Body Cavity Screening for Criminal Justice: Market Survey

(Version 1.1)

DOJ Office of Justice Programs
National Institute of Justice
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1.0 INTRODUCTION

Body scanners are used to screen for contraband in a variety of places. Airports, schools, government buildings, and corrections facilities are examples of the types of places that have employed body scanners. Different types of body scanners have different capabilities based on the imaging technologies used and the sophistication of the internal system analysis. Metal detection was one of the first technologies developed to identify metallic objects on a person, but contraband can take many other forms, such as powders (e.g., drugs), paper (e.g., money), and even ceramic or plastic weapons. Correctional facilities in particular are faced with various forms of contraband, and with elaborate methods of evading detection employed by the local population.[1] Manufacturers have responded by producing scanners that are able to detect non-metallic contraband, as well as systems that can detect contraband inside body cavities. This report identifies commercially available body scanners and discusses the technologies used by these products. Technological limitations pertaining to the type of materials detected and/or the ability to detect contraband inside body cavities are discussed.

1.1 About the SSBT CoE

The NIJ SSBT CoE is a center within the National Law Enforcement and Corrections Technology Center (NLECTC) System.[2] The Center provides scientific and technical support to NIJ's research and development (R&D) efforts. The Center also provides technology assistance, information, and support to criminal justice agencies. The Center supports the sensor and surveillance portfolio and biometrics portfolio. The CoEs are the authoritative resource within the NLECTC System for both practitioners and developers in their technology area(s) of focus. The primary role of the CoEs is to assist in the transition of law enforcement technology from the laboratory into practice by first adopters.

1.2 Need for Contraband Scanners

Body scanners have been in use for the detection of contraband in many different scenarios where there is a heightened risk of individuals attempting to pass contraband materials into a controlled environment. Environments such as airports, corrections facilities, government buildings, and schools are some examples where contraband screening has been incorporated.

A large number of weapons are constructed (at least in part) out of metal. Metal detectors have been used for this purpose for many years, but they do not detect non-metallic objects, such as drugs, explosives, or plastic weapons. Pat-downs are effective at finding items concealed on a person, but these are time consuming, and have heightened scrutiny with respect to privacy and appropriate officer conduct. Body scanners may help reduce the burden of manually searching for contraband, however there are technological limitations.

Ideally, a body scanner would be able to detect metallic as well as non-metallic contraband that is hidden underneath clothing as well as detect contraband hidden inside body cavities. The ideal scanner would also perform these tasks without the possibility of harmful effects (short or long term) to the subject or the operator(s) of the scanner, and maintain the privacy of individuals to the fullest extent possible.

1.3 BCS Information Sought

In December 2013, the SSBT CoE (through NIJ) published a notice within the Federal Register requesting information and comments from vendors in support of this market survey (https://federalregister.gov/a/2013-30241).[3] The following categories of information were sought for the various systems contained herein. As needed, additional comments for the categories are also included here. This report relies heavily on the information provided by the manufacturers that responded to this Request For Information (RFI); however some information was also obtained through literature review and online research of product information.

Table 1: Information Sought from Vendors

Information Categories	
1.	**Model Number** and **Name** of the screening system/device.
2.	**Technology** used by the system/device for detection (e.g., transmission X-ray, active millimeter wave).
3.	**Size Class** of the system/device: Fixed, Portable, or Handheld.
4.	**Physical Dimensions** of the system/device.
5.	**Weight** of the system/device.
6.	Whether the system/device **Detects Metal** objects. If YES, whether there are any types of metals that are NOT detected by the system.
7.	Whether the system/device **Detects Non-Metal** objects. If YES, whether any of the following can be detected by the system/device: Liquids (in a container or bag), Gels (in a container or bag), Plastic, Wood, Ceramic, Powder (in a small packet), and/or Paper (e.g., folded currency).
8.	Whether the system/device can detect objects **Concealed within Body Cavities**. If YES, whether any screening limitations exist or if all body cavities are covered by the system/device.
9.	For object materials detected by the system/device (Question #6-7), the minimum **Detected Size** of objects on a person and concealed within body cavities.
10.	**Scan Rate** of the system/device.
11.	**Total Inspection Time** per individual screened with the system/device (i.e. Throughput).
12.	**Penetration Depth** of the system/device's scan when used on a clothed person.

Information Categories	
13.	Whether the system/device scan penetrates concealed **Body Armor**. If so, what classifications or types of armor can be imaged through.
14.	**Spatial Resolution** of the system/device scan with respect to concealed object dimensions/features (indicate Not Applicable for a system/device that only provides a detection alarm and no image).
15.	When scanning a person, the **Information View** displayed to the operator – Alarm Only, Body Location Alarm, Anomaly Image, Body Region Image, or Full Body Image.
16.	Whether the system/device includes any **Privacy** safeguards or features (e.g., remote viewing, body masking).
17.	**Image Visualization Time** of the system/device – Alarm Only, Real-Time Dynamic Imaging, Delayed Dynamic Imaging, or Static Imaging.
18.	**Data Management** provided for images and alarms, with respect to saving, archiving, retrieving, and printing subject scan information.
19.	**Power** requirements of the system/device.
20.	**Regulatory & Compliance Safety** requirements and/or standards that the system/device adheres to.
21.	**Warranty** that comes standard with the system/device.
22.	**Manufacturer Suggested Retail Price (MSRP)**.
23.	**Extended Maintenance** plans available.
24.	Cost(s) of any **Service Contracts**.
25.	**Other** information or notes that is relevant to the system/device.

2.0 DISCLAIMERS

1. This project was supported by Award No. 2010-IJ-CX-K024, awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice (DOJ). The opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect those of the Department of Justice.

2. Commercial products included herein do not constitute an endorsement by NIJ, DOJ, NLECTC, or ManTech. NIJ, DOJ, NLECTC, and ManTech assume no liability for any use of publication content. This publication is a reference for educational purposes only. Please carefully consider the particular needs/requirements of your agency and any applicable laws before developing policies or procedures governing the use of any technology.

3. All legal aspects regarding expectation of privacy issues, probable cause, warrants, and any other operational law enforcement procedures should be researched by agencies and their officers in accordance with local, state, and federal laws prior to the implementation of technology described herein.

3.0 TECHNOLOGIES USED FOR BODY SCANNING

Metal detectors have been used for a while at entrances and screening areas, but they are limited to the detection of metals. X-ray devices and Millimeter Wave (MMW) devices are able to detect metallic and non-metallic contraband. Backscatter X-ray devices are able to detect contraband hidden beneath clothing, but do not image "through" a person. The imaging depth is typically a few mm below the skin surface. Devices using MMW technology are also able to image beneath typical clothing and to the surface of the skin. Neither of these techniques is able to detect contraband hidden inside the human body (e.g. swallowing contraband or contraband hidden in body cavities). Transmission X-ray based systems are able to image through the entire body, and are able to detect contraband hidden on and inside a subject.

There are safety and privacy concerns associated with some of these technologies. The exposure level of X-rays devices have been tested by several government agencies and found to be within acceptable limits set by governing bodies.[4,5] Even so, concerns regarding the safe use of X-rays to scan individuals can be an issue.[6] At a minimum, using X-rays is a public perception concern that should be considered when comparing these devices. Privacy issues have also been a concern, especially in public areas such as airports. Manufacturers responded to privacy concerns by producing devices that use generic "mannequins" to indicate suspicious areas during scanning. Once scanned, suspicious areas are highlighted on a generic mannequin and the subject undergoes additional screening. No images are viewed, or even produced. Privacy issues in non-public areas such as corrections facilities may not be as large a concern as compared to public areas, such as airports and schools.

3.1 Metal Detection

Metal detection is based on the way metallic objects react to magnetic fields. Metal detectors are designed such that it does not matter whether the object is magnetic or not, the main criterion for detection is that the object be an electrical conductor. Magnetic fields can be created using a loop of wire with an electrical current running through them. If current goes around the loop in only one direction, the magnetic field will have a specific North/South directionality. If the current is reversed and passed through the loop in the opposite direction then the directionality of the magnetic field produced will be in the opposite direction. Current that only goes in one direction through a wire is known as direct current, or DC. These single direction magnetic fields will interact strongly with magnetic materials, but they do not interact strongly with non-magnetic metals such as copper or certain stainless steel.

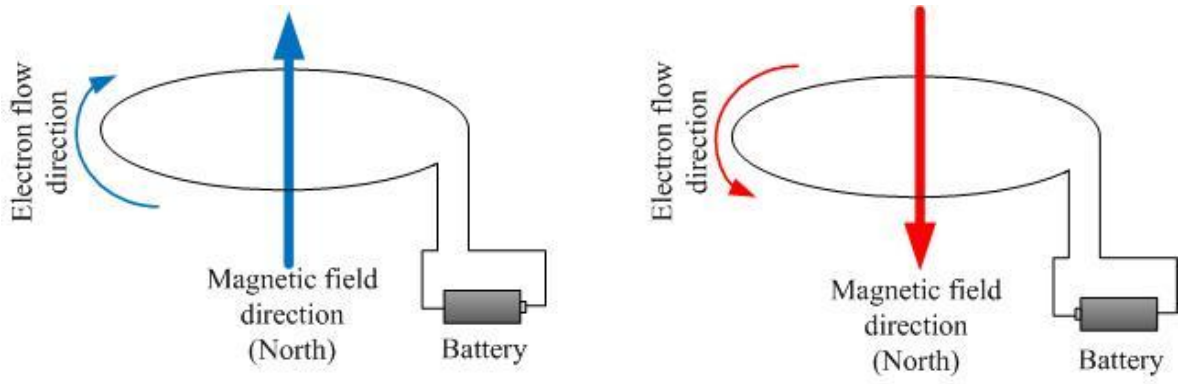

Figure 1: Magnetic fields produced by DC current in a loop of wire.
Note that the current direction is opposite to the flow of electrons in conductive wires.

In order to detect both magnetic and non-magnetic metals, the directionality of the magnetic field is switched very fast by quickly alternating the direction that the current passes through the loop. This type of current is known as alternating current (AC). When the alternating magnetic field interacts with a conductor (a metal), an opposing magnetic field is produced by the conductor. It does not matter whether the conductor is magnetic or not, an opposing magnetic field is set up in either case. The magnetic field that is produced by the loop is called the *applied* field, and the opposing magnetic field set up by the conductor is known as an *induced* magnetic field. The induced field can be detected directly by the use of a second loop of wire, or indirectly by the effect it has on the applied magnetic field. Either way, the presence of an induced magnetic field is strong evidence that a metallic object is close by. The magnetic field produced by the coils is able to penetrate through the human body and therefore able to detect metallic contraband hidden both underneath clothing and inside of body cavities as long as the metallic contraband can be placed close enough to the applied magnetic field. These devices do not produce images. In addition, they are unable to detect non-metallic contraband.

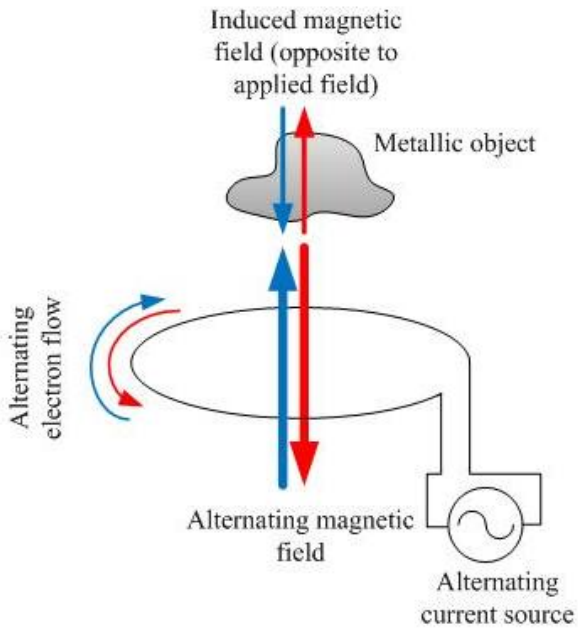

Figure 2: Alternating magnetic field induces an opposing magnetic field in a conductor Note that the current direction is opposite to the flow of electrons in conductive wires.

3.2 Types of Imaging Technologies

Other technologies have the ability to produce images that can then be examined to determine the presence of hidden contraband. To produce the images, X-rays, MMW, and thermal imaging devices can be used. If an image is produced, the image is typically inspected by security personnel in order to identify the presence of contraband. Health concerns have been raised with X-ray devices, and privacy concerns have been raised with devices that produce images with anatomical detail.

In response to privacy issues, the US Congress has disallowed the use of imaging producing devices during airport screening. Manufacturers responded by making devices that do not rely on image analysis by security personnel, but instead use computer algorithms to analyze the data without images being stored or even produced. If the algorithm detects something suspicious, security personnel are alerted by highlighted areas on a generic mannequin computer graphic. The subject then undergoes secondary screening by security personnel with a focus on the area(s) indicated by the initial scan. Privacy issues may not be as large a concern for non-public areas such as correctional facilities.

X-rays are known as ionizing radiation and are known to be a health risk under certain circumstances. The risk increases with exposure time and exposure intensity. Manufacturers attempt to minimize the intensities and the times that individuals must be exposed to X-rays when undergoing screening. Government agencies have also set limits on devices that use ionizing radiation for contraband detection.[4,5] Approved devices are tested to operate within the limits set by government agencies. However, the details and specifics of the tests are often

withheld because of security concerns. Even though these devices have been certified to operate within limits set by the government, there are some critics still question the safety aspects of devices that use ionizing radiation. Note that the European Union has also tested these devices and has disallowed their use for airport screening of passengers.[7]

Table 2: Examples of Radiation Dosages

Dose	Example
0.05 – 0.25 µSv	Dose from scanners described in this report
0.25 µSv	US limit on effective dose from a single airport security screening[8]
5 – 10 µSv	One set of dental radiographs[9]
1 mSv	US dose limit for members of the public per year[10]
1.5 – 1.7 mSv	Annual dose for flight attendants[11]
15 – 30 mSv	Single full-body CT scan[12]
500 mSv	US occupational dose limit per year[13]

3.2.1 X-Ray Screening Devices

X-ray devices come in two types – Transmission X-ray devices and Backscatter X-ray devices. Transmission X-ray devices use X-rays that pass through the body; these are the types of devices that people are most familiar with for dental and medical purposes. Backscatter X-ray devices use X-rays that are scattered off the subject and travel back toward the source of X-rays. Backscatter devices expose the subject to less ionizing radiation than transmission devices, but they do not image the interior of the body.

3.2.1.1 Transmission X-Ray

Devices that rely on transmission produce higher energy X-rays that penetrate through the subject. Materials of different composition and density absorb or reflect X-rays differently. Bones and metal objects are better able to block X-rays than soft tissue. This difference shows up on an image produced by X-rays passing through the subject to a detector. The image produced is then examined for contraband. Since transmission devices use X-rays that pass completely through the body, metallic and non-metallic contraband material concealed either on or inside the body have the potential of being detected.

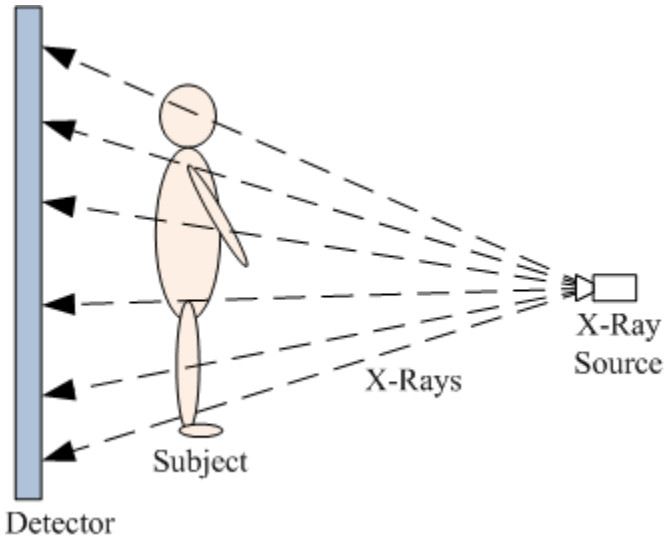

Figure 3: Transmission X-ray devices rely on X-rays passing through the subject

3.2.1.2 Backscatter X-Ray

Backscatter devices use X-rays to image through clothing, but do not image inside the human body. This is because backscatter X-ray devices use lower energy radiation that reflects off of the target to be detected from the same side as the emitter. Backscatter X-rays devices have the potential to detect metallic and non-metallic contraband hidden on a person and underneath clothing, but they would not be able to detect contraband hidden within body cavities.

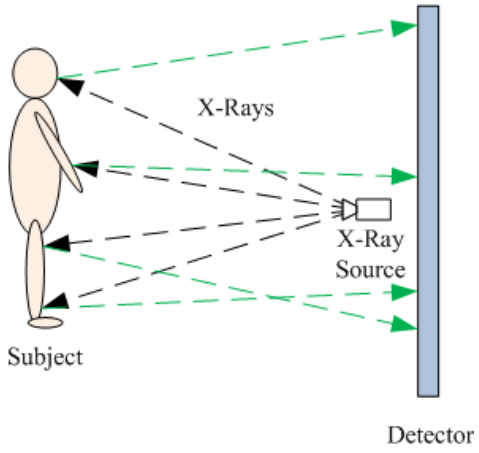

Figure 4: Backscatter X-ray devices rely on X-rays scattered from the subject

3.2.2 Millimeter Wave (MMW)

MMW are high frequency electromagnetic radio waves that have much less energy than X-rays; they are not considered ionizing radiation. The use of MMW devices is generally considered safe to the subject and the operators. MMWs are able to pass through typical clothing and bounce off of the skin's surface and other objects beneath the clothing. While an image of the subject may be produced, US Congress has disallowed the use of devices that produce images in US airports because of privacy concerns.[14] MMW devices have the potential to detect metallic and non-metallic contraband beneath clothing, but would be unable to detect contraband hidden in body cavities.

3.2.3 Thermal Conductivity

Thermal conductivity imagers does not use electromagnetic radiation to penetrate the body or clothing, but instead use slight temperature differences on the surface of clothing to detect the presence of foreign objects. Thermal conductivity relies on the ability of contraband hidden under clothing to heat or cool the surface of the clothing faster than the skin surface. Warm air is used to heat up the surface of the clothing. How fast the clothing cools is dependent, in part, on what is beneath it. Items that cool the clothing faster or slower than the surface of the skin will be identified by a thermal image of the clothing.

Images produces by this method are images of temperature variations on clothing. Privacy issues should not be a concern for this technology, nor should safety issues that are associated with the use of ionizing radiation. In principle, this technology is able to detect metallic and non-metallic contraband hidden beneath clothing, but because it images the surface of clothing, contraband hidden in body cavities would not be detected.

4.0 CONTRABAND SCREENING SYSTEMS

4.1 Millimeter Wave (MMW) Systems

MMW devices produce images of contraband beneath clothing by using extremely high frequency radio waves that are able to detect objects through typical clothing.

4.1.1 ProVision Imaging

Characteristic	Details[15, 16, 17, 18]
Model and Name	ProVision Imaging
Technology	Active Millimeter Wave
Size Class	Fixed
Dimensions	105 x 77 x 104 inches
Weight	1500 lbs
Detect Metals	Yes
Detect Non-Metals	Yes
Detect Cavity Concealed	No
Which Cavities	N/A
Size of Detected Objects	*"Detection is consistent with TSA and EU regulations for Aviation threats"*
Scan Rate	< 1.5 seconds
Inspection Time	10 – 30 seconds
Penetration Depth	2 – 4 layers of typical clothing for indoor environment
Spatial Resolution	< 0.42" (10 mm)
Info View	Full Body Image
Image Visualization	3D image ~3 seconds after scanning
Power	100/240 VAC 50/60 Hz
Regulatory & Compliance Safety	UL-61010-1, CFR Title 47 15.107 and 15.109, IEC 61000-6-3, IEEE C95.1, Safety Code 6, RSS 102, ICNIRP
Warranty	1+ Year
MSRP	GSA Schedule: $148,362.72[18]
Other	

Figure 5: ProVision Imaging
Image Reproduced with Permission

Manufacturer:
L-3 Security & Detection Systems

http://www.sds.l-3com.com/advancedimaging/provision.htm

The ProVision Imaging device is an active MMW device that is able to image metallic and non-metallic contraband including liquids, gels, rubber, wood, ceramic, powder, and explosives (both sheet and bulk). The scan can penetrate some body armor (contact vendor for specifics). It generates a three dimensional (3D) image that can be inspected by security personnel. Saved images include a scan ID, date and time stamp, and location of alarms identified. Privacy safeguards include remote viewing and body masking (face, chest, crotch, and others). ProVision Imaging systems can reveal threats smaller than the aviation regulations to an image analyst.

4.1.2 ProVision ATD

Characteristic	Details[16, 18, 19]	
Model and Name	ProVision ATD	
Technology	Active Millimeter Wave	
Size Class	Fixed	
Dimensions	105 x 77 x 104 inches	
Weight	1500 lbs	
Detect Metals	Yes	
Detect Non-Metals	Yes	
Detect Cavity Concealed	No	
Which Cavities	N/A	
Size of Detected Objects	*"Detection is consistent with TSA and EU regulations for Aviation threats"*	
Scan Rate	< 1.5 seconds	
Inspection Time	12 – 15 seconds	
Penetration Depth	2 – 4 layers of typical clothing for indoor environment within 6 seconds	
Spatial Resolution	< 0.42" (10 mm)	
Info View	Body Location Alarm	
Image Visualization	Alarm area marked on generic mannequin figure	
Power	100/240 VAC 50/60 Hz	
Regulatory & Compliance Safety	UL-61010-1, CFR Title 47 15.107 and 15.109, IEC 61000-6-3, IEEE C95.1, Safety Code 6, RSS 102, ICNIRP	
Warranty	1+ Year	
MSRP	GSA Schedule: $162,720.40[18]	
Other		

Figure 6: ProVision ATD
Image Reproduced with Permission

Manufacturer:
L-3 Security & Detection Systems

http://www.sds.l-3com.com/advancedimaging/provision-at.htm

The ProVision ATD is an active MMW device that is able to detect metallic and non-metallic contraband, including liquids, gels, rubber, wood, ceramic, powder, and explosives (both sheet and bulk). The scan can penetrate some body armor (contact vendor for specifics). Potential contraband is automatically identified by computer algorithms with no image produced. Scan ID, date, time, and location of alarms produced can also be stored. The system is completely private with contraband indications displayed on a generic mannequin figure.

4.1.3 ProVision 2

Characteristic	Details[16, 18, 20]	
Model and Name	ProVision 2	
Technology	Active Millimeter Wave	
Size Class	Fixed	
Dimensions	93 x 59 x 89 inches	
Weight	1500 lbs	
Detect Metals	Yes	
Detect Non-Metals	Yes	
Detect Cavity Concealed	No	
Which Cavities	N/A	
Size of Detected Objects	*"Detection is consistent with TSA and EU regulations for Aviation threats"*	
Scan Rate	< 1.5 seconds	
Inspection Time	12 – 15 seconds	
Penetration Depth	2 – 4 layers of typical clothing for indoor environment within 6 seconds	
Spatial Resolution	< 0.42" (10 mm)	
Info View	Body Location Alarm	
Image Visualization	Alarm area marked on generic mannequin figure	
Power	100/240 VAC 50/60 Hz	
Regulatory & Compliance Safety	UL-61010-1, CFR Title 47 15.107 and 15.109, IEC 61000-6-3, IEEE C95.1, Safety Code 6, RSS 102, ICNIRP	
Warranty	1+ Year	
MSRP	GSA Schedule: $177,078.09[18]	
Other		

Figure 7: ProVision 2
Image Reproduced with Permission

Manufacturer:
L-3 Security & Detection Systems

http://www.sds.l-3com.com/advancedimaging/provision-2.htm

The ProVision 2 is a more compact version of the ProVision ATD, and is able to be deployed in checkpoints with low (2.4 m / 8 ft) ceilings. It is an active MMW device that is able to detect metallic and non-metallic contraband, including liquids, gels, rubber, wood, ceramic, powder, and explosives (both sheet and bulk). The scan can penetrate some body armor (contact vendor for specifics). Potential contraband is automatically identified by computer algorithms with no image produced. Scan ID, date, time, and location of alarms produced can also be stored. The system is completely private with contraband indications displayed on a generic mannequin figure.

4.2 Transmission X-Ray Systems

Transmission X-ray systems use X-rays that pass through a subject to reveal contraband hidden under clothing or even inside the body of the subject.

4.2.1 RadPro SecurPASS

Characteristic	Details[21, 22, 23]
Model and Name	RadPro SecurPASS
Technology	X-ray Transmission
Size Class	Fixed
Dimensions	101 x 86 x 89 inches
Weight	1433 lbs (650 kg)
Detect Metals	Yes
Detect Non-Metals	Yes
Detect Cavity Concealed	Yes
Which Cavities	All
Size of Detected Objects	Spatial Resolution: 0.25 mm
Scan Rate	7 seconds
Inspection Time	15 – 20 seconds (based on 4 – 5 people per min)
Penetration Depth	Through Body
Spatial Resolution	0.25 mm
Info View	Full Body Image
Image Visualization	Real Time Dynamic or Scroll Bar
Power	110V, 30A
Regulatory & Compliance Safety	ETL, UL, ANSI
Warranty	1+ year
MSRP	$215,000
Other	Dose per inspection = 0.25µSv (25µREM) / scan

Figure 8: RadPro SecurPASS
Image Reproduced with Permission

Manufacturer:
Virtual Imaging Canon Security

http://www.virtualimaging-fl.com/

The SecurPASS is a transmission X-ray system that is able to detect metallic and non-metallic contraband hidden both on a person and inside the body. Example non-metallic materials that can be detected include liquids, plastic, powders, paper, and wood. Scans can penetrate ceramic body armor and steel armor up to 30 mm in thickness. Images can be stored on the device and are stamped with the time, date, scan number, subject's name, number and operator's name. The device has the ability to track the scan history of an individual or scans can be automatically saved in a "Daily No ID Folder". For privacy reasons, images can be masked and a remote viewing station can also be incorporated.

4.3 Backscatter X-Ray

Backscatter X-ray devices detect contraband beneath clothing by imaging the X-rays that scatter off a subject and their surface clothing/objects.

4.3.1 Rapiscan Secure 1000 DP

Characteristic	Details[24, 25, 26]
Model and Name	Rapiscan Secure 1000 DP
Technology	X-ray Backscatter
Size Class	Fixed
Dimensions	54 x 36 x 80 inches
Weight	1097 lbs
Detect Metals	Yes
Detect Non-Metals	Yes
Detect Cavity Concealed	No
Which Cavities	N/A
Size of Detected Objects	~0.05" (1 mm) metallic; 0.25" (~6.35 mm) non-metallic
Scan Rate	6.5 seconds
Inspection Time	24 – 30 seconds
Penetration Depth	0.25 – 0.5 inches
Spatial Resolution	~0.05" (1 mm) metallic; 0.25" (~6.35 mm) non-metallic
Info View	Full Body
Image Visualization	Static image reviewed in approximately ~15 seconds
Power	120/240 VAC @ 16/8 A
Regulatory & Compliance Safety	Safety Act Certified: ISO 9001: 2008 Certified
Warranty	1+ year
MSRP	$124,000
Other	Dose per inspection < 0.05 µSv (5 µREM)

Figure 9: Rapiscan Secure 1000 DP
Image Reproduced with Permission

Manufacturer:
Rapiscan Systems

http://www.rapiscansystems.com/en/products/item/productsrapiscan_secure_1000_dual_pose/

The Rapiscan DP is Backscatter X-ray system that is able image metallic and non-metallic contraband including liquids, gels, plastic, wood, ceramic, powder, and paper. The device is intended to image through clothing, but will not image through body armor. An image is produced and requires ~15 seconds to analyze. Face masking and remote viewing options are available for privacy concerns. Standard data records for each scan are available, including scan time, decision time, and decision result (Clear/Search). All reports are in text and/or CSV format for easy transport to standard PC programs for printing.

4.3.2 Rapiscan Secure 1000 SP

Characteristic	Details[24, 27, 26]	
Model and Name	Rapiscan Secure 1000 SP	
Technology	X-ray Backscatter	
Size Class	Fixed	
Dimensions	142 x 36 x 80 inches	
Weight	2194 lbs	
Detect Metals	Yes	
Detect Non-Metals	Yes	
Detect Cavity Concealed	No	
Which Cavities	NA	
Size of Detected Objects	~0.05" (1 mm) metallic; 0.25" (~6.35 mm) non-metallic	
Scan Rate	6.5 seconds	
Inspection Time	12 – 15 seconds	
Penetration Depth	0.25 – 0.5 inches	
Spatial Resolution	~0.05" (1 mm) metallic; 0.25" (~6.35 mm) non-metallic	
Info View	Full Body	
Image Visualization	Static image reviewed in ~15 seconds	
Power	120/230 VAC at 12/6 Amps	
Regulatory & Compliance Safety	Safety Act Certified: ISO 9001: 2008 Certified	
Warranty	1+ year	
MSRP	$220,000	
Other	Dose per inspection < 0.05 µSv (5 µREM)	

Figure 10: Rapiscan Secure 1000 DP
Image Reproduced with Permission

Manufacturer:
Rapiscan Systems

http://www.rapiscansystems.com/en/products/ps/productsrapiscan_secure_1000_single_pose/

The Rapiscan SP is a Backscatter X-ray system that is able to image metallic and non-metallic contraband including liquids, gels, plastic, wood, ceramic, powder, and paper. The device is intended to image through clothing, but will not image through body armor. An image is produced and requires ~15 seconds to analyze. Face masking and remote viewing options are available for privacy concerns. Standard data records for each scan are available including scan time, decision time, and decision result (Clear/Search). All reports are in text and/or CSV format for easy transport to standard PC programs for printing. The 1000 SP scans the front and back of a subject at once. This reduces subject interaction and improves throughput as compared to the 1000 DP.

4.3.3 SmartCheck HT

Characteristic	Details[28, 29]	
Model and Name	SmartCheck HT Inspection Module System	
Technology	X-ray Backscatter w/ Edge Transmission	
Size Class	Fixed	
Dimensions	90 x 64 x 97 inches	
Weight	3,000 lbs	
Detect Metals	Yes	
Detect Non-Metals	Yes	
Detect Cavity Concealed	No	
Which Cavities	N/A	
Size of Detected Objects	~ 1" (metallic), ~ 1 – 2" (nonmetallic)	
Scan Rate	~ 10 seconds	
Inspection Time	~ 15 seconds	
Penetration Depth	*Proprietary*	
Spatial Resolution	~ 0.08" (2 mm)	
Info View	Full Body Image	
Image Visualization	Real-Time Dynamic Imaging	
Power	120 VAC (2 20 amp circuits required)	
Regulatory & Compliance Safety	ANSI N43.17-2009, 21 CFR 1020.40, ISO 9001:2000, 29 CFR 1910, UL 61010-1A, ISO 1600, 47 CFR 15	
Warranty	1+ year	
MSRP	$195,000	
Other	Dose per scan < 0.1 µSv (10 µREM)	

Figure 11: SmartCheck HT
Image Reproduced with Permission

Manufacturer:
American Science & Engineering (AS&E)

http://as-e.com/products-solutions/personnel-screening/checkpoint-lobby/product/smartcheck-ht/

The SmartCheck HT system is a dual Backscatter X-ray system capable of taking three images simultaneously: two backscatter images (front and back) and one transmission image used to identify metallic threats on the edges of the subjects image. The system can detect non-metallic objects, such as liquids, gels, plastic, wood, ceramic, powder, and paper. The device is able to penetrate non-metallic body armor, and up to 0.25" thickness of steel armor. Photo-like images are produced; the system has the capacity to store 15,000 images in non-volatile media. The system can be configured with export to TIF and/or printing. Remote viewing and image modification (production of an outline of the raw image) are available for privacy concerns.

4.3.4 SmartCheck

Characteristic	Details[28, 30]	
Model and Name	SmartCheck Inspection Module System	
Technology	X-ray Backscatter	
Size Class	Fixed	
Dimensions	90 x 64 x 34 inches	
Weight	1,500 lbs	
Detect Metals	Yes	
Detect Non-Metals	Yes	
Detect Cavity Concealed	No	
Which Cavities	N/A	
Size of Detected Objects	~ 1" (metallic), ~1 – 2" (nonmetallic)	
Scan Rate	~ 10 seconds	
Inspection Time	30 – 45 seconds (two scans / person)	
Penetration Depth	*Proprietary*	
Spatial Resolution	~0.08" (2 mm)	
Info View	Full Body Image	
Image Visualization	Real-Time Dynamic Imaging	
Power	110/220 VAC 50/60 Hz	
Regulatory & Compliance Safety	ANSI N43.17-2009, 21 CFR 1020.40, ISO 9001:2000, 29 CFR 1910, UL 61010-1A, ISO 1600, 47 CFR 15	
Warranty	1+ Year	
MSRP	$100,000	
Other	Dose per scan < 0.1 µSv (10 µREM)	

Figure 12: SmartCheck
Image Reproduced with Permission

Manufacturer:
AS&E

http://as-e.com/products-solutions/personnel-screening/checkpoint-lobby/product/smartcheck/

The SmartCheck system is a Backscatter X-ray system able to detect metallic and non-metallic contraband including liquids, gels, plastic, wood, ceramic, powder, and paper. The device is able to detect contraband underneath non-metallic body armor. Photo-like images are produced; the system has the capacity to store 15,000 images in non-volatile media. Remote viewing and image modification (production of an outline of the raw image) are available for privacy concerns. Unlike the SmartCheck HT model, the SmartCheck scans only one side of the subject at a time, and does not have the option to check the edges of a subject using a transmission type mode.

4.4 Thermal Conductivity

Thermal conductivity devices detect contraband underneath typical clothing by imaging slight changes in temperature that occur on the surface of clothing from concealed objects.

4.4.1 Iscon 1000D Portal

Characteristic	Details[31,32]
Model and Name	1000D Portal
Technology	Thermo Conductive IR
Size Class	Fixed
Dimensions	97 x 51 x 45 inches
Weight	800 lbs
Detect Metals	Yes
Detect Non-Metals	Yes
Detect Cavity Concealed	No
Which Cavities	N/A
Size of Detected Objects	Approximately the size of a single 500 mg pill
Scan Rate	Varies
Inspection Time	~30 seconds
Penetration Depth	2 – 3 layers of cotton clothing
Spatial Resolution	~ 0.04 – 0.1” (1 – 3 mm)
Info View	Region or Full Body Image
Image Visualization	Real Time Imaging
Power	208 VAC, 10KW
Regulatory & Compliance Safety	UL / CE Compliant
Warranty	1+ year
MSRP	$110,000
Other	

Figure 13: Iscon 1000D
Image Reproduced with Permission

Manufacturer:
Iscon Imaging

http://isconimaging.com/iscon1000d.htm

The Iscon 1000D Portal system is a thermal conductivity based system that is able to detect metallic and non-metallic contraband including liquids, gels, plastic, wood, ceramic, powder, and paper hidden underneath clothing. The device is not able to detect contraband underneath body armor. Subtle temperature differences of the subjects clothing are imaged. Because clothing is imaged, privacy issues are minimized. Streaming video and individual images can be saved and/or printed.

4.4.2 1000M Mini Portal

Characteristic	Details[31, 33]	
Model and Name	1000M Mini Portal	
Technology	Thermo Conductive IR	
Size Class	Fixed	
Dimensions	91 x 59 x 37 inches	
Weight	300 lbs	
Detect Metals	Yes	
Detect Non-Metals	Yes	
Detect Cavity Concealed	No	
Which Cavities	N/A	
Size of Detected Objects	Approximately the size of a single 500mg pill	
Scan Rate	Varies	
Inspection Time	~7 – 11 seconds	
Penetration Depth	2 – 3 layers of cotton clothing	
Spatial Resolution	~ 0.04 – 0.1” (1 – 3 mm)	
Info View	Region or Full body image	
Image Visualization	Real Time Imaging	
Power	208 VAC, 30 A	
Regulatory & Compliance Safety	UL / CE Compliant	
Warranty	1+ yr	
MSRP	$75,000	
Other		

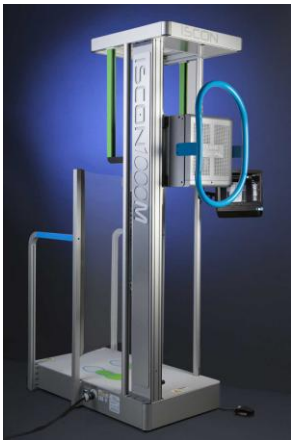

Figure 14: Mini Portal
Image Reproduced with Permission

Manufacturer:
Iscon Imaging

http://isconimaging.com/miniportal.htm

The Iscon 1000M Mini Portal system is a thermal conductivity based system that is able to detect metallic and non-metallic contraband including liquids, gels, plastic, wood, ceramic, powder, and paper hidden underneath clothing. The device is not able to detect contraband underneath body armor. Subtle temperature differences of the subjects clothing are imaged. Because clothing is imaged, privacy issues are minimized. Streaming video and individual images can be saved and/or printed.

4.4.3 GameChangIR

Characteristic	Details[31, 34]	
Model and Name	GameChangeIR	**No Image Available** Manufacturer: **Iscon Imaging** http://isconimaging.com/gamechangeir.htm
Technology	Thermo Conductive IR	
Size Class	Portable	
Dimensions	32 x 18 x 11 inches	
Weight	80 lbs	
Detect Metals	Yes	
Detect Non-Metals	Yes	
Detect Cavity Concealed	No	
Which Cavities	N/A	
Size of Detected Objects	Approximately the size of a single 500mg pill	
Scan Rate	Varies	
Inspection Time	Varies	
Penetration Depth	2 – 3 layers of cotton clothing	
Spatial Resolution	~ 0.04 – 0.1” (1 – 3 mm)	
Info View	Region or Full body image	
Image Visualization	Real Time Imaging	
Power	110/220 VAC 50-60Hz	
Regulatory & Compliance Safety	UL / CE Compliant	
Warranty	1+ yr	
MSRP	$25,000	
Other		

The Iscon GameChangeIR system is a thermal conductivity based system that is able to detect metallic and non-metallic contraband including liquids, gels, plastic, wood, ceramic, powder, and paper hidden underneath clothing. The device is not able to detect contraband underneath body armor. Subtle temperature differences of the subjects clothing are imaged. Because clothing is imaged, privacy issues are minimized. Streaming video and individual images can be saved and/or printed. The entire system is portable and folds into its own compact suitcase for re-location or other transportation

4.5 Metal Detection

No responses were received from the RFI by manufacturers of metal detection based systems. Readers are encouraged to investigate other references on walk-through metal detectors prepared for the Department of Homeland Security (DHS) System Assessment and Validation for Emergency Responders (SAVER) Program, such as:

- *Walk-Through Metal Detectors Markey Survey Report* by National Urban Security Technology Laboratory (NUSTL) (pending 2014)[35]
- *TechNote: Metal Detectors for Personnel Screening* by Space and Naval Warfare Center (SPAWAR) Atlantic (2009)[36]
- *Walk-Through Metal Detectors Market Survey Report* by Naval Surface Warfare Center Dahlgren Division (NSWCDD) (2006)[37]

4.5.1 BOSS Series (Xeku Corporation)

The SSBT CoE identified one set of metal detection based screening devices that appears to be specifically targeted for the detection of metallic contraband hidden inside body cavities. The Body Orifice Security Scanners (BOSS) series of products from Xeku Corporation are chairs that the subject interacts with in order to be scanned for metallic contraband.[38] Four models are currently listed on the website – Standard BOSS 2-Zone[39], BOSS III 3-Zone[40], Big BOSS 4-Zone[41], and the BOSS II 5-Zone[42].

Presumably, these models have metal detection circuitry imbedded in the chairs at specific locations that are capable of detecting metallic contraband hidden inside body cavities. The different zones are able to check different body areas depending on the proximity of the subject. The BOSS 2-Zone is able to scan the oral and the anal/vaginal areas, the BOSS III also scans the oral and the anal/vaginal areas and adds the capability to scan the abdominal area; the Big BOSS 4-Zone includes the oral, anal/vaginal, and abdominal areas and adds the capability to scan a subjects feet; finally the BOSS II 5-Zone can scan all the areas scanned by the Big BOSS4-Zone model plus the area of the upper legs.

More information about the BOSS line of products and their capabilities can be found on the Xeku website (http://xekucorp.com/welcome/products/b-o-s-s/).

5.0 BCS TECHNICAL SUMMARY COMPARISON

Table 3: Technical Summary Comparison

Device	Detect Metals	Detect Non-Metals	Detect Cavity Concealed	Total Inspection Time	Information View	Technology
ProVision Imaging	Yes	Yes	No	10 – 30 seconds	Full Body Image	Active MMW
ProVision ATD	Yes	Yes	No	12 – 15 seconds	Body Location Alarm	Active MMW
ProVision 2	Yes	Yes	No	12 – 15 seconds	Body Location Alarm	Active MMW
RadPro SecurPASS	Yes	Yes	Yes	15 – 20 seconds	Full Body Image	X-ray Transmission
Rapiscan Secure 1000 DP	Yes	Yes	No	24 – 30 seconds	Full Body Image	X-ray Backscatter
Rapiscan Secure 1000 SP	Yes	Yes	No	12 – 15 seconds	Full Body Image	X-ray Backscatter
SmartCheck HT	Yes	Yes	No	15 seconds	Full Body Image	X-ray Backscatter
SmartCheck	Yes	Yes	No	30 – 45 seconds	Full Body Image	X-ray Backscatter
1000D Portal	Yes	Yes	No	30 seconds	Region or Full Body Image	Thermo Conductive IR
1000M Mini Portal	Yes	Yes	No	7 – 11 seconds	Region or Full Body Image	Thermo Conductive IR
GameChangIR	Yes	Yes	No	Varies	Region or Full Body Image	Thermo Conductive IR
Standard BOSS 2-Zone	Yes	No	Yes	*Not Specified*	Audible and Visual Alarm	Metal Detection
BOSS III 3-Zone	Yes	No	Yes	*Not Specified*	Audible and Visual Alarm	Metal Detection
Big BOSS 4-Zone	Yes	No	Yes	*Not Specified*	Audible and Visual Alarm	Metal Detection
BOSS II 5-Zone	Yes	No	Yes	*Not Specified*	Audible and Visual Alarm	Metal Detection

6.0 CONCLUSIONS

Of all the technologies listed, only Transmission X-ray devices can detect metallic and non-metallic contraband hidden underneath clothing as well as contraband hidden inside body cavities. Metal detection has the capability to detect metallic objects hidden both on a person and inside body cavities. However, metal detection based technologies do not have the ability to detect non-metallic contraband. Backscatter X-ray, MMW, and thermal imaging devices are able to detect metallic and non-metallic contraband hidden on a person (underneath clothing). They would not be able to detect contraband hidden inside body cavities.

APPENDIX A: ACRONYMS, ABBREVIATIONS, AND REFERENCES

A.1 Acronyms and Abbreviations

ACRONYM	DESCRIPTION
AC	Alternating Current
ANSI	American National Standards Institute
AS&E	American Science & Engineering
BCS	Body Cavity Screening
BOSS	Body Orifice Security Scanner
CDRH	Center for Devices and Radiological Health
CE	Conformité Européenne
CoE	Center of Excellence
CSV	Comma Separated Variable
DC	Direct Current
DOJ	Department of Justice
DP	Dual Pose
ETL	Electrical Testing Laboratories
ETU	Electrical Trade Union
EU	European Union
FCC	Federal Communications Commission
GSA	General Services Administration
HT	High Throughput
ICNIRP	International Commission on Non-Ionizing Radiation Protection
ID	Identification
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IR	Infrared
ISO	International Organization for Standardization
MMW	Millimeter Wave
MSRP	Manufacturer's Suggested Retail Price
NA	Not Applicable
NIJ	National Institute of Justice
NLECTC	National Law Enforcement and Corrections Technology
NRC	Nuclear Regulatory Commission
NSWCDD	Naval Surface Warfare Center Dahlgren Division

ACRONYM	DESCRIPTION
NUSTL	National Urban Security Technology Laboratory
OSHA	Occupational Safety and Health Administration
PC	Personal Computer
REM	Roentgen Equivalent Man
RFI	Request for Information
RSS	Radio Standards Specifications
SDS	Security & Detection Systems
SP	Single Pose
SPAWAR	Space and Naval Warfare Center
SSBT	Sensors, Surveillance, and Biometric Technologies
Sv	Sievert
TIF	Tagged Image File
TSA	Transportation Security Administration
TUV	Technischer Überwachungsverein
UL	Underwriters Laboratory
US	United Stated
VAC	Volts AC
RFI	Request for Information
RSS	Radio Standards Specifications
SDS	Security & Detection Systems
SP	Single Pose
SSBT	Sensors, Surveillance, and Biometric Technologies
TIF	Tagged Image File
TSA	Transportation Security Administration
TUV	Technischer Überwachungsverein
UL	Underwriters Laboratory
US	United Stated
VAC	Volts AC

A.2 References

[1] NLECTC, *An Introduction to Portal Contraband Detection Technology*, https://www.justnet.org/pdf/00-Portal%20Primer_web.pdf (June 2010).

[2] NLECTC; *Sensor, Surveillance, and Biometric Technologies Center of Excellence;* https://www.justnet.org/our_centers/coes/sensor-tce.html (Accessed March 27, 2014).

[3] Federal Register; "Contraband Screening for Criminal Justice Applications;" 78 FR 76860, p. 76860; https://federalregister.gov/a/2013-30241 (December 19, 2013).

[4] FDA; *Products for Security Screening of People*; http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/SecuritySystems/ucm227201.htm (Accessed March 27, 2014).

[5] FDA; *Very Low Health Risks from Full-Body X-ray Scanners*; http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm231758.htm (Accessed March 27, 2014).

[6] Scribd; *UCSF Letter to Holden Concerning Health Risks of Full Body Scanner TSA Screenings 4-6-2012*; http://www.scribd.com/doc/35498347/UCSF-letter-to-Holdren-concerning-health-risks-of-full-body-scanner-TSA-screenings-4-6-2010 (Accessed March 27, 2014).

[7] Scientific American; *Europe Bans X-Ray Body Scanners Used at U.S. Airports;* www.scientificamerican.com/article/europe-bans-x-ray-body-scanners/ (Accessed March 27, 2014).

[8] Health Physics Society, *Use of Ionizing Radiation for Security Screening Individuals,* http://hps.org/documents/securityscreening_ps017-1.pdf (December 2009).

[9] D. Hart and B.F. Wall, National Radiological Protection Board; *Radiation Exposure of the UK Population from Medical and Dental X-ray Examinations;* http://cloud.medicalphysicist.co.uk/nrpb_w4.pdf (March 2002).

[10] Nuclear Regulatory Commission (NRC), *Subpart D—Radiation Dose Limits for Individual Members of the Public,* http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-1301.html (Accessed April 23, 2014).

[11] Barbara Grajewski, et al.; "Radiation dose estimation for epidemiologic studies of flight attendants," *American Journal of Industrial Medicine* 41, pp. 27-37 (January 2002).

[12] David Brenner and Eric Hall; "Computed Tomography – An Increasing Source of Radiation Exposure," *The New England Journal of Medicine* 357, pp. 2277-2284 (November 29, 2007).

[13] NRC, *Subpart C—Occupational Dose Limits,* http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/part020-1201.html (Accessed April 23, 2014).

[14] Mike Ahlers, CNN; *TSA removes body scanners criticized as too revealing;* http://www.cnn.com/2013/05/29/travel/tsa-backscatter (Accessed April 22, 2014).

[15] Ronald Allman, L3 Security & Detection Systems; *L-3 ProVision response to NIJ SSBT CoE Contraband Screen RFI Worksheet v1.pdf (*January 21, 2014).

[16] L3 Security & Detection Systems; *Advanced Personnel Screening;* http://www.sds.l-3com.com/products/advancedimagingtech.htm (Accessed March 27, 2014).

[17] L3 Security & Detection Systems; *Provision: Advanced People Screening;* http://www.sds.l-3com.com/advancedimaging/provision.htm (Accessed March 27, 2014).

[18] *General Services Administration (GSA) Federal Acquisition Service (FAS), Authorized Federal Supply Schedule Price List*, February 26, 2014; Available at https://www.gsaadvantage.gov/ref_text/GS07F5377P/0MKTOQ.2S4H7L_GS07F5377P_GS-07F-5377P-3-6-2014-402068.PDF (Accessed March 27, 2014).

[19] L3 Security & Detection Systems; *Provision ATD: Advanced Imaging Technology*; http://www.sds.l-3com.com/advancedimaging/provision-at.htm (Accessed March 27, 2014).
[20] L3 Security & Detection Systems; *Provision 2: Advanced Imaging Technology*; http://www.sds.l-3com.com/advancedimaging/provision-2.htm (Accessed March 27, 2014).
[21] Dennis Wolfe, Virtual Imaging; *NIJ SSBT CoE Contraband Screen RFI Worksheet v1 sl.docx* (January 21, 2014).
[22] Virtual Imaging, Inc.; *Virtual Imaging, Inc. A Canon U.S.A. Company – Interim Home Page;* http://www.virtualimaging-fl.com/ (Accessed March 27, 2014).
[23] Virtual Imaging, Inc.; *Digital Security Screening System: SecurPASS: Full Body Security Screening System* (2012); http://www.crescentcitysecurity.net/docs/SecurPASS.pdf (Accessed March 27, 2014).
[24] Sean Bullock, Rapiscan Systems; *NIJ SSBT CoE Contraband Screen RFI Worksheet v1 S1K version.docx* (January 21, 2014).
[25] Rapiscan Systems; *Rapiscan Secure 1000 DP*; http://www.rapiscansystems.com/en/products/item/productsrapiscan_secure_1000_dual_pose/ (Accessed March 27, 2014).
[26] Rapiscan Systems, *Rapiscan Secure 1000 Health and Safety Fact Sheet,* http://www.rapiscansystems.com/extranet/downloadFile/24_Rapiscan%20Secure%201000-Health%20and%20Safety-Fact%20Sheet.pdf (May 2012).
[27] Rapiscan Systems; *Rapiscan Secure 1000 SP*; http://www.rapiscansystems.com/en/products/ps/productsrapiscan_secure_1000_single_pose/ (Accessed March 27, 2014).
[28] Art Delgado, AS&E; *SmartCheck Technical Proposal – RFI Response.pdf* (March 12, 2014).
[29] AS&E; *SmartCheck HT – American Science & Engineering*; http://as-e.com/products-solutions/personnel-screening/checkpoint-lobby/product/smartcheck-ht/ (Accessed March 27, 2014).
[30] AS&E; *SmartCheck – American Science & Engineering*; http://as-e.com/products-solutions/personnel-screening/checkpoint-lobby/product/smartcheck/ (Accessed March 27, 2014).
[31] Doug Branscombe, Iscon Imaging; *NIJ SSBT CoE Contraband Screen RFI Worksheet v1 Iscon.docx* (February 2, 2014).
[32] Iscon Imaging, *Iscon 1000D*, http://isconimaging.com/iscon1000d.htm (Accessed April 4, 2014).
[33] Iscon Imaging, *Mini Portal Datasheet*, http://isconimaging.com/PDFs/Miniportal%20DS%204-2012.pdf (April 2012).
[34] Iscon Imaging, *GameChangeIR Datasheet*, http://isconimaging.com/PDFs/datasheet_gamechangeir_final.pdf (October 2010).
[35] NUSTL, *Walk-Through Metal Detectors Markey Survey Report*, Prepared for the DHS SAVER Program (pending 2014).
[36] SPAWAR Atlantic, *TechNote: Metal Detectors for Personnel Screening*, Prepared for the DHS SAVER Program, http://www.firstresponder.gov/Saver/MetalDetectPersonScreen_TN.pdf (July 2009).
[37] NSWCDD, *Walk-Through Metal Detectors (WTMD) Market Survey Report*, Prepared for the DHS SAVER Program, http://www.firstresponder.gov/Saver/WalkThrMetalDetect_HLT.pdf (July 2006).

[38] Xeku; *B.O.S.S. Models*; http://www.bodyorificescanner.com/us/ (Accessed March 27, 2014).
[39] Xeku; *Standard BOSS 2-Zone*; http://www.bodyorificescanner.com/us/b-o-s-s-models/standard-boss-2-zone/ (Accessed March 27, 2014).
[40] Xeku; *BOSS III 3-Zone*; http://www.bodyorificescanner.com/us/b-o-s-s-models/boss-iii-3-zone/ (Accessed March 27, 2014).
[41] Xeku; *Big BOSS 4-Zone*; http://www.bodyorificescanner.com/us/b-o-s-s-models/big-boss-4-zone/ (Accessed March 27, 2014).
[42] Xeku; *BOSS II 5-Zone*; http://www.bodyorificescanner.com/us/b-o-s-s-models/boss-ii-5-zone/ (Accessed March 27, 2014).