proper modifications can be made prior to the installation of the equipment. Consideration needs to be given to how power and data will be provided at the SSCP to serve the new equipment. The routing of new utilities to the SSCP can be accomplished by coming from above the ceiling and 'dropping' to the equipment in encased power poles that look similar to small columns or by coming from the floor up to the equipment. While coming from below into an elevated slab provides flexibility as to where utilities can be located, walker ducts also provide utility placement flexibility.

Passenger impacts
The focus of this paper has been on the airport operator relative to how the deployment of new AT equipment to an existing facility can affect many aspects, not just the SSCP, but adjacent terminal spaces as well. However, a dynamic piece of the equation is the passenger screening
process and how it needs to be considered in the SSCP and facility modifications.

From a process standpoint, the first noticeable impact to a facility operating AT equipment at the SSCP is the passenger queue at the SSCP entry point. The goal of the TSA is to improve current SSCP protocols and processes to increase the speed of passenger processing. A typical two to one lane configuration utilising WTMD (and not AIT) portals for passenger processing is capable of processing an average of 180 passengers per hour (pph). Comparatively, the same two to one lane configuration utilising AT equipment is currently processing approximately 150 pph. The specific reasons for reduced throughput rates will be discussed, but it should be noted that, as the processing rates are currently slower, queues may increase at the SSCP entry. This can cause the queues to spill over into valuable circulation spaces or in front of tenants and concessionaires. Additional space will need to be identified for extending queues to accommodate the increased passengers waiting in line to be processed. Over time, as screening processes improve, both throughput and TSA protocols, the throughput rates should increase, and the queuing spaces should decrease.

The original goals for passenger processing rates utilising AT equipment at the SSCP were approximately 240 pph. In the initial equipment deployments, actual processing rates were approximately 140 pph. The perception is that with newer, more advanced technologies, the processing rates would increase. What needs to be understood about these slower processing rates are two primary reasons for the slower rates — airline checked baggage fees and added divesture requirements.

Starting with the passenger carry-on items, the airline checked baggage fees have done a wonderful job in providing millions of dollars per year to the airlines in additional revenue, but the adverse effect is not only the increase in sizeable carry-on items, but what gets put in these carry-on items. Infrequent travellers not wanting to pay these fees bring with them carry-on baggage and items that now take on the attributes of checked baggage, primarily with more than 100 mL of liquids in any given container or the total containers not fitting into a plastic bag. The sheer amount of items in these bags makes any screening activity challenging. Current screening protocols will require some baggage to be stopped or even backed up in the x-ray to better identify potential threat objects, very similar to how dual-energy x-ray is currently utilised. Until the travelling habits of passengers change, these over-packed carry-on bags ultimately will cause the AT x-ray screening lanes to be the determining factor in throughput rates, not the AIT.

The AIT portal does require full divesting of all objects to allow for accurate body images and to reduce the number of anomalies a screener needs to clear. This is quite a change from the divesting requirements for the WTMD. Passengers will need to be educated on the AIT divesting requirements to ensure full divesting and reduction in secondary screening. TSA is currently training and deploying ‘coaches’ who will serve as educators at the SSCP to continually communicate the requirements for divesting, to answer questions and ideally keep the flow of passengers constant. Once the travelling public better understands the divesting requirements for the AIT portal, the wait times to go through the device should greatly improve. But until that time, it should be anticipated that queue lines pre-portal will be longer, again affecting the airport facility.
WHAT’S ON THE HORIZON

The future of AT equipment is already looking bright. The AIT portal, for instance, is undergoing further research and development to include automatic threat recognition (ATR) in the next generation of deployed equipment. The computer algorithms included within the screening protocol allow for automatic identification of threat objects and anomalies instantly, at the time a passenger exits the portal. If an anomaly is identified, a screener is alerted to provide secondary screening. Not only does this increase throughput rates, but ATR would allow for the deletion of private resolution rooms as all screening resolution is handled automatically.

For the AT x-ray, AT2 is coming. The AT x-ray equipment deployed today is a vast improvement on the dual-energy x-ray in use at many US airports nationwide. The AT technology provides better imaging and algorithms that provide automatic threat detection of suspect objects. What it does not allow for is leaving computers in briefcases or liquids in baggage. The next generation of AT x-ray, the AT2, will allow for both. These two items that are currently divested will be able to be left in their bags. Again, one is talking about improved protocols, improved throughput and happier passengers.

The proposed improvements to the advanced screening technologies are only going to get better. Throughput capability will be greatly enhanced. Divesting requirements will be easier on the passenger as the number of items divested will be decreased. Screeners will have access to better imaging technology for clearing passengers or identifying threats. Eventually, shoe scanning will appear at the SSCP. Actually, pilots are underway for developing this technology which would eliminate the need for removal of shoes.

What this new technology does is improve SSCP throughput, reduce the lengths of queues and ultimately reduce negative impacts to the terminal facility. A by-product of all of this is a contented passenger.

IN CONCLUSION

The world of the security screening checkpoint has changed dramatically due to the events of 25th December, 2009. While new advanced technologies were on the drawing board and being pilot-tested to be considered for deployment, in the USA these events rapidly accelerated the deployment of the equipment nationwide. The initial deployments of equipment were strategically planned for airport terminal facilities that already had excess space to allow for the immediate installation of the equipment, basically meaning that the ‘low-hanging fruit’ were easily reached. As more equipment is deployed, airport operators of existing facilities with more restricted expansion capabilities will begin receiving this equipment. While similar to shared funding for EDS deployment, TSA shared funding of SSCP equipment deployment costs will not only include the equipment, but also the necessary infrastructure modifications.

Terminal facility operators need to be well aware of the equipment that potentially may be received. After being notified that their facility has been selected for equipment deployment, the reality of the ensuing impacts for airport operators will or should sink in. Getting past the initial perceptions of the travelling public with regards to the safety of passing through this equipment, which is less of a concern than the effects of a cellphone, the focus needs to be placed on the facility itself.

First, operators need to understand what equipment has been determined to
be installed in their SSCP. If not already, operators need to become intimately familiar with their facility infrastructure. The initial focus will be on the dimensional layouts of the SSCP and how to fit the new lane layouts within the existing limits of the SSCP. TSA is very cooperative in modifications to the published standardised layouts, so it should be kept in mind that there are options. The orientation of some equipment can be adjusted to tighten up the dimensions of the SSCP layout, but needs approval from the TSA.

Secondly, operators need to understand the equipment they will receive. The equipment weight references and comparisons described above should make operators aware of potential impacts to the structural system they have. When the equipment arrives, operators need to have the entire infrastructure modifications completed to ensure a timely installation with few or no issues arising from lack of preparation. Each of the certified vendors will provide operators with all of the selected product specifications, so they will be better versed on weights, power and data requirements, and the basic information to determine what, if anything, needs to be modified.

Finally, operators need to understand the passenger impacts to the SSCP and how those can inadvertently affect areas surrounding the SSCP. While AIT portals provide better imaging and threat object identification, the passenger divesting requirements are greater than today’s WTMD. As mentioned earlier, the TSA is taking steps by providing coaches at the SSCP to educate and verbally communicate what to divest and what to expect during the screening process. While this can slow down the targeted throughput and processing times of passengers through the AIT, it should improve over time as passengers become increasingly familiar with the processes and technology. What may be more difficult to improve, at least in the short term, is the carry-on bag dilemma. Airline checked baggage fees are here to stay and so are the increased number of bags going through the SSCP and into aircraft cabins. While the AT x-ray provides the screener with better tools to screen bags, screening protocols will still dictate what items need a second look or need to be removed for secondary screening. That, coupled with the numbers of items being placed in these bags, means that the number of alarms may well increase and slow down the process altogether.

The new AT equipment being deployed nationwide in the USA is a vast improvement over current technologies and will continue to improve over time, especially improving the level of security. The challenge in all of this is modifying an airport’s current facilities to work with this equipment. With early preparation, possible consultation with building design professionals and working closely with the TSA, the facility modifications can be handled efficiently, with minimum disruptions to the airport and reduced if no impact to customer service. Regardless of what is read in newspapers or heard on the news, to an airport operator, it is not just about the passenger.