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# Body Cavity Screening for Criminal Justice: Market Survey

(Version 1.1)

DOJ Office of Justice Programs National Institute of Justice

Sensor, Surveillance, and Biometric Technologies (SSBT) Center of Excellence (CoE)



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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.<sup>[11]</sup> 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.<sup>[2]</sup> 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.

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### **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 (<u>https://federalregister.gov/a/2013-30241</u>).<sup>[3]</sup> 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

Infor	mation Categories
1.	Model Number and Name of the screening system/device.
2.	<b>Technology</b> 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.	<b>Physical Dimensions</b> of the system/device.
5.	Weight of the system/device.
6.	Whether the system/device <b>Detects Metal</b> objects.
	If YES, whether there are any types of metals that are NOT detected by the system.
7.	Whether the system/device <b>Detects Non-Metal</b> 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 <b>Concealed within Body Cavities</b> . 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 <b>Detected Size</b> of objects on a person and concealed within body cavities.
10.	Scan Rate of the system/device.
11.	<b>Total Inspection Time</b> per individual screened with the system/device (i.e. Throughput).
12.	<b>Penetration Depth</b> of the system/device's scan when used on a clothed person.

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Infor	mation Categories
13.	Whether the system/device scan penetrates concealed <b>Body Armor</b> . If so, what classifications or types of armor can be imaged through.
14.	<b>Spatial Resolution</b> 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 <b>Information View</b> 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 <b>Privacy</b> safeguards or features (e.g., remote viewing, body masking).
17.	<b>Image Visualization Time</b> of the system/device – Alarm Only, Real-Time Dynamic Imaging, Delayed Dynamic Imaging, or Static Imaging.
18.	<b>Data Management</b> provided for images and alarms, with respect to saving, archiving, retrieving, and printing subject scan information.
19.	Power requirements of the system/device.
20.	<b>Regulatory &amp; Compliance Safety</b> 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.	<b>Other</b> information or notes that is relevant to the system/device.

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#### 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.

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#### **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 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.<sup>[4,5]</sup> Even so, concerns regarding the safe use of X-rays to scan individuals can be an issue.<sup>[6]</sup> 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.

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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.

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# 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**

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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.<sup>[4,5]</sup> Approved devices are tested to operate within the limits set by government agencies. However, the details and specifics of the tests are often

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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.<sup>[7]</sup>

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

#### Table 2: Examples of Radiation Dosages

#### **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.

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#### 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

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#### 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.<sup>[14]</sup> 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.

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#### 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	<b>Details</b> <sup>[15, 16, 17, 18]</sup>	
Model and	DroVision Imaging	
Name	Provision imaging	
Technology	Active Millimeter Wave	
Size Class	Fixed	
Dimensions	105 x 77 x 104 inches	(B)Provision
Weight	1500 lbs	
<b>Detect Metals</b>	Yes	
Detect Non-	Vas	
Metals	165	
Detect Cavity	No	
Concealed	INO	
Which Cavities	N/A	
Size of Detected	"Detection is consistent with TSA and EU regulations"	
Objects	for Aviation threats"	
Scan Rate	< 1.5 seconds	Figure 5: ProVision
Inspection Time	10-30 seconds	Imaging
Penetration	2-4 layers of typical clothing for indoor environment	Image Reproduced with
Depth	2 4 hayers of typical clothing for indoor chynolinient	Permission
Spatial	< 0.42" (10 mm)	
Resolution	(0.12 (10 mm))	Manufacturer
Info View	Full Body Image	I -3 Socurity &
Image	3D image ~3 seconds after scanning	Detection Systems
Visualization	55 mage 5 seconds after seaming	Detection Systems
Power	100/240 VAC 50/60 Hz	
<b>Regulatory &amp;</b>	UL-61010-1, CFR Title 47 15.107 and 15.109, IEC	http://www.sds.l-
Compliance	61000-6-3, IEEE C95.1, Safety Code 6, RSS 102,	3com.com/advancedimagi
Safety	ICNIRP	ng/provision.htm
Warranty	1+ Year	
MSRP	GSA Schedule: \$148,362.72 <sup>[18]</sup>	
Other		

The ProVision Imaging device is an active MMW device that is able to image metallic and nonmetallic 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.

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#### 4.1.2 ProVision ATD

Characteristic	Details <sup>[16, 18, 19]</sup>	
Model and	DraVision ATD	
Name	Provision AID	
Technology	Active Millimeter Wave	
Size Class	Fixed	
Dimensions	105 x 77 x 104 inches	
Weight	1500 lbs	1 Elevendration
<b>Detect Metals</b>	Yes	
Detect Non-	Vas	
Metals	1 85	
Detect Cavity	No	
Concealed	INO	
Which Cavities	N/A	
Size of Detected	"Detection is consistent with TSA and EU regulations	
Objects	for Aviation threats"	
Scan Rate	< 1.5 seconds	
Inspection Time	12-15 seconds	Figure 6: ProVision ATD
Penetration	2-4 layers of typical clothing for indoor environment	Image Reproduced with
Depth	within 6 seconds	Permission
Spatial Resolution	< 0.42" (10 mm)	Manufaaturar
Info View	Body Location Alarm	I 2 Security & Detection
Imoview	body Location Alarm	L-5 Security & Detection
Visualization	Alarm area marked on generic mannequin figure	Systems
Power	100/240 VAC 50/60 Hz	http://www.adal
<b>Regulatory &amp;</b>	UL-61010-1, CFR Title 47 15.107 and 15.109, IEC	<u>Intp://www.sus.i-</u>
Compliance	61000-6-3, IEEE C95.1, Safety Code 6, RSS 102,	<u>scom.com/advancedimagi</u>
Safety	ICNIRP	<u>ng/provision-at.htm</u>
Warranty	1+ Year	
MSRP	GSA Schedule: \$162,720.40 <sup>[18]</sup>	
Other	· · · · · · · · · · · · · · · · · · ·	

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.

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#### 4.1.3 ProVision 2

Characteristic	<b>Details</b> <sup>[16, 18, 20]</sup>	
Model and	DroVision 2	
Name	PTO VISION 2	
Technology	Active Millimeter Wave	
Size Class	Fixed	
Dimensions	93 x 59 x 89 inches	ProVision'
Weight	1500 lbs	
<b>Detect Metals</b>	Yes	
Detect Non-	Vac	
Metals	103	<b>⊨</b>
Detect Cavity	No	
Concealed	110	
Which Cavities	N/A	
Size of Detected	"Detection is consistent with TSA and EU regulations	
Objects	for Aviation threats"	
Scan Rate	< 1.5 seconds	Figure 7: ProVision 2
Inspection Time	12 - 15 seconds	Image Reproduced with
Penetration	2-4 layers of typical clothing for indoor environment	Permission
Depth	within 6 seconds	
Spatial	< 0.42" (10 mm)	Manufacturer:
Resolution		L-3 Security &
Info View	Body Location Alarm	Detection Systems
Image	Alarm area marked on generic mannequin figure	Detection Systems
Visualization	marin area marked on generie maniequin rigure	http://www.edel
Power	100/240 VAC 50/60 Hz	<u>antp://www.sus.r-</u>
<b>Regulatory &amp;</b>	UL-61010-1, CFR Title 47 15.107 and 15.109, IEC	<u>scom.com/advancedima</u>
Compliance	61000-6-3, IEEE C95.1, Safety Code 6, RSS 102,	ging/provision-2.htm
Safety	ICNIRP	
Warranty	1+ Year	
MSRP	GSA Schedule: \$177,078.09 <sup>[18]</sup>	
Other		

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	<b>Details</b> <sup>[21, 22, 23]</sup>	
Model and		
Name	RadPro SecurPASS	1 100 - 100 M
Technology	X-ray Transmission	
Size Class	Fixed	
Dimensions	101 x 86 x 89 inches	-
Weight	1433 lbs (650 kg)	
<b>Detect Metals</b>	Yes	
Detect Non-	Vac	
Metals	Tes	
Detect Cavity	Ves	
Concealed	105	
Which Cavities	All	
Size of Detected	Spatial Pasalution: 0.25 mm	
Objects	Spatial Resolution: 0.25 min	Figure 8: RadPro
Scan Rate	7 seconds	SecurPASS
Inspection Time	15-20 seconds (based on $4-5$ people per min)	Image Reproduced with
Penetration	Through Body	Permission
Depth	Through Dody	
Spatial	0.25 mm	Manufacturer:
Resolution	0.25 mm	Virtual Imaging
Info View	Full Body Image	Canon Security
Image	Real Time Dynamic or Scroll Bar	<i>.</i>
Visualization	Real Time Dynamic of Scron Dar	http://www.virtualimagi
Power	110V, 30A	ng-fl.com/
<b>Regulatory &amp;</b>		<u>ing-in.com/</u>
Compliance	ETL, UL, ANSI	
Safety		
Warranty	1+ year	
MSRP	\$215,000	
Other	Dose per inspection = $0.25\mu$ Sv ( $25\mu$ REM) / scan	

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.

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#### 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 <sup>[24, 25, 26]</sup>	
Model and	Raniscan Secure 1000 DP	
Name	Rapiscan Secure 1000 DI	<b>B</b>
Technology	X-ray Backscatter	
Size Class	Fixed	
Dimensions	54 x 36 x 80 inches	
Weight	1097 lbs	
<b>Detect Metals</b>	Yes	
Detect Non-	Vas	
Metals	165	
Detect Cavity	No	
Concealed	NO	
Which Cavities	N/A	
Size of Detected	~0.05" (1 mm) metallic; 0.25" (~6.35 mm) non-	
Objects	metallic	
Scan Rate	6.5 seconds	
<b>Inspection Time</b>	24 - 30 seconds	Figure 9: Rapiscan
Penetration	0.25 0.5 inches	Secure 1000 DP
Depth	0.23 - 0.3 menes	Image Reproduced with
Spatial	~0.05" (1 mm) metallic; 0.25" (~6.35 mm) non-	Permission
Resolution	metallic	
Info View	Full Body	Manufacturer:
Image	Static image reviewed in approximately 15 seconds	Rapiscan Systems
Visualization	Static image reviewed in approximately ~15 seconds	
Power	120/240 VAC @ 16/8 A	http://www.rapiscansyst
<b>Regulatory &amp;</b>	Safaty Act Cartified	ems.com/en/products/ite
Compliance	ISO 0001: 2008 Cartified	m/productsrapiscan_sec
Safety	150 9001. 2008 Certified	ure 1000 dual poso/
Warranty	1+ year	<u>ure_1000_uuai_pose/</u>
MSRP	\$124,000	
Other	Dose per inspection $< 0.05 \ \mu Sv \ (5 \ \mu REM)$	

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	<b>Details</b> <sup>[24, 27, 26]</sup>	
Model and	Raniscan Secure 1000 SP	
Name	Rapiscan Secure 1000 St	
Technology	X-ray Backscatter	
Size Class	Fixed	
Dimensions	142 x 36 x 80 inches	
Weight	2194 lbs	
<b>Detect Metals</b>	Yes	
Detect Non-	Ves	(# <mark>44</mark> #)
Metals	105	
Detect Cavity	No	
Concealed	140	
Which Cavities	NA	
Size of Detected	~0.05" (1 mm) metallic; 0.25" (~6.35 mm) non-	
Objects	metallic	Figure 10: Rapiscan
Scan Rate	6.5 seconds	Secure 1000 DP
Inspection Time	12 - 15 seconds	Image Reproduced with
Penetration	0.25  0.5 inches	Permission
Depth	0.25 – 0.5 menes	
Spatial	~0.05" (1 mm) metallic; 0.25" (~6.35 mm) non-	Manufacturer:
Resolution	metallic	Rapiscan Systems
Info View	Full Body	
Image	Static image reviewed in 15 seconds	http://www.rapiscansyst
Visualization	Static Illiage reviewed III ~15 seconds	ems.com/en/products/ps/
Power	120/230 VAC at 12/6 Amps	productsrapiscan secure
<b>Regulatory &amp;</b>	Safaty Act Cartified	1000 single pose/
Compliance	Salety Act Certified	pose/
Safety	ISO 9001. 2008 Cerunieu	
Warranty	1+ year	
MSRP	\$220,000	
Other	Dose per inspection $< 0.05 \ \mu$ Sv (5 $\mu$ REM)	

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	<b>Details</b> <sup>[28, 29]</sup>	
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	15 E
Weight	3,000 lbs	
<b>Detect Metals</b>	Yes	
Detect Non- Metals	Yes	
Detect Cavity Concealed	No	
Which Cavities	N/A	
Size of Detected Objects	~ 1" (metallic), ~ $1 - 2$ " (nonmetallic)	Figure 11: SmartCheck HT
Scan Rate	~ 10 seconds	Image Reproduced with
Inspection Time	~ 15 seconds	Permission
Penetration Depth	Proprietary	Manufacturer:
Spatial Resolution	~ 0.08" (2 mm)	American Science & Engineering (AS&E)
Info View	Full Body Image	
Image Visualization	Real-Time Dynamic Imaging	<u>http://as-</u> e.com/products-
Power	120 VAC (2 20 amp circuits required)	solutions/personnel-
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	screening/checkpoint- lobby/product/smartchec
Warranty	1+ year	<u>K-nt/</u>
MSRP	\$195,000	1
Other	Dose per scan $< 0.1 \ \mu$ Sv (10 $\mu$ REM)	

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.

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#### 4.3.4 SmartCheck

Characteristic	<b>Details</b> <sup>[28, 30]</sup>	
Model and	SmartChack Inspection Module System	
Name	Smartcheck inspection Module System	
Technology	X-ray Backscatter	
Size Class	Fixed	
Dimensions	90 x 64 x 34 inches	smartCheck
Weight	1,500 lbs	
<b>Detect Metals</b>	Yes	
Detect Non-	Vec	
Metals	105	
Detect Cavity	No	
Concealed	110	
Which Cavities	N/A	
Size of Detected	~ 1" (metallic) ~ 1 – 2" (nonmetallic)	
Objects	(inclusio), 41 2 (infinite ante)	
Scan Rate	~ 10 seconds	Figure 12: SmartCheck
Inspection Time	30-45 seconds (two scans / person)	Image Reproduced with
Penetration	Proprietary	Permission
Depth	Тторпецату	
Spatial	~0.08" (2 mm)	Manufacturer:
Resolution	0.00 (2 mm)	AS&E
Info View	Full Body Image	
Image	Real-Time Dynamic Imaging	http://as-
Visualization		e.com/products-
Power	110/220 VAC 50/60 Hz	solutions/personnel-
<b>Regulatory &amp;</b>	ANSI N43 17-2009 21 CFR 1020 40 ISO 9001-2000	screening/checkpoint-
Compliance	29 CFR 1910 III 61010-1A ISO 1600 47 CFR 15	lobby/product/smartchec
Safety	27 CI K 1710, OL 01010-17, 150 1000, 47 CI K 15	
Warranty	1+ Year	<u>K/</u>
MSRP	\$100,000	
Other	Dose per scan $< 0.1 \ \mu$ Sv (10 $\mu$ REM)	

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.

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#### **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 <sup>[31,32]</sup>		
Model and	1000D Doutol		
Name	1000D Portal		
Technology	Thermo Conductive IR		
Size Class	Fixed		
Dimensions	97 x 51 x 45 inches		
Weight	800 lbs		
<b>Detect Metals</b>	Yes	LICON .	
Detect Non-	Vas		
Metals	1 05		
Detect Cavity	No		
Concealed	110		
Which Cavities	N/A		
Size of Detected	Approximately the size of a single 500 mg pill		
Objects	Approximately the size of a single 500 mg pm		
Scan Rate	Varies		
Inspection Time	~30 seconds		
Penetration	2-3 layers of cotton clothing		
Depth	2 = 5 have s of could clothing	Figure 13: Iscon 1000D	
Spatial	$\sim 0.04 - 0.1$ " (1 - 3 mm)	Image Reproduced with	
Resolution	······································	Permission	
Info View	Region or Full Body Image		
Image	Real Time Imaging	Manufacturer:	
Visualization		Iscon Imaging	
Power	208 VAC, 10KW		
<b>Regulatory &amp;</b>		http://isconimaging.com	
Compliance	UL / CE Compliant	/iscon1000d.htm	
Safety			
Warranty	1+ year		
MSRP	\$110,000		
Other			

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	<b>Details</b> <sup>[31, 33]</sup>	
Model and	1000M Mini Portal	
Name		
Technology	Thermo Conductive IR	
Size Class	Fixed	
Dimensions	91 x 59 x 37 inches	
Weight	300 lbs	
<b>Detect Metals</b>	Yes	
Detect Non-	Vas	
Metals	105	
Detect Cavity	No	
Concealed		
Which Cavities	N/A	
Size of		
Detected	Approximately the size of a single 500mg pill	
Objects		
Scan Rate	Varies	
Inspection	$\sim 7 - 11$ seconds	
Time		
Penetration	2-3 layers of cotton clothing	Figure 14. Mini Dontol
Depth		- Image Perroduced with
Spatial	$\sim 0.04 - 0.1$ " (1 - 3 mm)	Permission
Resolution		
Into View	Region or Full body image	Manufacturer:
Image	Real Time Imaging	Iscon Imaging
Visualization	200 MAC 20 A	
Power	208 VAC, 30 A	http://isconimaging.com
Regulatory &		/miniportal.htm
Compliance	UL / CE Compliant	
Safety	1	_
warranty	$\frac{1+yr}{r}$	_
MSKP	\$75,000	_
Uther		

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	<b>Details</b> <sup>[31, 34]</sup>		
Model and	GameChangeIR		
Name	Gunicenaugent		
Technology	Thermo Conductive IR		
Size Class	Portable		
Dimensions	32 x 18 x 11 inches		
Weight	80 lbs		
<b>Detect Metals</b>	Yes		
Detect Non-	Vas		
Metals	1 85		
Detect Cavity	No		
Concealed	110		
Which	$N/\Delta$		
Cavities		No Image	
Size of		Available	
Detected	Approximately the size of a single 500mg pill		
Objects			
Scan Rate	Varies	Manufacturer:	
Inspection	Varies	Iscon Imaging	
Time			
Penetration	2-3 layers of cotton clothing	http://isconimaging.com	
Depth		/gamechangeir.htm	
Spatial	$\sim 0.04 - 0.1$ " (1 - 3 mm)		
Resolution			
Info View	Region or Full body image		
Image	Real Time Imaging		
Visualization			
Power	110/220 VAC 50-60Hz		
<b>Regulatory &amp;</b>			
Compliance	UL / CE Compliant		
Safety			
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 relocation 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)<sup>[35]</sup>
- *TechNote: Metal Detectors for Personnel Screening* by Space and Naval Warfare Center (SPAWAR) Atlantic (2009)<sup>[36]</sup>
- *Walk-Through Metal Detectors Market Survey Report* by Naval Surface Warfare Center Dahlgren Division (NSWCDD) (2006)<sup>[37]</sup>

#### 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.<sup>[38]</sup> Four models are currently listed on the website – Standard BOSS 2-Zone<sup>[39]</sup>, BOSS III 3-Zone<sup>[40]</sup>, Big BOSS 4-Zone<sup>[41]</sup>, and the BOSS II 5-Zone<sup>[42]</sup>.

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 (<u>http://xekucorp.com/welcome/products/b-o-s-s/</u>).

#### 5.0 BCS 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
<b>ProVision ATD</b>	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

#### **Table 3: Technical Summary Comparison**

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#### 6.0 CONCLUSIONS

Of all the technologies listed, only Transmission X-ray devices can detect metallic and nonmetallic 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.

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APPENDIX A: ACRONYMS, ABBREVIATIONS, AND REFERENCES

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### 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		

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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			

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#### A.2 References

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- <sup>3</sup> Federal Register; "Contraband Screening for Criminal Justice Applications;" 78 FR 76860, p. 76860; <u>https://federalregister.gov/a/2013-30241</u> (December 19, 2013).
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- <sup>16</sup> L3 Security & Detection Systems; Advanced Personnel Screening; <u>http://www.sds.l-3com.com/products/advancedimagingtech.htm</u> (Accessed March 27, 2014).
- <sup>17</sup> L3 Security & Detection Systems; *Provision: Advanced People Screening;* <u>http://www.sds.l-</u> <u>3com.com/advancedimaging/provision.htm</u> (Accessed March 27, 2014).

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- <sup>35</sup> NUSTL, *Walk-Through Metal Detectors Markey Survey Report*, Prepared for the DHS SAVER Program (pending 2014).
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- <sup>38</sup> Xeku; *B.O.S.S. Models*; <u>http://www.bodyorificescanner.com/us/</u> (Accessed March 27, 2014).
- <sup>39</sup> Xeku; *Standard BOSS 2-Zone*; <u>http://www.bodyorificescanner.com/us/b-o-s-s-</u> models/standard-boss-2-zone/ (Accessed March 27, 2014).
- <sup>40</sup> Xeku; *BOSS III 3-Zone*; <u>http://www.bodyorificescanner.com/us/b-o-s-s-models/boss-iii-3-zone/</u> (Accessed March 27, 2014).
- <sup>41</sup> Xeku; *Big BOSS 4-Zone*; <u>http://www.bodyorificescanner.com/us/b-o-s-s-models/big-boss-4-zone/</u> (Accessed March 27, 2014).
- <sup>42</sup> Xeku; *BOSS II 5-Zone*; <u>http://www.bodyorificescanner.com/us/b-o-s-s-models/boss-ii-5-zone/</u> (Accessed March 27, 2014).

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