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Report to Congressional Addressees

December 2019

AVIATION SECURITY

TSA Should Ensure Screening Technologies Continue to Meet Detection Requirements after Deployment

GAO-20-56

GAO Highlights

Highlights of GAO-20-56, a report to congressional addressees

December 2019

AVIATION SECURITY

TSA Should Ensure Screening Technologies Continue to Meet Detection Requirements after Deployment

Why GAO Did This Study

TSA is responsible for overseeing security operations at roughly 440 TSA-regulated airports as part of its mission to protect the nation's civil aviation system. TSA uses technologies to screen passengers and their bags for prohibited items.

The TSA Modernization Act includes a provision for GAO to review TSA's deployment of screening technologies, and GAO was asked to review the detection standards of these screening technologies. This report addresses, among other things, (1) how TSA operationalizes detection standards, (2) the extent to which TSA considered risk when making deployment decisions, and (3) the extent to which TSA ensures technologies continue to meet detection requirements after deployment.

GAO reviewed DHS and TSA procedures and documents, including detection standards; visited DHS and TSA testing facilities; observed the use of screening technologies at seven airports, selected for varying geographic locations and other factors; and interviewed DHS and TSA headquarters and field officials.

What GAO Recommends

GAO is making five recommendations, including that TSA document analysis of risk in deploying technologies, and implement a process to ensure technologies continue to meet detection requirements after deployment. DHS agreed with all five recommendations and said TSA either has taken or will take actions to address them.

View GAO-20-56. For more information, contact William Russell at (202) 512-8777 or russellw@gao.gov.

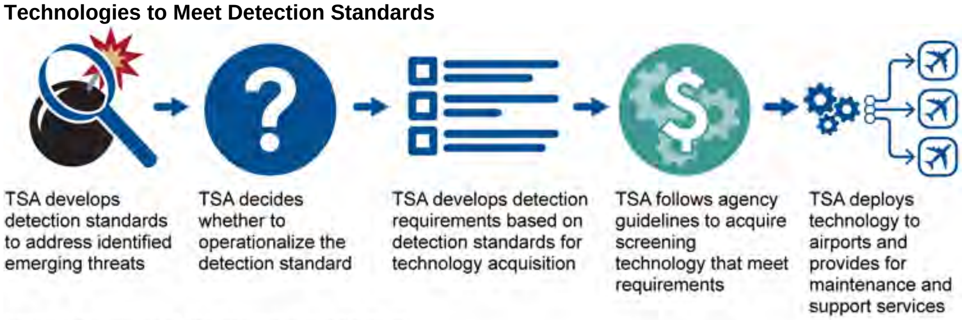
What GAO Found

The Department of Homeland Security's (DHS) Transportation Security Administration (TSA) operationalizes, or puts into effect, detection standards for its screening technologies by acquiring and deploying new technologies, which can take years. Detection standards specify the prohibited items (e.g., guns, explosives) that technologies are to detect, the minimum rate of detection, and the maximum rate at which technologies incorrectly flag an item. TSA operationalizes standards by adapting them as detection requirements, working with manufacturers to develop and test new technologies (software or hardware), and acquiring and deploying technologies to airports. For the standards GAO reviewed, this process took 2 to 7 years, based on manufacturers' technical abilities and other factors.

TSA's deployment decisions are generally based on logistical factors and it is unclear how risk is considered when determining where and in what order technologies are deployed because TSA did not document its decisions. TSA considers risks across the civil aviation system when making acquisition decisions. However, TSA did not document the extent risk played a role in deployment, and could not fully explain how risk analyses contributed to those decisions. Moving forward, increased transparency about TSA's decisions would better ensure that deployment of technologies matches potential risks.

Technology performance can degrade over time; however, TSA does not ensure that technologies continue to meet detection requirements after deployment to airports. TSA certifies technologies to ensure they meet requirements before deployment, and screeners are to regularly calibrate deployed technologies to demonstrate they are minimally operational. However, neither process ensures that technologies continue to meet requirements after deployment. In 2015 and 2016, DHS tested a sample of deployed explosives trace detection and bottled liquid scanner units and found that some no longer met detection requirements. Developing and implementing a process to ensure technologies continue to meet detection requirements after deployment would help ensure that TSA screening procedures are effective and enable TSA to take corrective action if needed.

Transportation Security Administration's (TSA) Process for Acquiring Screening Technologies to Meet Detection Standards



Source: GAO analysis of TSA information. | GAO-20-56

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Abbreviations

AIT	advanced imaging technology
AT x-ray	advanced technology x-ray
BLS	bottled liquid scanner
BPS	boarding pass scanner
CAD	chemical analysis device
CAT	credential authentication technology
CT	computed tomography
DHS	Department of Homeland Security
EDS	explosives detection system
ETD	explosives trace detection
PIR	post implementation review
S&T	Science and Technology Directorate
TSA	Transportation Security Administration
TSO	transportation security officer
WTMD	walk-through metal detector

GAO U.S. GOVERNMENT ACCOUNTABILITY OFFICE

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December 5, 2019

Congressional Addressees

In March 2017, U.S. intelligence agencies confirmed that terrorist organizations had the capability to conceal explosives in laptops and other personal electronic devices that could be taken aboard an aircraft. Recognizing terrorists' longstanding attempts to target passenger aircraft through the use of conventional and homemade explosives, in 2016 the Department of Homeland Security's (DHS) Transportation Security Administration (TSA) developed a ranked list of over 300 of the most likely military and homemade explosive materials to be used in an attack against the U.S. aviation sector. To mitigate this threat, TSA employs technologies to screen passengers and their carry-on and checked baggage for explosive materials and other prohibited items that could be used to cause catastrophic damage to an aircraft.

In September 2019, the agency reported screening roughly 2.8 million passengers, 1.4 million checked bags, and 5.1 million carry-on bags each day. The ongoing threat of terrorism and the projected growth in air travelers require TSA to continually assess the effectiveness of screening operations. This includes identifying new and emerging threats, assessing potential risks to the aviation system, and, if necessary, developing and deploying new screening technologies. In January 2019, we reported that TSA obligated about $1.4 billion for screening technologies and associated services, such as maintenance and engineering support, from December 18, 2014, through July 2018.[1]

The TSA Modernization Act of 2018 includes a provision for us to review whether TSA allocates resources—including advanced imaging and computed tomography (3D imaging) technologies—appropriately based on risk at TSA-regulated airports (i.e., "commercial" airports), and the costs allocated or incurred by TSA to purchase, deploy, install, and

[1]GAO, *Transportation Security Acquisition Reform Act: TSA Generally Addressed Requirements, but Could Improve Reporting on Security-Related Technology*, GAO-19-96 (Washington, D.C.: Jan. 17, 2019) (referring specifically to amounts obligated for "security-related technology," as that term is defined in the Transportation Security Acquisition Reform Act (see 6 U.S.C. § 561(4)), and services associated with the operation of security-related technology).

maintain screening technologies at commercial airports.[2] In addition, you asked us to review TSA's processes for developing detection standards—which identify the characteristics of the prohibited items, such as explosives, that screening technologies are to detect—and ensuring that screening technologies meet operational requirements after deployment.

We addressed (1) the extent to which TSA has a process for developing explosives detection standards for screening technologies in response to identified emerging threats; (2) how TSA operationalizes detection standards to update detection capabilities; (3) the extent to which TSA has considered risk when deploying screening technologies to commercial airports; (4) the extent to which TSA ensures screening technologies meet the requirements for detection standards after deployment; and (5) TSA's estimated expenditures to purchase, deploy, install, and maintain its inventory of screening technologies as of the end of fiscal year 2018.

To address all of our objectives, we identified screening technologies in use at commercial airports in the United States as of September 24, 2018, as recorded in TSA's 'Government Property Management database.[3] We identified nine technologies used to screen passengers and their carry-on bags (two of these were in operation at select airports as pilot projects) and two technologies used for screening checked baggage. Additional details on the screening technologies we reviewed, including their function and the number of units deployed, are in appendix I. We assessed the reliability of the inventory data by interviewing agency officials and reviewing related documentation, such as the database user

[2]See Pub. L. No. 115-254, div. K, tit. I, § 1923, 132 Stat. 3186, 3561 (2018) (enacted as part of the FAA Reauthorization Act of 2018).

[3]The inventory is limited to technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018, and does not include units that were deployed or in use at other locations, such as for testing or repair. The deployed technologies inventory consists of advanced imaging technology, advanced technology x-ray, bottled liquid scanner, boarding pass scanner, chemical analysis device, credential authentication technology, explosives detection system, explosives trace detection, and walk-through metal detector. We do not include computed tomography and threat image projection x-ray in the inventory because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review. The inventory and associated estimated costs may include technologies, such as walk-through metal detector, that transferred from the Federal Aviation Administration to TSA when the latter assumed responsibility for civil aviation security.

manual, and determined the data were sufficiently reliable to identify the type and number of screening technologies deployed.

We conducted site visits to seven commercial airports to observe the operation of screening technologies in the airport setting. We selected the airports to reflect a range of airport categories, technologies, and geographic diversity.[4] The results of these site visits and interviews cannot be generalized to all commercial airports, but they provided us with important context about the installation, use, and maintenance of screening technologies across the different categories of commercial airports. We also conducted a site visit to the TSA Systems Integration Facility to better understand how screening technologies are tested and evaluated prior to deployment.

To determine the extent to which TSA has a process for developing detection standards, we examined documents such as approved detection standards, action memos, and guidance describing TSA's process for assessing threat materials. We also reviewed reports that summarized DHS Science and Technology Directorate's (S&T) testing and analyses of explosive materials—referred to as material threat assessments—for the development of detection standards from fiscal years 2014 through 2018.[5] We compared S&T's testing and analyses to agency guidance to determine the extent to which these practices were followed consistently across materials; we did not analyze the sufficiency of the testing and analyses. We also assessed the extent to which TSA and S&T's processes and key decisions were documented in accordance with *Standards for Internal Control in the Federal Government*.[6] In addition, we conducted a site visit to S&T's Commercial Aircraft Vulnerability and Mitigation Program testing site to better understand how the agency tests the vulnerability of commercial aircraft to explosive materials.[7] We also discussed agency processes and procedures,

[4]The agency classifies commercial airports into five categories (X, I, II, III, and IV) based on various factors, such as the number of take-offs and landings annually, and other security considerations. In general, category X airports have the largest number of passenger boardings and category IV airports have the smallest.

[5]S&T is responsible for coordinating all research and development activities across DHS, including determining the characteristics of explosive threat materials for TSA.

[6]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

[7]The Commercial Aircraft Vulnerability and Mitigation Program tests the vulnerability of commercial aircraft to explosive materials placed inside various areas of an aircraft.

supporting documents, and material threat assessments with TSA and S&T officials.

To determine how TSA operationalizes—puts into effect—detection standards, we reviewed relevant acquisition documents and approved detection standards. We obtained information from TSA about the deployment of the five screening technologies subject to explosives detection standards to understand the agency's process and timeline for operationalizing detection standards.

To understand how TSA officials had considered risk in their approach to deploying screening technologies to airports, we reviewed available documentation related to deployment decisions, including capability analysis reports, decision memos, deployment plans, and acquisition guidance. We assessed TSA's decision-making process for deploying and updating screening technologies, generally, against DHS risk management criteria, such as DHS's *Risk Management Fundamentals*.[8] We interviewed agency officials to further understand how TSA deploys screening technologies and the extent to which risk is considered.

To determine the extent to which TSA ensures screening technologies meet the requirements for detection standards (detection requirements) after deployment to airports, we reviewed detection requirements for each screening technology as well as guidance related to the testing and evaluation of screening technologies.[9] We also observed verification and calibration procedures performed on screening technologies and interviewed TSA and S&T Transportation Security Laboratory officials about requirements for testing screening technologies prior to and after deployment.[10] We reviewed TSA guidance to determine the extent to which its procedures ensure that screening technologies continue to meet detection requirements in airports. We then evaluated the procedures

[8]DHS, *Risk Management Fundamentals: Homeland Security Risk Management Doctrine* (April 2011).

[9]For the purposes of this report, we use the term "detection requirements" to refer to TSA operational requirements for detection standards.

[10]The Transportation Security Laboratory is a DHS Federal Laboratory that, among other things, provides TSA with certification and qualification tests and laboratory assessments regarding screening technologies and their ability to detect explosives.

against *Standards for Internal Control in the Federal Government* for monitoring.[11]

We reviewed TSA programs' life-cycle cost estimates to identify its estimated spending to purchase, deploy, install, and maintain its inventory of screening technologies as of the end of fiscal year 2018.[12] We assessed the reliability of the life-cycle cost data estimates by reviewing TSA's methodology for developing the estimates and interviewing TSA officials, and determined the estimates were sufficiently reliable for our purposes. We identified estimated costs by multiplying the estimated per-unit-cost of each technology, by phase, against the number of units deployed to commercial airports as of September 24, 2018, using inventory data from the Government Property Management database. We chose this methodology in consultation with TSA officials and after determining that historical records of expenditures and obligations were not complete and do not provide consistent and sufficient detail for the purposes of our analysis. Because the life-cycle cost estimates were developed in different years, we used TSA guidelines to adjust costs for inflation and convert our estimates to 2018 dollars. Additional details on our scope and methodology are contained in appendix II. For computed tomography, which is a newer technology for screening carry-on bags, we obtained information on price and quantity from the technology's life-cycle cost estimate and TSA.

We conducted this performance audit from April 2018 to December 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

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[11]GAO-14-704G.

[12]The inventory is limited to technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018, the last week of fiscal year 2018. We included all TSA screening technologies used in checkpoint and checked baggage screening, as identified to us by TSA, with the exception of computed tomography and threat image projection x-ray because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review. For the purposes of this report, references to TSA spending reflect the estimated amounts TSA expended to purchase, deploy, install, and maintain its fiscal year 2018 screening technology. The estimates do not include costs associated with earlier phases of the lifecycle, such as developmental and operational testing.

Background

TSA is responsible for implementing and overseeing security operations at roughly 440 commercial airports as part of its mission to protect the nation's civil aviation system.[13]

Screening Technologies

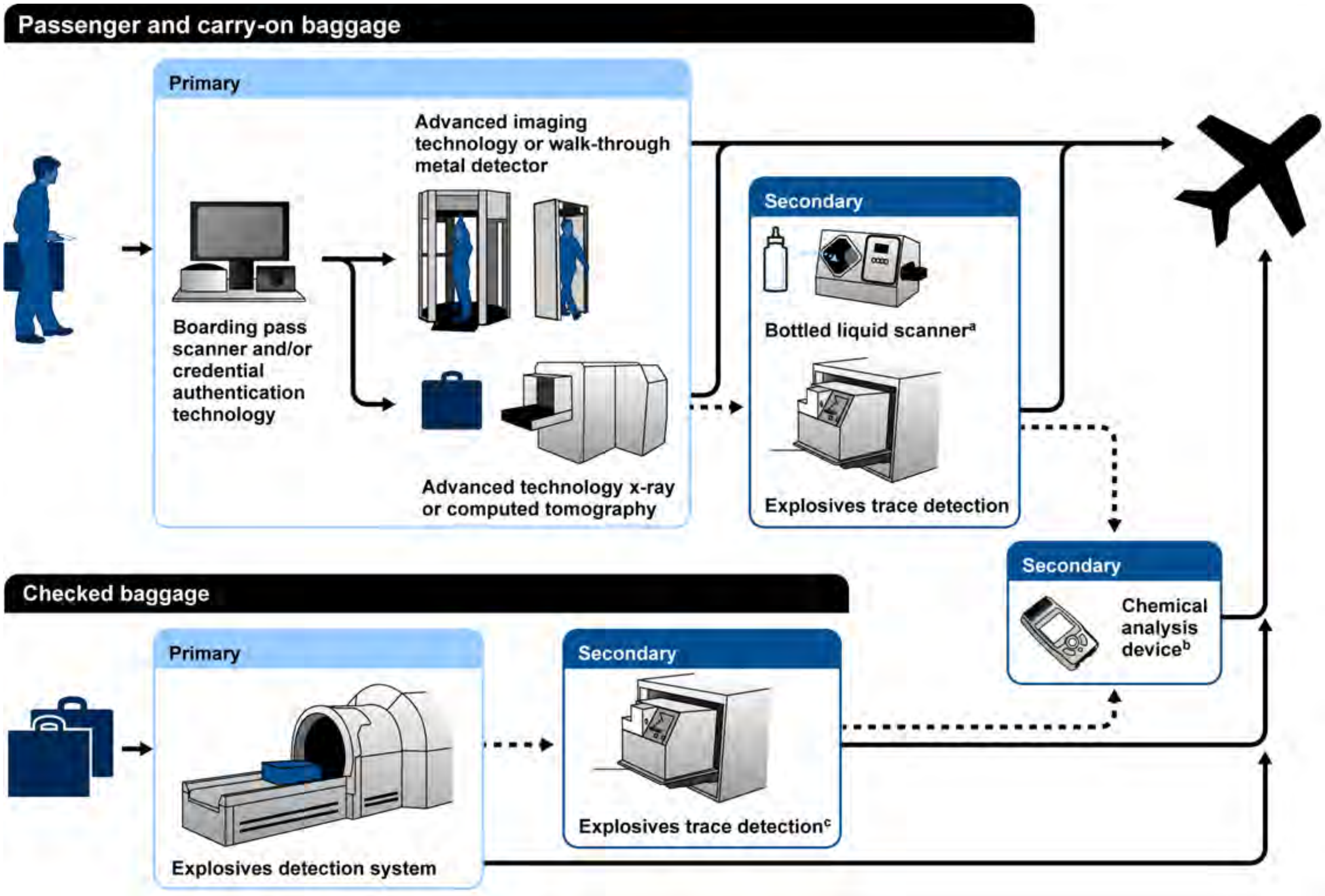
TSA is responsible for ensuring that all passengers, their carry-on bags, and their checked baggage are screened to detect and deter the smuggling of prohibited items, such as explosives, into the sterile areas of airports and onto aircraft.[14] Agency procedures generally provide that passengers pass through security checkpoints where their person, identification documents, and carry-on bags are screened by transportation security officers (TSO).[15] TSA uses a variety of screening technologies—screening systems, as well as software and hardware for those systems—to carry out its mission. Figure 1 depicts the various screening technologies a passenger may encounter in primary and secondary security screening.

[13]See generally Pub. L. No. 107-71, 115 Stat. 597 (2001); 49 U.S.C. § 114(d)-(e).

[14]See 49 U.S.C. §§ 114(e), 44901. The sterile area of the airport is the area that provides passengers access to boarding aircraft and is an area to which access is generally controlled through the screening of persons and property. See 49 C.F.R. § 1540.5.

[15]For the purposes of this report, references to TSOs include both TSA-employed screening personnel and personnel employed by a private-sector company contracted with TSA to perform screening services at airports participating in TSA's Screening Partnership Program. See 49 U.S.C. § 44920. TSA's screening procedures—called standard operating procedures—govern how screening personnel are supposed to screen passengers, their carry-on bags, and checked baggage for prohibited and other dangerous items.

Figure 1: Transportation Security Administration (TSA) Screening Technologies Used at Checkpoint and Checked Baggage Screening



Source: GAO analysis of TSA information. | GAO-20-56

[a]Bottled liquid scanners are located at secondary screening, but, according to officials, may be used for either primary or secondary screening of liquids.

[b]The chemical analysis device is used by TSA explosives specialists to resolve alarms for passenger, carry-on, and checked baggage screening.

[c]At certain TSA-regulated airports explosives trace detection is the primary technology for screening checked baggage.

Process for Acquiring and Deploying Screening Technologies

TSA develops detection standards that identify and describe the prohibited items—such as guns, knives, military explosives, and homemade explosives—that each technology is to detect during the screening process.[16] The standards, which are classified, also identify how often the technology should detect prohibited items (referred to as the required probability of detection) and the maximum rate at which the technology incorrectly identifies prohibited items (the probability of false alarm). For explosive materials, the standards also identify what the screening technology is to be able to detect in terms of (1) the minimum amount or weight of the material (the minimum detection mass) and (2) the chemical and physical makeup of the material (density range of the explosive material).[17]

S&T supports TSA in the development of standards by, among other things, analyzing the characteristics (threat mass, or the amount of material that constitutes a threat, and density) of explosive materials. The agency uses the resulting data to develop detection standards that are specific to each screening technology.

After a detection standard is approved, TSA decides whether to operationalize—put into effect—detection standards by acquiring and deploying technologies to update detection capabilities to meet the standard. That is, it decides whether to take steps to develop new technology capable of meeting the standard and put the new technology in place at commercial airports. Technology can mean new software to upgrade existing screening systems as well as entirely new screening systems. TSA does not always or immediately operationalize detection standards, for reasons which are explained later in this report.

[16]In detection standards, prohibited items are referred to as “threats of interest.” The screening technologies for which explosives detection standards are developed are advanced imaging technology, advanced technology x-ray, bottled liquid scanner, computed tomography, explosives detection system, and explosives trace detection. According to TSA and S&T officials, other threats of interest are explosive precursors—chemical substances that, when combined with another substance, could be used to create a homemade explosive after passing through checkpoint screening. Explosives precursors can be used for legitimate purposes, but can also be used to manufacture homemade explosives.

[17]According to TSA, the minimum detection mass is the minimum amount of the material that constitutes a threat. Density describes the mass of a substance per a specified volume and can vary based on how an explosive material is prepared (e.g., poured, tapped, tamped—driving down a material with a succession of light or medium blows—or pressed).

To operationalize a detection standard, TSA must acquire technology capable of meeting the standard. TSA officials told us they follow DHS acquisition policies and procedures when acquiring new screening technologies.[18] Officials said they adapt detection standards as detection requirements to guide the acquisition process, meaning the specifications described in the standards are incorporated into the requirements manufacturers must meet when developing new technology. Once manufacturers have developed new technologies that meet detection requirements, the technologies undergo a test and evaluation process, known as the qualification process. The following are key steps in that process:

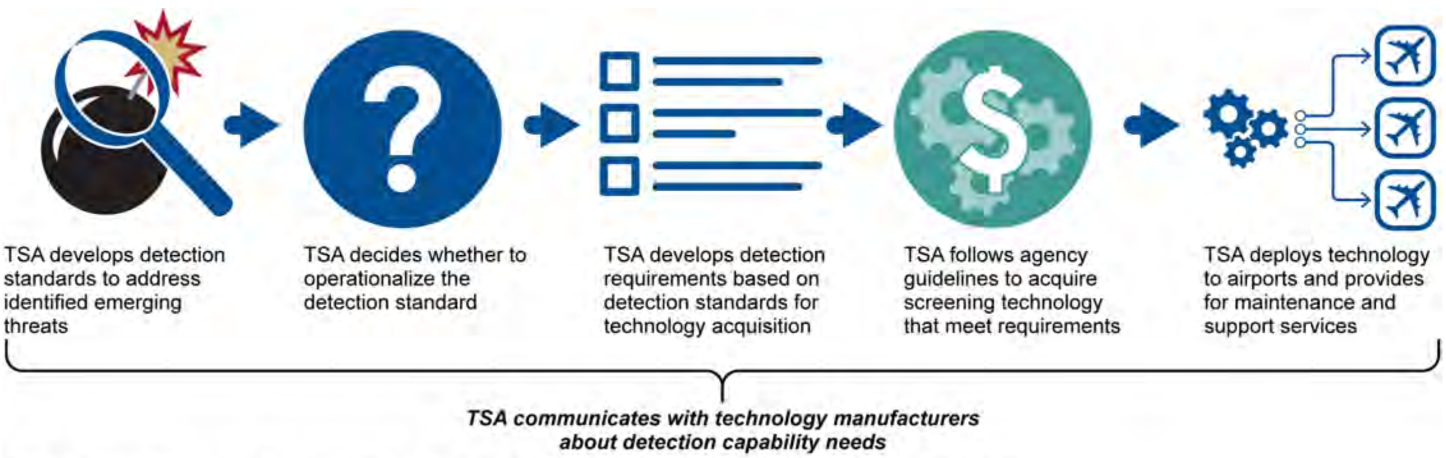
1. Certification – Certification is a preliminary step in TSA's qualification process. For TSA to certify that a screening technology meets its detection requirements, S&T's Transportation Security Laboratory conducts certification testing on a manufacturer's initial submission of its proposed screening technology to determine whether it meets TSA's detection requirements (i.e., the rate at which it must accurately detect each category of explosive it is designed to detect, among other things).
2. Integration/Implementation Testing – TSA Systems Integration Facility administers qualification testing to test system performance against additional requirements, such as reliability, availability, and maintainability. TSA also conducts field testing to ensure readiness for operational test and evaluation.
3. Operational Test and Evaluation - TSA deploys units to selected airports to conduct operational testing. Operational testing allows TSA to evaluate the operational effectiveness, suitability, and cyber resiliency of the technology in a realistic environment.

After new technologies have been tested and approved, TSA can purchase and deploy them to commercial airports. When a deployed screening system can no longer be updated to meet new detection standards, TSA considers it obsolete and generally designates it for replacement with a newer version of the technology.

[18]TSA's acquisition programs and policies are primarily set forth in DHS, *Acquisition Management Directive,* 102-01, Rev 3.1 (Feb. 25, 2019) and DHS, *Acquisition Management Instruction*, 102-01-001*, Rev 1* (May 3, 2019). See also Department of Homeland Security Acquisition Regulation, 48 C.F.R. ch. 30 (establishing uniform acquisition policies and procedures to implement and supplement the Federal Acquisition Regulation).

Figure 2 shows TSA’s process for acquiring and deploying new screening technologies to meet detection standards.

Figure 2: Transportation Security Administration’s (TSA) Process for Acquiring Screening Technologies to Meet Detection Standards



Detection standard: Specifies the prohibited items the technology should detect, the minimum rate of detection,and the maximum rate the technology may incorrectly identify an item.

Operationalize: Acquire and deploy technology to update detection capabilities to meet a new detection standard.

Detection requirement: The minimum detection capability the technology must provide for acquisition purposes.

Source: GAO analysis of TSA information. | GAO-20-56

DHS Risk Management

DHS guidance provides that its components, including TSA, use risk information about security threats and analysis to inform decision-making. Risk management helps decision makers identify and evaluate potential risks so that actions can be taken to mitigate them. DHS defines a risk assessment as a function of threat, vulnerability, and consequence.[19] DHS guidance also says that risk assessments and transparency are key elements of effective homeland security risk management.

[19]DHS guidance says threat likelihood is estimated based on intent and capability of an adversary. Vulnerability is a physical feature or operational attribute that renders an entity open to exploitation or susceptible to a given hazard. Consequence refers to the negative effect of an event, incident, or occurrence.

TSA Has a Process for Developing Detection Standards, but Has Not Updated Its Guidance or Documented Key Decisions

TSA Has Consistently Followed Testing Protocols in Developing Detection Standards

TSA develops detection standards to address identified emerging threats

Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

TSA has a process to develop new explosives detection standard in response to emerging, credible threats involving a homemade explosive (see sidebar for more information on homemade explosives).[20] According to TSA officials, the first step in the process is to determine whether a new detection standard is needed, which they do by working with S&T and other federal partners to ”characterize” the threat material—that is, identify the chemical and physical properties of the material, such as the threat mass and density. Below is the process (steps) TSA and S&T officials told us they use to characterize a threat material and determine whether a new detection standard is needed.

Computer modeling and equivalency testing. S&T uses computer modeling to estimate select properties—such as effective atomic number—of the threat material.[21] Depending on the threat material, S&T also conducts equivalency testing for explosives. This involves detonating the explosive and comparing the blast with the blast effects of known explosives, such as C-4. This allows officials to calculate the threat mass

[20]An emerging, credible threat involving a homemade explosive is just one reason TSA might develop a new detection standard. Officials said other reasons may include new information about the makeup of a threat material, or improvements in screening technology such that smaller amounts of explosives may be detected. They also noted that when a new threat emerges involving a homemade explosive, TSA works with the U.S. intelligence community to disseminate threat assessments that provide a more comprehensive understanding of the threat, such as the threat actor’s tactics, techniques, and procedures, to ensure that agency components have the most detailed information available to plan mitigation steps.

[21]S&T officials said they are moving away from using modeling software because they now have the capabilities to detonate real explosives to calculate blast strength. The effective atomic number is the average atomic number, a unique identifier of elements, for a compound or mixture of materials.

Homemade Explosives

Homemade explosives are designed to cause destruction when used in improvised explosive devices. The picture below shows damage to an aircraft panel from a homemade explosive. Beginning in the early 2000s, homemade explosives replaced military and conventional explosives as the preferred tool of terrorists, and challenged the capabilities of existing screening technologies. Unlike conventional threats, homemade explosives are often made of common commercial items and it can be challenging to distinguish them from innocuous gels and liquids stored in personal baggage or cargo. They also have different detonation patterns from conventional explosives in that they often release energy much more slowly, which may lead to incomplete or delayed detonation. This pattern is not well understood, which makes it much more difficult to predict the resulting damage.

The Transportation Security Administration and the Science and Technology Directorate have ranked 300 conventional and homemade explosives that pose the most likely threat to aviation security based on factors such as availability, stability, performance, and method of initiation.

Source: Department of Homeland Security Science and Technology Directorate. | GAO-20-56

of the explosive—the minimum amount of the material that constitutes a threat to civil aviation.

Material down selection (selection of possible mixtures for testing). Because the exact formulation of the explosive can vary, S&T must test and model various formulations in different proportions to gain an understanding of the homemade explosive. In this step, TSA determines the representative formulations and preparations that are to be prepared and tested, based on data provided by S&T.[22]

Synthesis, formulation, and preparation of materials. S&T establishes how the threat material could be made, including its chemical synthesis (as applicable), possible formulations or mixtures of the material with other components, and the preparation of those mixtures. S&T uses this information to develop samples of the threat material for testing.

Data acquisition and analysis. S&T examines the samples using micro-computed tomography and explosives detection system, and the resulting data are sent to S&T's Transportation Security Laboratory for verification. The verified data are then sent to the U.S. Department of Energy's Lawrence Livermore National Laboratory for analysis.

Region of responsibility. Lawrence Livermore National Laboratory generates preliminary results in the form of the "region of responsibility," which is a map or explosive detection "window" outlining the characteristics of the threat material in terms of density and effective atomic number. These preliminary results are discussed among TSA and S&T stakeholders, with TSA determining the final region of responsibility. The region of responsibility data are used to develop software algorithms that will allow screening technologies to recognize explosive materials whose characteristics fall within the region of responsibility.

Detection standard. TSA and S&T also use the region of responsibility data to determine whether the explosive material can already be detected by deployed screening technologies. If screening technologies can already detect the material, TSA will not contract with technology manufacturers to develop a new software algorithm or screening technology. But regardless of whether a new software algorithm or new

[22]During material down select, S&T focuses on the detonable preparations and mixtures that would be within the adversary's expected technical abilities.

technology is needed, TSA will draft a new detection standard for the material that, generally, will specify the minimum threat mass and density range to be detected, the acceptable probability of detection, and probability of false alarm. The draft standard is reviewed by TSA senior management before being approved.

We found that the work S&T and other stakeholders performed to characterize explosive threat materials was consistent across the threat materials. Specifically, we found that S&T consistently followed the process described to us (as outlined above) for characterizing a threat material in the seven material threat assessments we reviewed.[23] We also reviewed documentation regarding additional testing and analysis S&T performed on select threat materials, and found the additional testing and analyses were performed consistently.[24]

TSA Has Not Updated Its Guidance for Developing Detection Standards to Reflect Required Procedures, Key Stakeholder Roles, and New Organizational Structure

TSA has not updated its 2015 guidance for developing new detection standards to reflect key changes in their procedures. In December 2015, TSA issued the *Detection Requirements Update Standard Operating Procedure*, which a senior official told us served as the agency's approved guidance for developing detection standards.[25] Our review of the document found that, as of August 2019, it did not accurately reflect (1) designated procedures for developing detection standards, (2) the roles and responsibilities of key stakeholders such as S&T, and (3) TSA's organizational structure. For example, one way in which the 2015 guidance has not been updated is in the designated procedures it describes for reviewing available intelligence information. Specifically, the guidance calls for an annual assessment of emerging threats, which a senior TSA official told us TSA no longer conducts because relevant

[23]According to TSA and S&T officials, they used 7 material threat assessments summarizing testing and analyses of materials to support new detection standards from fiscal years 2014 through 2018. Specifically, we reviewed characterization steps from computer modeling to the development of regions of responsibility (with the exception of equivalency testing) as discussed above.

[24]According to TSA officials, the additional testing supported changes to the approved detection standards. The additional testing and analysis varied—for example, S&T provided additional region of responsibility data for five threat materials and new explosive equivalency information on four threat materials. We reviewed the test plan TSA officials said was used to conduct the equivalency testing, but did not analyze the steps performed in that testing.

[25]TSA, *Detection Requirements Update Standard Operating Procedure* (December 2015).

emerging threats are now occurring more frequently and intelligence information is processed on an ongoing basis.

In another example, the guidance specifies that TSA will form working groups composed of agency officials and stakeholders to assess potential threat materials and develop an analysis plan, and that each working group will define the roles and responsibilities of its members. According to a senior TSA official, the agency does not convene working groups to assess intelligence or develop an analysis plan, although officials regularly meet with stakeholders to discuss the steps needed to characterize new threat materials and document the minutes from these meetings.

Finally, while the guidance discusses in detail which TSA offices and management positions are responsible for implementing and overseeing the process, the agency has since reorganized and these offices and positions no longer exist. Therefore, the 2015 guidance is no longer relevant in terms of which offices and positions are responsible for implementing and overseeing the approval of detection standards.

Officials told us that, as of August 2019, they had begun revising the guidance to reflect existing standard operating procedures for developing detection standards, but had yet to finalize a draft of the new guidance or document plans or timeframes for completing and approving it. Further, it is not clear to what extent the revised guidance will address designated procedures for developing detection standards, the key roles and responsibilities of stakeholders, and TSA's new organizational structure. Officials said they had not updated the guidance earlier because both TSA and S&T had been undergoing agency reorganizations.

Standards for Internal Control in the Federal Government provides that agencies should identify, on a timely basis, significant changes to internal conditions that have already occurred, such as changes in programs or activities, oversight structure, and organizational structure.[26] Additionally, agencies are to develop and maintain documentation of internal controls, such as policies and procedures necessary to achieve objectives and address related risks. By documenting the processes and procedures TSA uses to develop detection standards, clarifying the roles and responsibilities of stakeholders, and documenting organizational changes,

[26] GAO-14-704G.

TSA could have better assurance that detection standards are developed in accordance with established policies and practices.

TSA and S&T Did Not Document All Key Decisions Regarding the Development of Detection Standards

Our review of TSA's steps to develop detection standards from fiscal years 2014 through 2018 found that TSA and S&T did not document all key decisions—those that could potentially affect outcomes—regarding the testing and analyses (characterization) of explosive threat materials and the development of explosives detection standards. We found that TSA and S&T produced a series of detailed material threat assessments to document the characterization of threat materials and consistently developed action memos to justify proposed detection standards. However, we also found that in five of the seven material threat assessments we reviewed TSA and S&T did not consistently document key steps in the testing and analyses of materials, such as how selected samples were prepared for testing. For example, one S&T material threat assessment we reviewed did not document the method used to synthesize (chemically produce) material samples used for testing. Not documenting the method could prevent officials from fully understanding the results of the analysis. Specifically, the assessment noted that there are multiple methods of synthesis, and that the chosen method could affect the makeup of the resulting material and therefore the ability of the screening technologies to detect it. Additionally, while two of the seven material threat assessments cited standard operating procedures for sample preparation for all participating laboratories, three did not cite standard operating procedures for at least one laboratory and two stated that sample preparation information had not been provided by one or more of the participating laboratories. Without documentation, TSA might not have all the necessary information to address future issues involving detection of these materials.

We also found four instances in which TSA did not clearly document why select materials were sent for additional testing or did not document key decisions regarding the development and consideration of detection standards. For example, S&T performed additional testing and analysis on select threat materials after the material threat assessment was finalized. However, the documentation of this additional testing left out key elements regarding how and why the additional testing was needed and conducted. The action memo documenting new standards based on the results of the additional testing did not include a justification for why specific threat materials were selected for additional data collection.[27] While a test plan for equivalency testing of one material stated that the additional testing was conducted because data reported in the literature were not considered representative of current threat configurations, similar justification was not included in the action memo justifying changes to the new standard based on the additional testing. Finally, a senior TSA official told us he requested the additional equivalency testing because the values in the previous detection standards appeared to be more conservative than expected and there was no documentation explaining how TSA had arrived at those numbers. According to the official, the previous detection standard was approved before his tenure and the determining officials were no longer with TSA. He also stated that he did not know whether TSA required documentation of testing and analysis when the previous detection standard was being developed.

We found that TSA did not document key decisions regarding the development and consideration of detection standards. For example, officials could not provide documentation of conclusions reached on specific key decisions, such as the consideration and decision not to approve a proposed explosives trace detection standard. A senior TSA official said he did not know why the decision had not been documented because the officials involved were no longer with the agency.

According to *Standards for Internal Control in the Federal Government*, documentation is required for the effective design, implementation, and operating effectiveness of an agency.[28] Documentation also provides a means to retain organizational knowledge and mitigate the risk of having that knowledge limited to a few personnel, as well as a means to communicate that knowledge as needed to external parties. By documenting key decisions regarding the development of detection standards, including instances in which draft standards are not approved, TSA could better ensure that effective decisions are made and that organizational knowledge is retained regardless of changes in personnel.

[27]The additional testing and analysis included region of responsibility data collection on five threat materials and new explosive equivalency information from air-blast testing on four materials.

[28]GAO-14-704G.

TSA Operationalizes Detection Standards by Updating its Screening Technologies, Which Can Take Years to Complete

TSA officials said one way to operationalize detection standards—acquire and deploy technologies to update detection capabilities and meet the detection standard—is to update existing screening systems with new technology, such as software or firmware. When possible, the agency installs software as part of routine maintenance. TSA can also deploy new hardware or replace screening systems to update detection capabilities. According to officials, the agency applies an incremental approach to updating existing screening technologies—it updates technologies when manufacturers are able to develop the requisite capabilities and as resources allow—which can take years to complete.

According to officials, all fully deployed TSA screening technologies had detection capabilities that met detection standards approved from 2006 through 2012. That is, as of August 2019, TSA's fleet of screening technologies met detection standards that were approved in 2012 or earlier. For example:

- Bottled liquid scanner units met a detection standard that was approved in 2006;
- Advanced technology x-ray units met two detection standards, depending on their manufacturer, that were both approved in 2010; and
- Explosives trace detection units met a detection standard that was approved in 2012.

Further, for each screening technology, the agency has approved two to three new detection standards that have not been operationalized, as of August 2019. For example, in addition to the 2006 detection standard for bottled liquid scanner, TSA approved standards for bottled liquid scanner in 2012 and in 2017 that have not been operationalized.

TSA decides whether to operationalize detection standards

Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

TSA officials said they were working to operationalize some of the detection standards approved since 2012. Officials said they were working with manufacturers to develop new technologies to operationalize some of these standards. In other cases they were in the process of deploying new technologies that meet these standards. For example, as of August 2019, TSA was in the process of updating and replacing explosives detection systems to meet a detection standard that was approved in 2014. Officials said they expected to have the entire fleet updated by September 2023. TSA officials said they were also in the process of updating deployed advanced technology x-ray units for one of its two manufacturers to meet a standard that was approved in 2014. For more information about the detection standards TSA had approved for each technology as of August 2019, and the status of TSA's progress in operationalizing them, see appendix I.

TSA follows agency guidelines to acquire screening technology that meet detection requirements

Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

TSA shares information about the capabilities it needs with manufacturers through requests for proposal, requests for information, and broad agency announcements. The agency places approved technologies on a qualified products list—a list of technologies that have been tested and certified as meeting requirements by TSA and DHS—and the agency can then award a contract to one of the manufacturers to purchase and deploy the technology. Before deploying technologies to airports, TSA conducts testing to ensure consistency in the manufacturing process, system configuration, and functionality following production, and then again after the technology is installed at airports.

Our analysis of the acquisition information TSA provided found it took from 2 to 7 years to fully develop, certify, test, and deploy screening technologies to airports.[29] For example, when operationalizing explosives trace detection standard 5.0, it took one manufacturer 4 years and a second manufacturer 7 years to develop, and for TSA to deploy, the software needed to update the capability of existing explosives trace detection units to meet the new standard.[30]

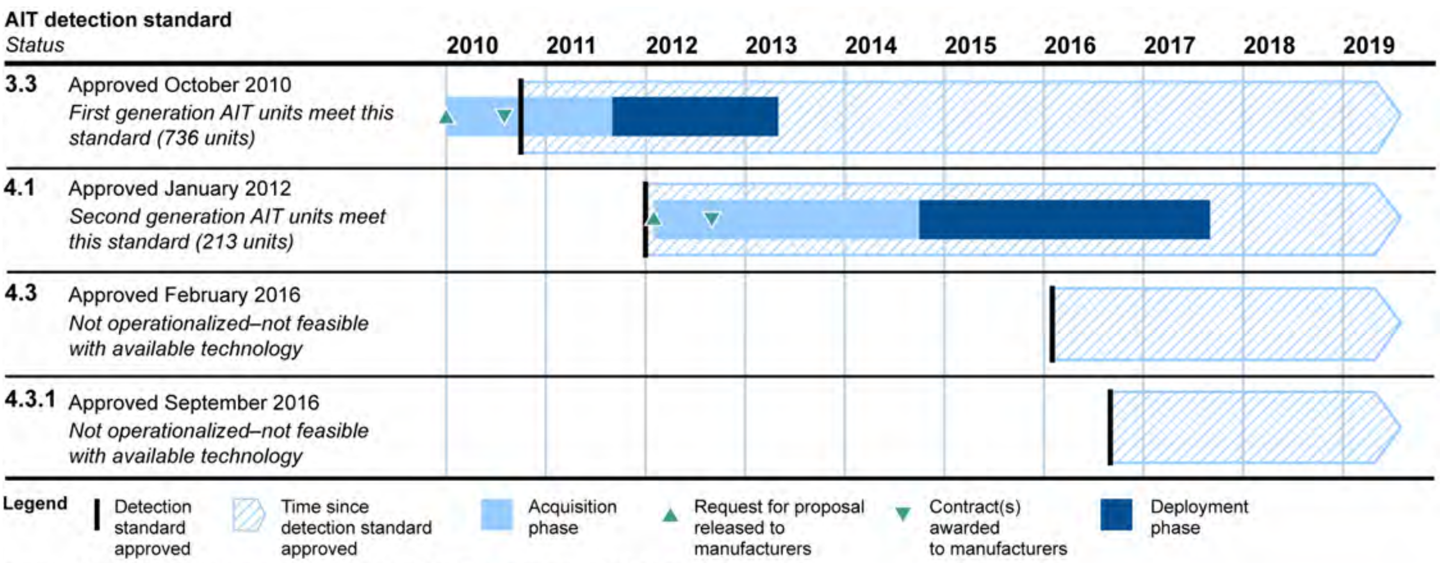
Figure 3 provides our analysis of TSA's timeline for operationalizing advanced imaging technology detection standards approved from 2010 through 2016. TSA officials said they approved detection standard 3.3 for advanced imaging technology in October 2010 and began deploying technology that met that standard to airports in August 2011. Officials said they approved a subsequent standard, 4.1, in January 2012, began deploying technology to meet it in October 2014, and completed the deployment in September 2017. Officials said it took 3 years to complete deployment because the demand for advanced imaging technology increased over time as airports experienced an increase in passenger volumes, among other reasons. Since 2012, TSA approved two additional detection standards for advanced imaging technology—4.3 in February 2016 and 4.3.1 in August 2016. TSA officials said they have not operationalized these two standards because the manufacturer has not

[29]We excluded advanced technology x-ray from this count because officials said they deployed those units on an ongoing basis.

[30]TSA identifies detection standards numerically.

been able to develop the requisite technology. As such, deployed advanced imaging technology units meet standards approved in 2010 and 2012.

Figure 3: Timeline for the Approval and Operationalization of Advanced Imaging Technology (AIT) Detection Standards



Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

Note: For detection standard 3.3, officials said the request for proposal date was estimated. Officials said detection standard 3.3 was signed after the acquisition milestones because officials with signing authority were not available to sign the draft version of the standard before the acquisition process began. The number of units deployed is from September 24, 2018.

TSA officials stated that they do not always, or immediately, operationalize detection standards after they are approved. They said they make these decisions on a case-by-case basis, depending on many factors. These include whether: (1) manufacturers have the technological ability, (2) a new technology is in development, and (3) screening technologies already have the capability.

Manufacturers do not have the technological ability. TSA officials said manufacturers do not always have the technical ability to meet detection standards. According to officials, it can be challenging for manufacturers to develop the technology necessary to detect new threats as presented in a detection standard, and in some cases impossible without further research and development. For example, TSA officials said that manufacturers have been unable to develop the requisite technology to meet the most recent detection standards (4.3 and 4.3.1) for advanced imaging technology. However, TSA officials said they have expanded their research and development efforts to try to develop the technology. TSA officials told us they plan to continue developing detection standards irrespective of the capabilities of currently deployed technologies so that they can focus on identifying emerging threats. The new detection standards then serve to set expectations for manufacturers about the capability to which they should aspire and justify research and development necessary to realize that capability. To better manage the difference between the capabilities of deployed technologies and the capabilities described in detection standards, TSA officials said they are in the process of developing a new position of Capability Manager, who would be responsible for managing the development of mission-essential capabilities—such as carry-on baggage screening—from start to finish. Officials said they expect this position will help bridge the gap between approved detection standards and the detection capabilities of deployed screening technologies over time, because the managers will have cross-cutting oversight of the process.

A new technology is in development. Officials said that they may not operationalize a detection standard if they expect a new type of screening technology will replace an existing one. For example, officials said that TSA is exploring new alarm resolution technologies—that is, screening technologies that are used to determine whether alarms are false positives. Officials said new alarm resolution technologies may replace the bottled liquid scanner in the future, and therefore they have not pursued operationalizing detection standard 2.3.[31]

Screening technologies already have the capability. According to TSA officials, new detection standards do not always add significant detection capabilities. For example, officials decided not to operationalize bottled liquid scanner detection standard 3.0 when it was approved in 2017 because the deployed units already had most of the capabilities called for in the detection standard; TSA developed the new standard to better align with standards for other technologies.

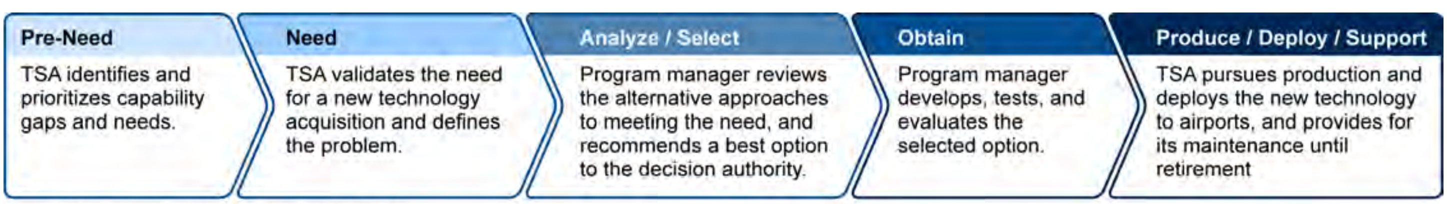
[31]Officials did not know why bottled liquid scanner detection standard 2.3 was not operationalized immediately after it was approved in 2012 and there is no documentation available explaining why the standard was not operationalized at that time.

TSA Deployment Decisions are Generally Based on Logistical Factors, and the Extent to Which TSA Considers Risk Is Unclear Because Decision-Making Lacks Documentation

TSA Assesses Risks and Capability Gaps When Determining Acquisition Needs

Our review of TSA acquisition documents found that TSA considers risk at the beginning of the screening technologies acquisition process.. Specifically, the agency considers risk in two phases—(1) a risk assessment developed from intelligence information and modeling tools, and (2) an annual capability analysis that analyzes and prioritizes capability gaps and determines mitigation options. Figure 4 provides an overview of TSA's acquisition process for new screening technologies.

Figure 4: Transportation Security Administration's (TSA) Acquisition Lifecycle Framework for New Technologies



Source: GAO analysis of TSA information. | GAO-20-56

Risk assessment. TSA uses intelligence information and modeling tools, such as the Risk and Trade Space Portfolio Analysis, to assess risk to the aviation system. The Risk and Trade Space Portfolio Analysis was developed in 2014 to analyze the security effectiveness of alternate combinations of some aviation security countermeasures. Officials said a recent example of a risk-informed deployment decision influenced by the Risk and Trade Space Portfolio Analysis was TSA's 2017 deployment of

141 advanced imaging technology units to category III and IV airports. Officials said that around 2014, TSA received intelligence about a potential terrorist threat to airports, as well as the results of covert testing at airports that identified screening vulnerabilities. Officials said a 2014 Risk and Trade Space Portfolio Analysis also identified disparities in screening capabilities at smaller airports. In part because of the vulnerability identified by these three factors, as well as ongoing conversations between TSA senior leadership, the DHS Inspector General, and members of Congress, officials said TSA procured and deployed additional advanced imaging technology units to some category III and IV airports that did not have them.

Capability analysis. TSA uses the Transportation Security Capability Analysis Process, a structured decision-making tool, to identify and prioritize capability gaps and help direct agency resources towards closing critical gaps to an acceptable level. When existing screening capabilities do not fully meet TSA's mission needs, the associated capability gap presents a security risk. As part of the Transportation Security Capability Analysis Process, TSA produces Capability Analysis Reports that identify and recommend solutions to closing capability gaps. Recommendations have included procedural changes, such as new training for TSOs, and investments in new technology. TSA's investment in computed tomography technology for checkpoint screening of carry-on baggage is an example of TSA's implementation of the Transportation Security Capability Analysis Process to validate capability gaps and identify recommended courses of action. Officials said that in some cases the agency may identify a capability gap that cannot be resolved to an acceptable level with commercially available screening technology, in which case it will pursue additional research and development.

TSA's Approach to How Risk Informs Deployment Decisions Lacks Documentation

TSA officials told us that they operate under the assumption that every airport is a possible entry point into the aviation system for a terrorist, and they do not consider there to be a significant difference in vulnerability among airports when deploying screening technologies. However, officials did not provide analysis or documentation that supported this conclusion. Officials noted the exception to this assumption is a handful of airports that are consistently considered to be the highest risk because of known threats and a high volume of international travelers.

Further, officials said that if they had information about a threat to a specific airport that would be mitigated by deploying a screening technology, they would modify their plans for deployment accordingly.

However, TSA's process for how it would change its deployment plans to specific airports based on risk lacks transparency. For example, officials said that as part of the acquisition process they have ongoing discussions with stakeholders about their deployment strategies, including security and intelligence officials who would inform them of any relevant risk information. Officials said these discussions are generally informal and not documented—it was unclear how these discussions have incorporated information about risk in the past, and officials could not provide an example of when risk information at specific airports had directly influenced deployment of technologies to airports in the recent past.

In 2018, the agency released its *Transportation Security Administration Systems Acquisition Manual*, which called for deployment plans to be written documents, and officials said they began documenting their plans for deploying screening technologies in the last two years.[32] TSA officials provided us with one deployment plan—for their 2018 deployment of explosives trace detection units—but we found that it was not transparent about how risk was a factor in officials' methodology for determining the order of airports to receive the technology.[33] The explosives trace detection plan documented TSA's schedule of deployment and the roles and responsibilities of relevant stakeholders, among other things. However, while the plan indicated that officials would coordinate with relevant offices within the agency for information about risks that might impact their deployment strategy, we found that the plan did not document how risk had informed their decisions about where and how to deploy the technology, including the assumptions, methodology, and uncertainties considered.

Additionally, TSA officials did not document, and could not fully explain, how risk analyses contributed to and factored into the following specific deployment decisions.

[32]TSA, *Transportation Security Administration Systems Acquisition Manual* (August 2018).

[33]TSA also provided us with an August 2018 documented methodology for how it selected airports to operationally test a limited number of computed tomography units for checkpoint screening. The document included a description of the criteria used to select the airports to receive units, and intelligence and risk were among the criteria considered. TSA's Intelligence Analysis office was included among the list of stakeholders that were consulted during the airport selection process.

Deployment of advanced imaging technology to smaller airports. Officials said many factors influenced their decision to deploy advanced imaging technology units to category III and IV airports, including information about threats and a related 2014 risk analysis. However, officials did not document their decisions and could not fully explain their risk analysis, including their process for analyzing and weighing relevant factors. According to officials, the decision was made during discussions with senior leadership, which were risk-informed and supported by whiteboard analyses and classified documents. Additionally, officials told us that, for practical reasons, they deployed units to those category III and IV airports that had the space to accommodate them, but did not further assess the priority of deployment among the smaller airports because they had determined that the risk was uniform and because they planned to deploy the units within a short timeframe.[34] Officials did not document the risk assessment that led to this determination, and could not explain how the three elements of risk—threat, vulnerability, and consequence—were used or assessed.

Deployment of targeted threat algorithm. In 2016, TSA deployed a targeted threat algorithm—software to improve detection capabilities—to a limited number of advanced imaging technology units in response to a specific threat. After testing the operational impacts of the software algorithm, the agency decided to stop further deployment. The documentation TSA provided did not explain how officials had analyzed the risk-mitigation benefits of the algorithm, including the underlying assumptions and uncertainty, or how they had weighed those benefits against the operational impacts and costs when they made their decision not to fully deploy the algorithm.

TSA officials said they follow the DHS acquisition process to acquire and deploy technologies and their deployment decisions are based on, and informed by, their initial assessments of capability gaps, as well as their understanding that every airport offers equal entry into the aviation system. However, officials had not documented the rationale for these decisions and could not fully explain how risk had informed their decisions about where and in what order to deploy screening technologies.

[34]The units were deployed between January and August 2017. Before the deployment, 237 category III and IV airports did not have an advanced imaging technology unit.

DHS's *Risk Management Fundamentals* states that components should consistently and comprehensively incorporate risk management into all aspects of the planning and execution of their organizational missions.[35] Additionally, it says transparency is vitally important in homeland security risk management, and documentation should include transparent disclosure of the rationale behind decisions, including the assumptions, methodology, and the uncertainty considered. By fully disclosing what risk factors are weighed and how decisions are made, TSA officials can better ensure that their deployment of screening technologies matches potential risks (threats, vulnerabilities, and consequences). This is of particular importance given the agency's limited resources and the fact that screening technologies are not easily relocated.

TSA Generally Deploys Screening Technologies Based on Logistical Factors

TSA officials said that absent a specific risk to an airport or category of airports that would be mitigated by deploying a screening technology, they consider a number of logistical factors that are aimed at maximizing the operational efficiency of the screening process. These factors influence the number of units of a technology the agency deploys to airports, the order in which they deploy them, and where they are deployed.

Officials said they use modeling software to determine the most efficient number of units to allocate to an airport for each type of screening system.[36] This analysis takes into account variables such as the number of flights at an airport, airport passenger volumes, items per passenger, and secondary search rates. Additionally, agency officials said the layout of an airport is a significant determining factor for the number of units it receives. For example, an airport that has centralized checked baggage screening areas will need fewer explosives detection systems than an airport that has checked baggage screening areas dispersed in different locations.

[35]Risk management is defined as the process for identifying, analyzing, and communicating risk and accepting, avoiding, transferring, or controlling it to an acceptable level considering the associated costs and benefits. DHS, *Risk Management Fundamentals: Homeland Security Risk Management Doctrine* (Washington, D.C.: April 2011).

[36]TSA officials said they use the Enhanced Staffing Model software to conduct this analysis, which utilizes inputs about an airport's unique operating characteristics to simulate passenger and baggage screening operations.

Additionally, TSA officials said that logistical and funding factors can influence the order of deployment, including the manufacturer's ability and resources to develop and deliver technologies. For example, as of June 2019, officials said the agency was in the process of updating the detection capabilities of 62 percent of its advanced technology x-ray fleet because one of its two manufacturers had completed testing and certification of the new technology, but the second manufacturer's technology had yet to be certified.[37] Officials said they also try to plan their deployment schedule around minimizing disruptions to airport operations, so if an airport could not absorb a full deployment of a technology because it would affect too many passengers, TSA would schedule the deployment in phases to minimize disruptions.

Further, TSA officials said that, as a result of these many logistical considerations, they generally fully deploy new screening technologies to category X airports first—generally, airports with the highest passenger volumes—and then proceed in order down to the airport with the lowest passenger volume. Officials said larger airports generally have the infrastructure in place to incorporate new technology without extensive disruption to operations, and they will screen the most passengers by deploying screening technologies to the largest airports first.[38]

TSA Does Not Ensure That Screening Technologies Continue to Meet Detection Requirements after Deployment to Airports

TSA practices do not ensure that screening technologies continue to meet detection requirements after they have been deployed to airports. According to agency officials, the agency uses certification to confirm that technologies meet detection requirements before they are deployed to airports, and calibration to confirm that technologies are at least minimally operational while in use at airports. Officials stated these processes are sufficient to assure TSA that screening technologies are operating as intended. However, while certification and calibration serve important purposes in the acquisition and operation of screening technologies, they have not ensured that TSA screening technologies continue to meet detection requirements after they have been deployed.

[37]The distribution of advanced technology x-rays between TSA's two manufacturers was calculated based on TSA's September 24, 2018, Deployed Locations Report.

[38]Our analysis of fiscal year 2018 passenger throughput data provided by TSA shows that 98 percent of annual domestic passengers travel through category X, I, and II airports.

TSA deploys technology to airports and provides maintenance and support services

Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

Certification occurs prior to deployment. TSA's certification process is designed to ensure screening technologies meet detection requirements during the acquisition process, prior to the procurement and deployment of the technologies, but it does not ensure screening technologies continue to meet detection requirements after deployment. As previously described, manufacturers provide an initial submission of the screening technology to TSA for certification testing as part of the acquisition process. During the certification process, S&T's Transportation Security Laboratory tests the technology under controlled conditions to determine whether it meets TSA's detection requirements. After TSA certifies that a screening technology meets detection requirements and it undergoes additional testing to determine whether it meets other TSA requirements in controlled testing facilities, TSA may deploy it to select airports for operational testing and evaluation to determine how it performs in an airport setting. Certification testing demonstrates that a manufacturer's screening technology meets detection requirements during the acquisition process, which allows TSA to determine whether it should continue to consider the technology for acquisition.

Certification does not ensure that deployed technologies continue to meet detection requirements because it does not account for the possibility that performance of technologies can degrade over time throughout the technologies' lifecycles after deployment. For example, in 2015 and 2016, DHS removed a sample of deployed explosives trace detection and bottled liquid scanner units from airports for testing in the Transportation Security Laboratory.[39] The laboratory concluded that some deployed units for each technology it tested no longer met detection requirements—either the required probability of detection for certain explosives or the required rate for false alarm, or both. One explosives trace detection unit that was tested was found to have a probability of detection much lower than required. According to TSA officials, the units did not meet detection requirements because they were not adequately maintained, which affected their performance. In light of this, officials stated that they

[39]Following the DHS Inspector General's 2015 covert test findings that identified vulnerabilities in TSA's checkpoint screening, DHS and TSA initiated a "tiger team" to address the vulnerabilities. To test deployed explosives trace detection units, S&T's Transportation Security Laboratory sampled units from each manufacturer, which had been deployed to different airports. The units were tested with a subset of explosives that were selected to cover the range of explosives that the technology is required to detect. To test deployed bottled liquid scanner units, the laboratory sampled units from each manufacturer, which had been deployed to different airports. The laboratory used a variety of bottle containers and liquids to test each unit.

introduced better controls to ensure that routine preventative maintenance is performed as required. However, because TSA does not test the units after they are deployed to airports, it cannot determine the extent to which these controls ensure technologies continue to meet detection requirements. Officials noted that TSA uses a layered security approach at airports, so if one layer should fail—such as a deployed technology—the agency can still rely on other security measures among the various layers of security to detect threats.[40] We have previously reported on the importance that TSA ensure each measure is effective to make the best use of its limited resources, in order to serve its aviation security mission.[41]

Calibration does not test whether technologies meet detection requirements. TSA officials stated that daily calibration also helps ensure that screening technologies continue to meet detection requirements after deployment. However, while calibration demonstrates that the screening technology is at least minimally operational, it is not designed to test whether the screening technology meets detection requirements. For example, each explosives detection system is calibrated with an operational test kit that contains items of various densities. To calibrate explosives detection systems, a TSO must run the operational test kit through the unit and verify that the item is correctly displayed on the monitor (see figure 5 below).[42] This process demonstrates whether the system can identify the known items' densities, but it does not ensure that the system meets detection requirements.[43] As a result, calibration could indicate that the unit is functioning even when its detection capabilities have degraded—that is, calibration determines that the technology is functional, but it does not ensure that the technology is meeting detection requirements.

[40]TSA uses a risk management strategy—referred to as "layers of security"—whereby TSA simultaneously deploys a mix of screening and other security countermeasures to deter and detect threats.

[41]See, for example, GAO, *Aviation Security: Actions Needed to Systematically Evaluate Cost and Effectiveness across Security Countermeasures*, GAO-17-794 (Washington, D.C.: Sep. 11, 2017).

[42]Calibration procedures vary in both frequency and type, by screening technology.

[43]TSA officials stated that explosives detection system manufacturers are currently developing or planning to develop American National Standards Institute compliant test kits for operational readiness testing following applicable upgrades of deployed systems and when the systems are relocated, or repositioned/redeployed.

Figure 5: Images of Calibration Procedures and Operational Test Kits Used for Explosives Detection System Technology

Source: GAO. | GAO-20-56

TSA officials stated that they plan to develop a process to review screening technologies on an annual basis to analyze their performance, including detection over time. TSA officials stated that, as of August 2019, they were actively working on developing a review process for the explosives detection system but did not have a date for when they planned to complete it. TSA officials for the passenger and carry-on screening technologies stated that they had not yet started developing a review process for those technologies and the timeline for developing a review process will depend on funding.

TSA officials also noted that there are challenges in designing a process to ensure that screening technologies continue to meet detection requirements after deployment. For example, TSA and S&T officials stated that it is not feasible to conduct live explosives testing in airports. Further, according to TSA officials, while it is relatively easy to temporarily transfer smaller screening technologies, such as explosives trace detection and bottled liquid scanner units, to a controlled setting for live explosives testing, it would not be feasible to transfer larger installed units, such as advanced imaging technology. Although testing with live explosives in an airport poses undue risks and transferring larger machines for testing may be costly, TSA could develop other measures.

TSA officials stated that there is no requirement to ensure that its screening technologies continue to meet detection requirements after deployment to airports. However, *Standards for Internal Control in the Federal Government* calls for agencies to establish and operate a system to continuously monitor the quality of performance over time.[44] Without taking additional steps to ensure screening technologies are meeting detection requirements, TSA may run the risk that its deployed screening technologies are not detecting explosives and other prohibited items. Developing and implementing a process to monitor screening technologies' detection performance over time would help provide TSA assurance that screening technologies continue to meet detection requirements, as appropriate, after deployment. In doing so, TSA would also be better positioned to take any necessary corrective actions if or when screening technologies no longer operate as required.

[44] GAO-14-704G.

TSA Spent an Estimated $3.1 Billion to Purchase, Deploy, Install, and Maintain its Fiscal Year 2018 Inventory of Screening Technologies

We estimate that TSA spent $3.1 billion to purchase, deploy, install, and maintain its inventory of screening technologies as of the end of fiscal year 2018, based on agency estimates of costs.[45] Of this $3.1 billion, we estimate that TSA spent 71 percent to purchase screening technologies, 9 percent to deploy, about 12 percent to install, and, for fiscal year 2018, about 9 percent to maintain them for 1 year.[46] The highest estimated total expenditures on a per-technology basis were for explosives detection systems ($2.1 billion, or 68 percent), advanced technology x-ray ($443 million, or 14 percent), explosives trace detection ($227 million, or 7 percent), and advanced imaging technology ($197 million, or 6 percent). Table 1 provides information on estimated expenditures for TSA's September 2018 inventory of screening technologies, by screening technology and life-cycle phase (i.e., purchase, deploy, install, and maintain). Appendix III provides additional information on estimated TSA expenditures, such as prices per unit of technology and estimated expenditures by airport category.

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[45]To review the costs allocated or incurred by TSA to purchase, deploy, install, and maintain screening technologies, we used agency life-cycle cost estimates to estimate TSA spending for its fiscal year 2018 inventory of passenger and checked baggage screening technologies. The inventory is limited to technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018, the last week of fiscal year 2018 and the last TSA deployment report of the fiscal year. We included all TSA screening technologies used in checkpoint and checked baggage screening, as identified to us by TSA, with the exception of computed tomography and threat image projection x-ray because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review. For the purposes of this report, references to TSA spending reflect the estimated amounts TSA expended to purchase, deploy, install, and maintain its fiscal year 2018 screening technology. Additionally, "purchase" refers to the per unit price of a technology; "deploy" refers to costs associated with transporting the technology to the airport; "install" refers to costs to set up the technology in the airport; and "maintain" refers to fiscal year 2018 costs to keep the technology operational after installation. We used the same guidelines used by TSA to adjust costs for inflation—the gross domestic product inflation guidelines from the DHS Chief Financial Officer—which averages to 1.9 percent per year for inflation. For more information on our methodology, as well as the screening technologies, see appendix II.

[46]These percentages do not sum to 100 due to rounding. Estimated expenditures for installation do not include amounts expended by TSA in support of airport facility modification projects undertaken to accommodate the deployment and installation of security screening equipment. See, e.g., 49 U.S.C. § 44923. The estimate for maintenance is the estimated yearly cost of maintenance, which recurs each year.

Table 1: Estimated Expenditures for the Transportation Security Administration's (TSA) Inventory of Screening Technologies in Use at TSA-Regulated Airports, by Life-Cycle Phase, as of September 24, 2018

Fiscal year 2018 dollars in thousands

Technology	Purchase	Deploy[a]	Install	Maintain[b]	Total
Advanced imaging technology	136,983	30,424	11,761	18,269	**197,438**
Advanced technology x-ray	339,672	53,310	9,790	40,062	**442,674**
Boarding pass scanner	4,560	n/a	722	55	**5,336**
Bottled liquid scanner	51,709	7,791	765	2,219	**62,484**
Chemical analysis device	24,574	n/a	243	2,268	**27,084**
Credential authentication technology	1,090	n/a	22	65	**1,176**
Explosives detection system	1,490,473	145,509	342,845	158,585	**2,137,413**
Explosives trace detection	151,363	28,176	1,415	46,083	**227,037**
Walk-through metal detector	14,949	9,637	703	1,174	**26,463**
Total	**2,215,373**	**274,687**	**368,266**	**268,780**	**3,127,105**

Legend:

n/a = not available

Source: GAO analysis of TSA lifecycle cost estimates and inventory data. | GAO-20-56

Notes: GAO used the same guidelines used by TSA to adjust costs for inflation—the gross domestic product inflation guidelines from the Department of Homeland Security Chief Financial Officer—which averages to 1.9 percent per year for inflation. The estimates do not include costs associated with earlier phases of the lifecycle, such as developmental and operational testing. We included all TSA screening technologies used in checkpoint and checked baggage screening, as identified by TSA, with the exception of computed tomography and threat image projection x-ray because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review.

[a]Some screening technologies do not have deployment costs because, for example, the technology may be small and placement can be handled by TSA airport staff .

[b]The maintenance cost is the estimated yearly cost of maintenance, which recurs every year.

TSA has also incurred costs, or has plans to incur costs, for additional actions related to screening technologies. Specifically, it has also incurred costs for modifications to commercial airport facilities to accommodate screening technologies. Further, TSA estimates additional life-cycle costs of $804 million to acquire, deploy, and maintain computed tomography systems through fiscal year 2026. The following provides more information on these estimated expenditures.

Airport modifications. TSA incurs costs related to modifying commercial airports to accommodate certain screening technologies, such as checked baggage screening systems (e.g., explosives detection systems). In December 2017, we reported that TSA had obligated at least $783 million from fiscal years 2012 through 2016 to reimburse airports for the allowable design and construction costs associated with installing, updating, or replacing screening technology.[47] For example, TSA may enter into agreements to reimburse airport operators for a percentage of the allowable design and construction costs associated with facility modifications needed for installing, updating, or replacing in-line explosives detection systems.[48] In-line screening systems use conveyor belts to route checked luggage through explosives detection systems, which capture images of the checked baggage to determine if a bag contains threat items not permitted for transport, including explosives. From fiscal years 2012 through 2016, agreements for TSA reimbursements to airports for checked baggage screening systems generally ranged in value from $50,000 to $150 million.[49] As we reported in December 2017, in general, depending on the airport's size, TSA will reimburse 90 or 95 percent of the allowable, allocable, and reasonable cost of certain projects. For other projects, TSA may provide 100 percent reimbursement—for example, where existing systems require the correction of security or safety deficiencies.

Computed tomography. In addition to its fiscal year 2018 inventory, TSA is currently in the process of deploying computed tomography to commercial airports to replace advanced technology x-ray systems. Computed tomography technology applies sophisticated algorithms to detect explosives and other prohibited items and creates a 3D image of carry-on baggage that a TSO can view and rotate 360 degrees. In fiscal year 2018, TSA determined that computed tomography is the best technology available to address rapidly evolving threats in the transportation sector, and plans to eventually deploy it to all checkpoints and replace advanced technology x-ray technology.[50] As recorded in TSA's Deployed Locations Report, TSA had deployed 11 computed tomography systems to category X and I airports as of September 24,

[47]GAO, *Transportation Security Administration: After Oversight Lapses, Compliance with Policy Governing Special Authority Has Been Strengthened*, GAO-18-172 (Washington, D.C.: Dec. 21, 2017).

[48]See, e.g., 49 U.S.C. § 44923.

[49]GAO-18-172.

[50]TSA intends to transition the procurement and deployment of computed tomography units, among other things, to the Checkpoint Property Screening System, which as of August 2019, had not yet been established. In February 2018, DHS leadership approved transitioning existing Passenger Screening Program projects—including advanced technology x-ray and computed tomography—into standalone programs to better align program office staffing to capabilities and focus on mitigating capability gaps, among other things.

2018. According to TSA's September 2018 life-cycle cost estimates, the agency plans to field 883 units by fiscal year 2026. As shown in table 2, TSA also planned to spend $805 million to purchase, deploy, and maintain this new technology through fiscal year 2026. However, in August 2019, TSA officials told us that they expect this estimated total procurement cost of $805 million to likely decrease as the per unit cost had decreased from $400,000 to $233,000 in the initial fiscal year 2019 contract for computed tomography.

Table 2: Life-Cycle Cost Estimates for Computed Tomography, as of September 2018

Fiscal year 2018 dollars in thousands

Cost element	Total estimated costs, fiscal years 2018 through 2026
Procurement	308,600
Testing	49,205
Deployment	177,827
Program support	8,513
Maintenance	174,952
Other costs	85,458
Total	**804,554**

Source: GAO analysis of Transportation Security Administration life-cycle cost estimates and inventory data. | GAO-20-56

Notes: Total may not sum due to rounding. Testing includes operational testing, facility acceptance testing, and site acceptance testing, among other kinds of testing. Program support includes training development, training delivery, and program initiatives, among other things. Other costs include costs to decommission transportation screening equipment and develop and deploy other enhancements.

Conclusions

TSA has invested billions of dollars in screening technologies as it responds to terrorists' attempts to use homemade explosives to disrupt and damage civil aviation. Forecasted increases in passenger volumes and ongoing terrorist threats make it imperative that TSA employ recommended management and internal control practices. TSA could help ensure that critical detection standards are developed in accordance with approved practices, and that agency goals are effectively met by updating its guidance for developing standards. Additionally, by documenting key decisions in the development of detection standards, TSA could better assure the effectiveness of decision-making and the retention of organizational knowledge in the face of inevitable changes in personnel.

Similarly, when making technology deployment decisions, incorporating DHS-recommended practices for risk management would improve TSA's ability to effectively fulfill its mission to secure the nation's civil aviation system. While TSA assesses risk when deciding whether to invest in a new technology to address an identified capability gap, it is unclear the extent to which it considers risk when determining where and in what order to deploy approved screening technologies to airports. DHS guidance for homeland security risk management calls for risk to be considered consistently and comprehensively in all aspects of an agency's work. Additionally, risk management includes transparent disclosure of the rationale behind decision-making so that stakeholders can understand how key factors were weighed. Incorporating these risk management principles into its decision-making for deploying screening technologies to airports would allow TSA to align its deployment strategies with potential threats, vulnerabilities, and consequences.

Lastly, TSA cannot ensure that its screening technologies continue to meet detection requirements after they have been deployed to airports. Developing and implementing a policy to ensure that TSA's screening technologies continue to meet their respective detection requirements after deployment may assure the agency that its deployed screening technologies are effectively detecting explosives and other prohibited items that they are designed to identify, which is a critical part of TSA's mission.

Recommendations for Executive Action

We are making the following five recommendations to TSA:

The TSA Administrator should update TSA guidance for developing and approving screening technology explosives detection standards to reflect designated procedures, the roles and responsibilities of stakeholders, and changes in the agency's organizational structure. (Recommendation 1)

The TSA Administrator should require and ensure that TSA officials document key decisions, including testing and analysis decisions, used to support the development and consideration of new screening technology explosives detection standards. (Recommendation 2)

The TSA Administrator should require and ensure that TSA officials document their assessments of risk and the rationale—including the assumptions, methodology, and uncertainty considered—behind decisions to deploy screening technologies. (Recommendation 3)

The TSA Administrator should develop a process to ensure that screening technologies continue to meet detection requirements after deployment to commercial airports. (Recommendation 4)

The TSA Administrator should implement the process it develops to ensure that screening technologies continue to meet detection requirements after deployment to commercial airports. (Recommendation 5)

Agency Comments and Our Evaluation

We provided a draft of this product to DHS for comment. We provided a draft of this report to DHS for review and comment. DHS provided written comments, which are reproduced in full in appendix IV. DHS concurred with our five recommendations and described actions undertaken or planned to address them. TSA also provided technical comments, which we incorporated as appropriate.

With regard to our first recommendation that TSA update guidance for developing and approving screening technology explosives detection standards, DHS concurred and stated that TSA has included updated guidance in its *Requirements Engineering Integrated Process Manual*, which was completed in September 2019.[51] According to DHS, the update provides TSA's process for developing and approving explosives detection standards, including designated procedures and roles and responsibilities of stakeholders, and reflects organizational changes to TSA. TSA provided us with the *Requirements Engineering Integrated Process Manual* in November 2019, concurrent with DHS comments. We will review the update and the extent to which it addresses the recommendation. This action, if fully implemented, should address the intent of the recommendation.

DHS concurred with our second recommendation that TSA ensure that officials document key decisions supporting the development of screening technology explosives detection standards. DHS stated that the updated *Requirements Engineering Integrated Process Manual* describes the process for documenting key decisions, including testing and analysis decisions, in the development of new detection standards. We will review the update and the extent to which it addresses the recommendation. This action, if fully implemented, should address the intent of the recommendation.

[51]TSA, Requirements and Capabilities Analysis, *Requirements Engineering Integrated Process Manual* (RE IPM), Version 1.0 (September 2019).

DHS also concurred with our third recommendation that TSA document its assessments of risk and the rationale behind its decisions to deploy screening technologies. According to DHS, TSA has instituted an improved process for documenting elements that contribute to deployment decisions—TSA's August 2019 deployment plan for computed tomography is an example of the process. DHS stated that TSA will continue to include a comparable level of documentation in future deployment plans for screening technologies. We agree the computed tomography deployment site selection strategy is an example of how TSA can document the rationale governing the deployment of a screening technology. Future plans can further benefit by explaining the risk analysis itself along with the role that risk considerations played in the selection of airports for deployment. Formalizing guidance that directs TSA officials to document risk assessments and the rationale behind deployment decisions would help TSA ensure that its deployment of screening technologies matches potential risks.

DHS concurred with our fourth and fifth recommendations that TSA, respectively, develop and implement a process to ensure that screening technologies continue to meet all detection requirements after deployment to commercial airports. DHS stated that TSA will develop recurring individual post implementation reviews (PIR) for all screening technologies in accordance with DHS Directive 102-01, to assess multiple aspects of system performance, including detection over time.[52] DHS also stated that TSA intends to examine the component performance of the detection chain rather than a direct measure of detection requirements, due to the limitations of using live explosives and simulants. DHS stated that because the detection chain for each technology is unique and will require individual reviews, TSA is developing a policy on the PIR development process, which it estimates will be completed by March 31, 2020. We appreciate the limitations live explosives and simulants present in testing and the need for reviews that are tailored to meet the unique characteristics of each screening technology. TSA plans to implement the review process on the first screening technology by December 31, 2020. These actions, if implemented across all applicable screening technologies, should address the intent of the recommendations.

[52]DHS, *Acquisition Management Directive,* 102-01, Rev 3.1 (Feb. 25, 2019).

We are sending copies of this report to the appropriate congressional committees and to the Acting Secretary of Homeland Security. In addition, this report is available at no charge on the GAO website at http://gao.gov.

If you or your staff have any questions concerning this report, please contact me at (202) 512-8777 or russellw@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made significant contributions to this report are listed in Appendix V.

W. William Russell, Director,
Homeland Security and Justice

List of Congressional Addressees

The Honorable Roger Wicker
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The Honorable Maria Cantwell
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The Honorable Ron Johnson
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The Honorable Gary C. Peters
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Ranking Member
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House of Representatives

The Honorable John Katko
House of Representatives

The Honorable Michael McCaul
House of Representatives

The Honorable Bonnie Watson Coleman
House of Representatives

Appendix I: Transportation Security Administration (TSA) Screening Technologies

This appendix presents additional details on the TSA screening technologies we reviewed, including their function and the number of units deployed.

Advanced Imaging Technology

Description

Advanced imaging technology (AIT) screens passengers for metallic and non-metallic threats including weapons, explosives, and other objects concealed under layers of clothing without physical contact. AIT is used for primary passenger screening.

Number of Units Deployed, as of September 24, 2018

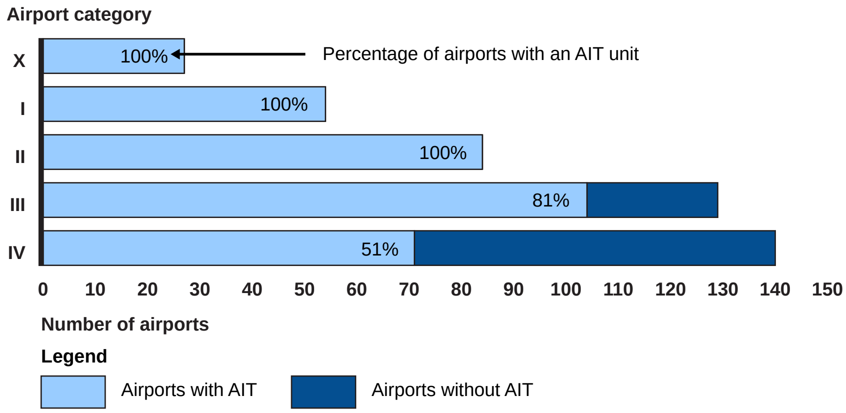
949

Estimated Purchase Price Per Unit (adjusted to fiscal year 2018 dollars)

$144,344

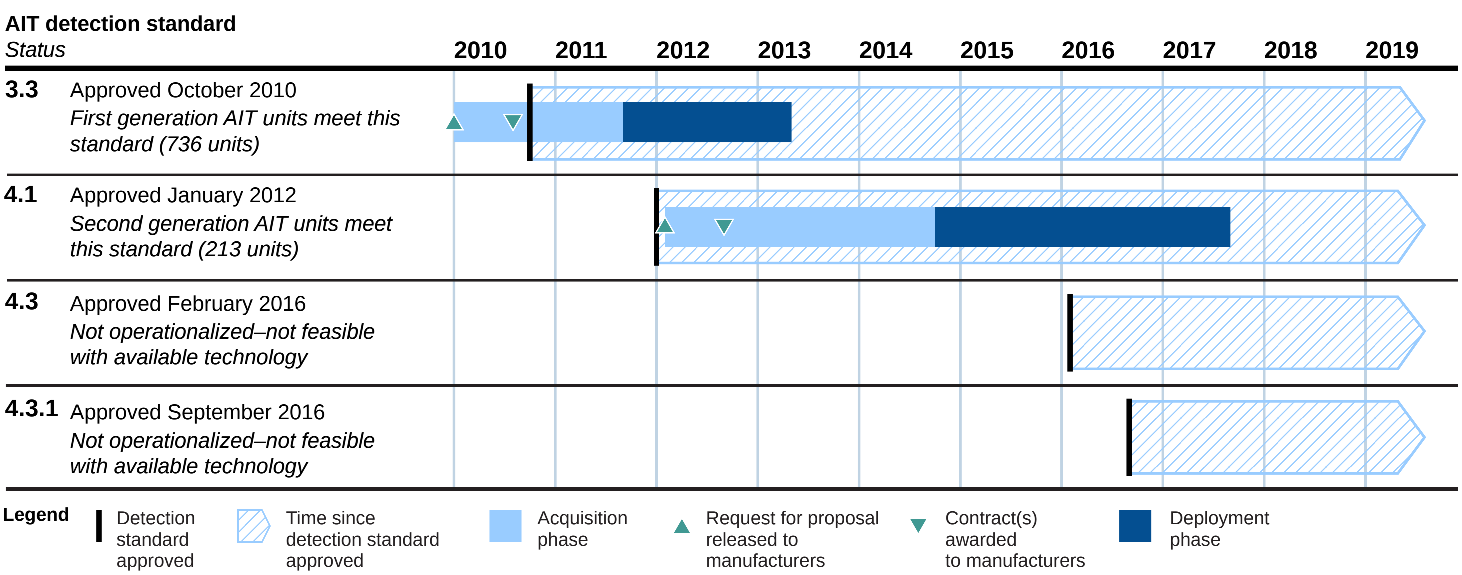
Source: GAO. | GAO-20-56

Figure 6: Number of Airports with an Advanced Imaging Technology (AIT) unit, by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

Figure 7: Timeline for Operationalizing Advanced Imaging Technology (AIT) Detection Standards



Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

Notes: The term "operationalize" refers to TSA's process for acquiring and deploying technologies to meet detection standards. For detection standard 3.3, officials said the request for proposal date was estimated. Officials said detection standard 3.3 was signed after the acquisition milestones because officials with signing authority were not available to sign the draft version of the standard before the acquisition process began. The number of units deployed was from September 24, 2018.

Advanced Technology X-Ray

Description

Advanced technology x-ray uses detection algorithm software to identify prohibited items and other potential threats, such as explosives, in carry-on bags, and provides a horizontal and vertical image of each item to the screener. Advanced technology x-ray is used for carry-on bag screening.

Number of Units Deployed, as of September 24, 2018

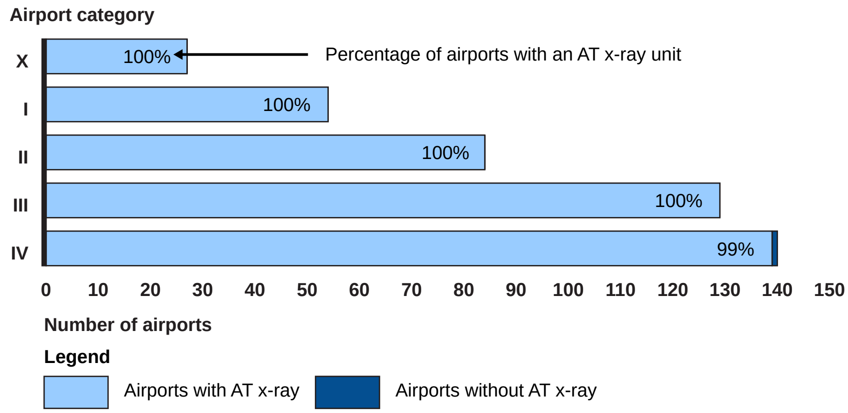
2,211

Estimated Purchase Price Per Unit (adjusted to fiscal year 2018 dollars)

$153,628

Source: GAO. | GAO-20-56

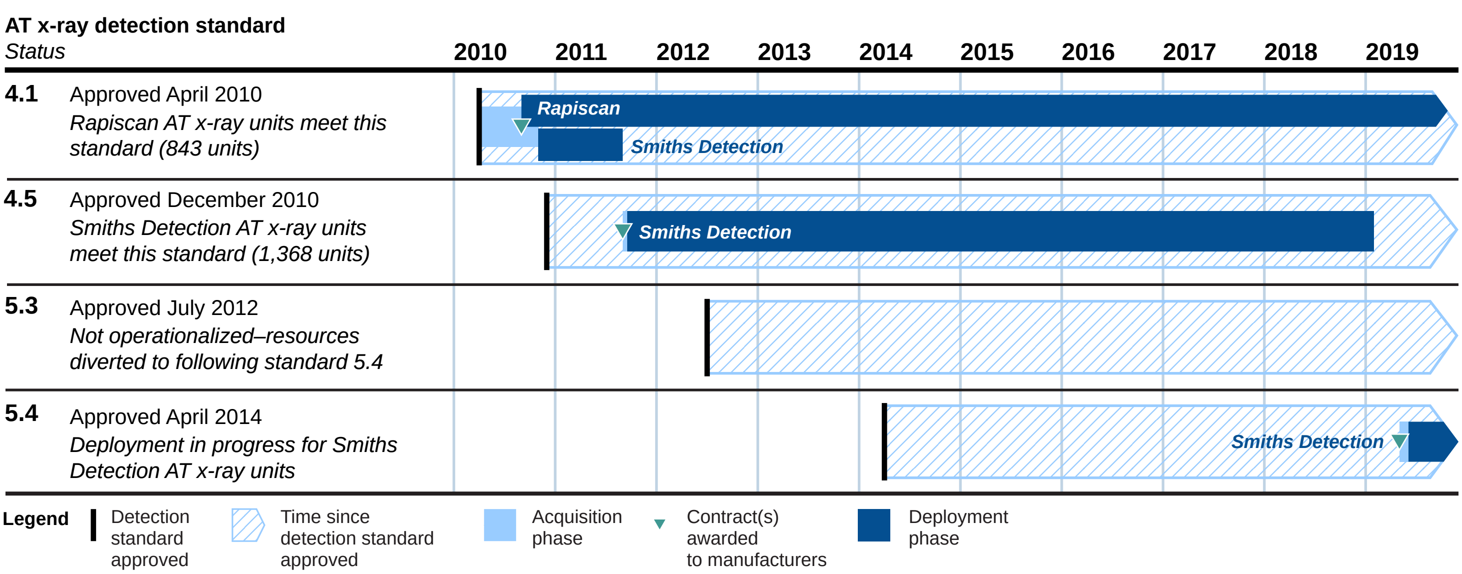
Figure 8: Airports with an Advanced Technology (AT) X-Ray Unit, by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

Note: The 1 percent of Category IV airports that did not have an AT x-ray had an alternative type of technology, which was removed and replaced with an AT x-ray in fiscal year 2019.

Figure 9: Timeline for Operationalizing Advanced Technology (AT) X-Ray Detection Standards



Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

Notes: The term "operationalize" refers to TSA's process for acquiring and deploying technologies to meet detection standards. Officials said they had contracts with two manufacturers—Rapiscan and Smiths Detection—to develop technology to meet these standards. Officials said they deployed AT x-ray units on an ongoing basis. As of July 2019, Rapiscan's technology was undergoing testing to meet detection standard 5.4. Officials said they updated their existing contracts with the manufacturers to procure the technologies. The number of units deployed was from September 24, 2018.

Boarding Pass Scanner

Description

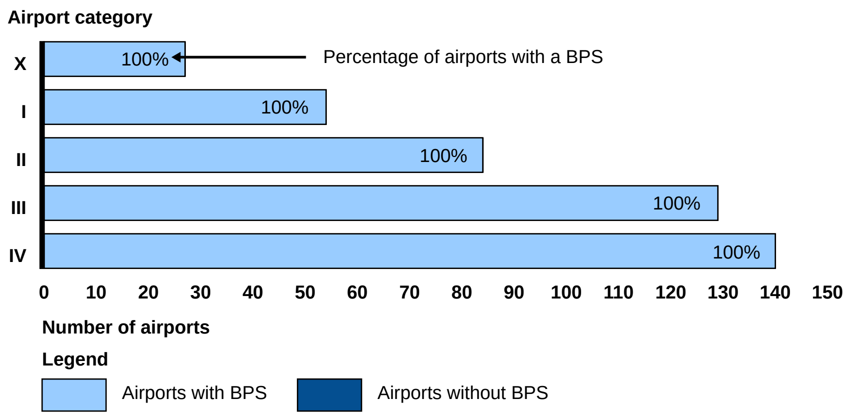
Boarding pass scanners confirm a passenger's status by automating the scanning of passenger boarding passes.

Number of Units Deployed, as of September 24, 2018
2,627

Estimated Purchase Price Per Unit (adjusted to fiscal year 2018 dollars)
$1,736

Source: Transportation Security Administration. | GAO-20-56

Figure 10: Number of Airports with a Boarding Pass Scanner (BPS), by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

The boarding pass scanner is not subject to explosives detection standards.

Bottled Liquid Scanner

Description

The bottled liquid scanner differentiates dangerous liquids from common, benign substances carried by passengers during the checkpoint screening process, and is used at secondary screening for both primary and secondary screening of liquids.

Number of Units Deployed, as of September 24, 2018

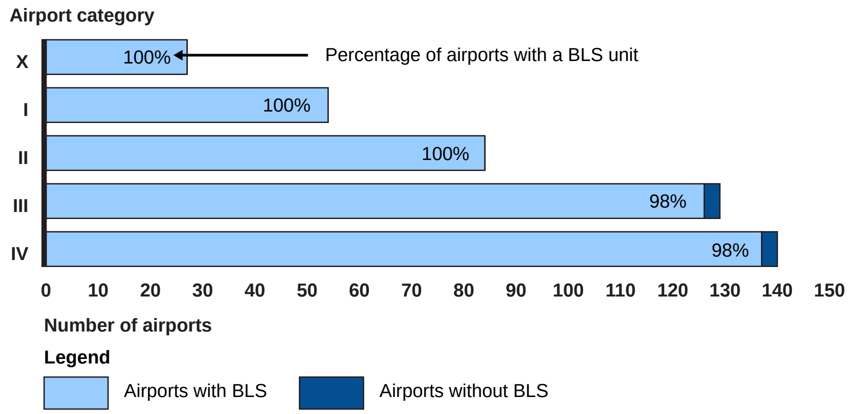
1,619

Estimated Purchase Price Per Unit (adjusted to fiscal year 2018 dollars)

$31,939

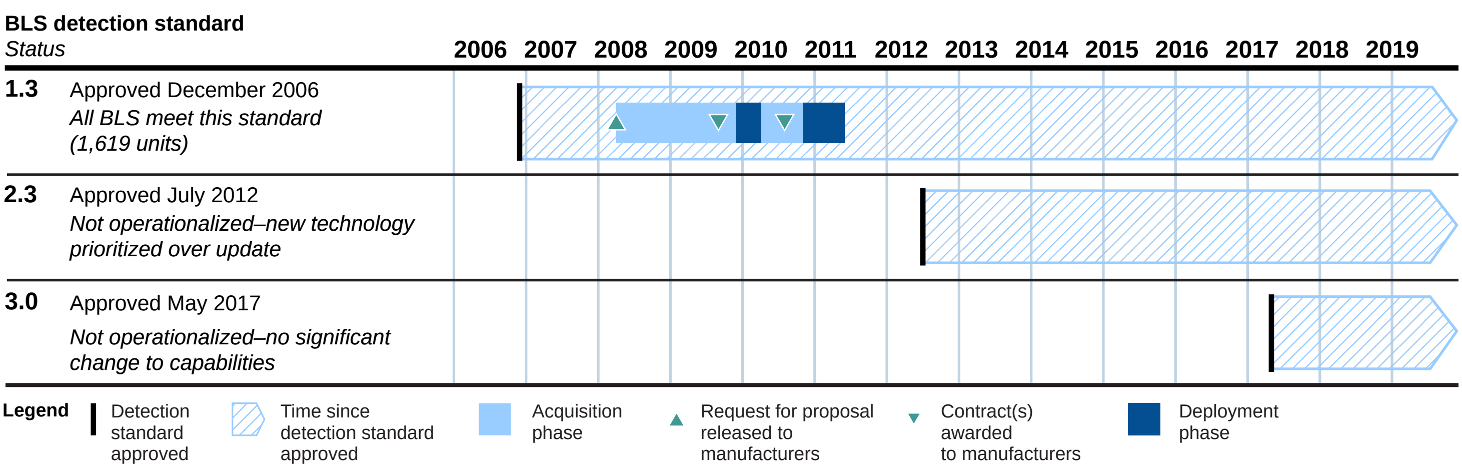
Source: Transportation Security Administration. | GAO-20-56

Figure 11: Number of Airports with a Bottled Liquid Scanner (BLS), by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

Figure 12: Timeline for Operationalizing Bottled Liquid Scanner (BLS) Detection Standards



Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

Notes: The term "operationalize" refers to TSA's process for acquiring and deploying technologies to meet detection standards. Officials said they contracted with two manufacturers—CEIA USA and Smiths Detection—for BLS technology that met detection standard 1.3. The number of units deployed was from September 24, 2018.

Chemical Analysis Device

Description

Chemical analysis devices determine, characterize, and quantify chemical components of screened items. They are used for secondary alarm resolution and are typically handled by explosives specialists.

Number of Units Deployed, as of September 24, 2018

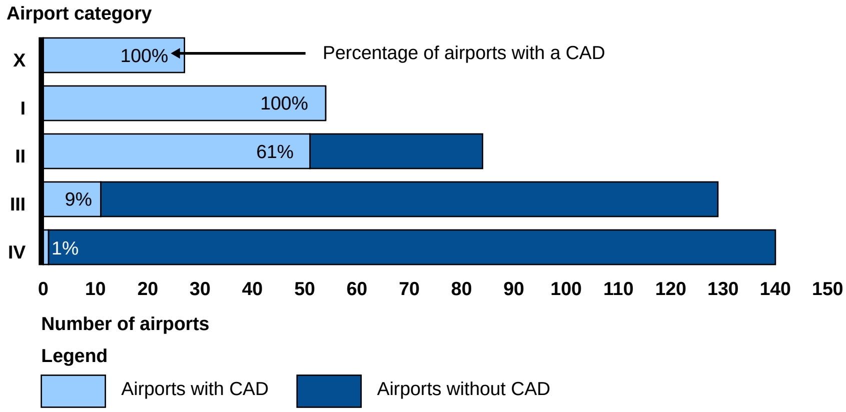
481

Estimated Purchase Price Per Unit (adjusted to fiscal year 2018 dollars)

$51,089

Source: Transportation Security Administration. | GAO-20-56

Figure 13: Number of Airports with a Chemical Analysis Device (CAD), by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

The chemical analysis device is not subject to detection standards.

Credential Authentication Technology

Description

Credential authentication technology (CAT) authenticates passenger identification and boarding passes before a passenger enters the screening checkpoint. CAT validates information from a passenger's identifiction against Secure Flight—the Transportation Security Administration's (TSA) passenger prescreening system. TSA is currently in the process of deploying CAT to airports.

Number of Units Deployed, as of September 24, 2018

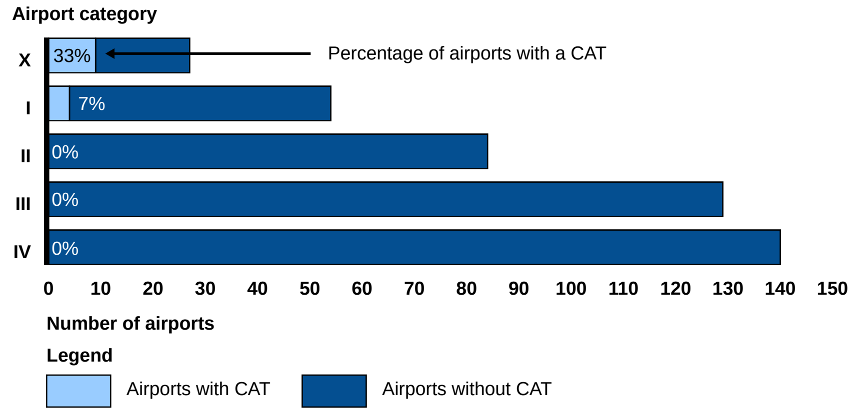
41

Fiscal Year 2019 Contract Price Per Unit

$16,733

Source: Transportation Security Administration. | GAO-20-56

Figure 14: Number of Airports with a Credential Authentication Technology (CAT) Unit, by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

The credential authentication technology is not subject to explosives detection standards.

Computed Tomography

Description

Computed tomography (CT) technology detects explosives and other prohibited items and creates a 3D image of carry-on baggage that a screener can rotate 360 degrees. As of September 2018, Transportation Security Administration (TSA) had deployed a limited number of CT units for testing. TSA plans to begin deploying at least 300 additional CT units in fiscal year 2020 for the primary screening of carry-on baggage.

Number of Units Deployed, as of September 24, 2018

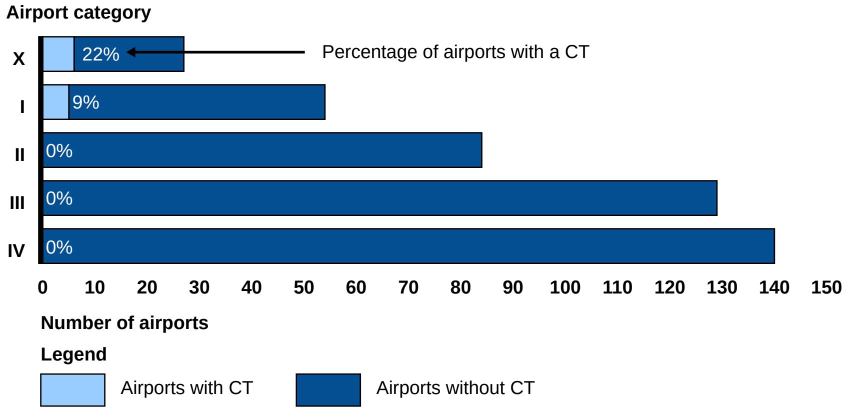
11

Fiscal Year 2019 Contract Price Per Unit

$232,731

Source: GAO. | GAO-20-56

Figure 15: Number of Airports with a Computed Tomography (CT) Unit, by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

CT systems tested were certified to meet the advanced technology x-ray detection standard 5.4. As of December 2018, TSA planned to develop an enhanced detection standard for accessible property (carry-on bags) screening, including CT technology.

Explosives Detection Systems

Description

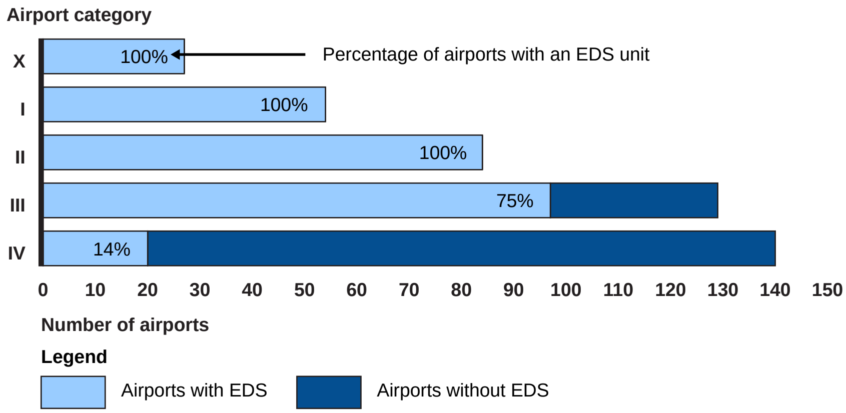
Explosives detection systems (EDS) use x-rays with computed tomography technology to automatically measure the physical characteristics of objects in checked bags, and alarms when objects that exhibit the physical characteristics of explosives are detected. EDS is used to screen checked baggage at most Transportation Security Administration-regulated airports.

Number of Units Deployed, as of September 24, 2018
1,658

Estimated Purchase Price Per Unit (adjusted to fiscal year 2018 dollars)
$898,959

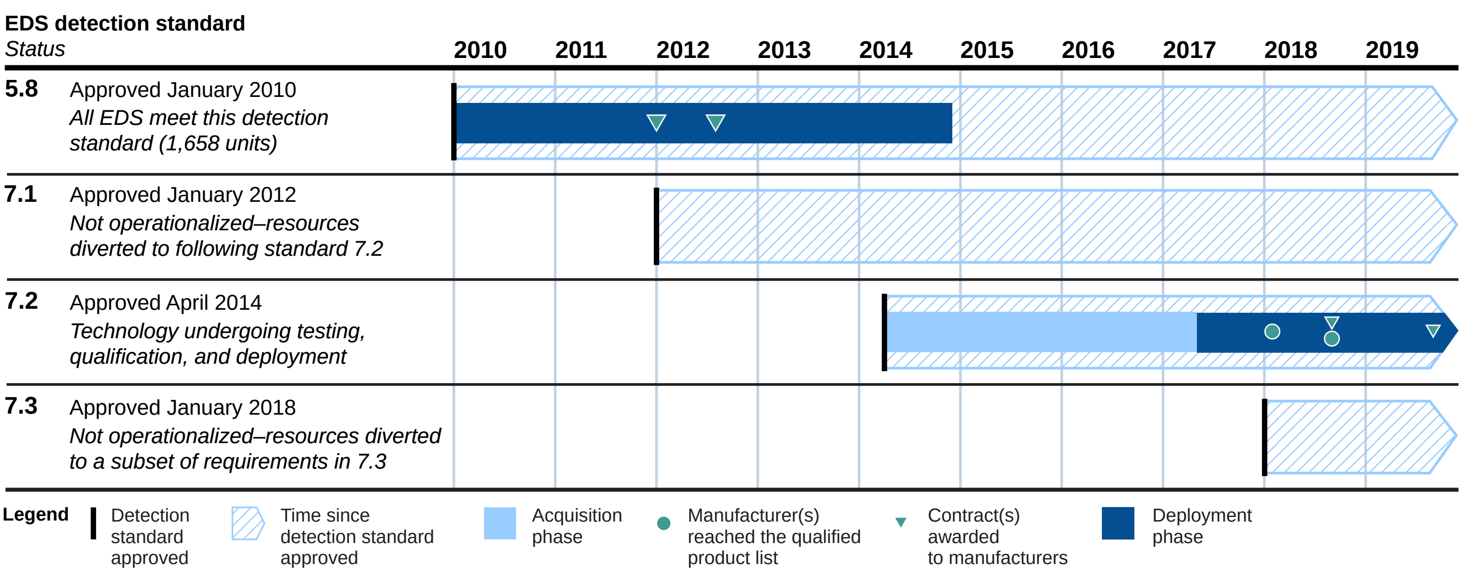
Source: GAO. | GAO-20-56

Figure 16: Number of Airports with an Explosives Detection Systems (EDS), by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

Figure 17: Timeline for Explosives Detection Systems (EDS) Detection Standards



Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

Notes: The term "operationalize" refers to TSA's process for acquiring and deploying technologies to meet detection standards. Officials said EDS at airports already had the capabilities of detection standard 5.8 when TSA approved it in 2010 because they met a comparable standard set by the Federal Aviation Administration, which had been responsible for civil aviation security before TSA. Officials said they awarded contracts to three manufacturers—L3 Technologies, Smiths Detection, and Reveal—in 2012 for additional EDS that met 5.8. In June 2018, TSA approved Detection Functional Requirements Document 7.3a—a subset of requirements based on standard 7.3—and officials said manufacturers are developing technology to meet those requirements. Officials said they released a request for proposal in 2011 that was used to develop technologies for 7.2 and 7.3a. The number of units deployed was from September 24, 2018.

Explosives Trace Detection

Description

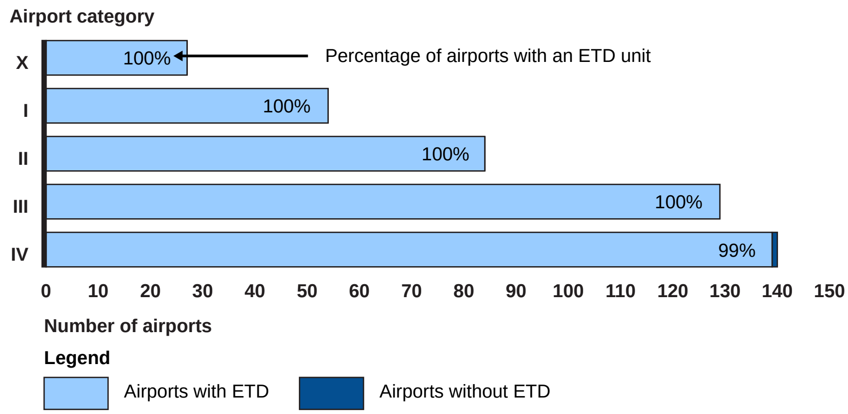
Explosives trace detection (ETD) technology detects explosives on persons, their carry-on bags, and checked baggage. ETD detects the chemical attributes of explosive residues. ETD is generally used for secondary screening, but airports that do not have an explosives detection system may use it for primary screening of checked baggage.

Number of Units Deployed, as of September 24, 2018
5,855

Estimated Purchase Price Per Unit (adjusted to fiscal year 2018 dollars)
$25,852

Source: GAO. | GAO-20-56

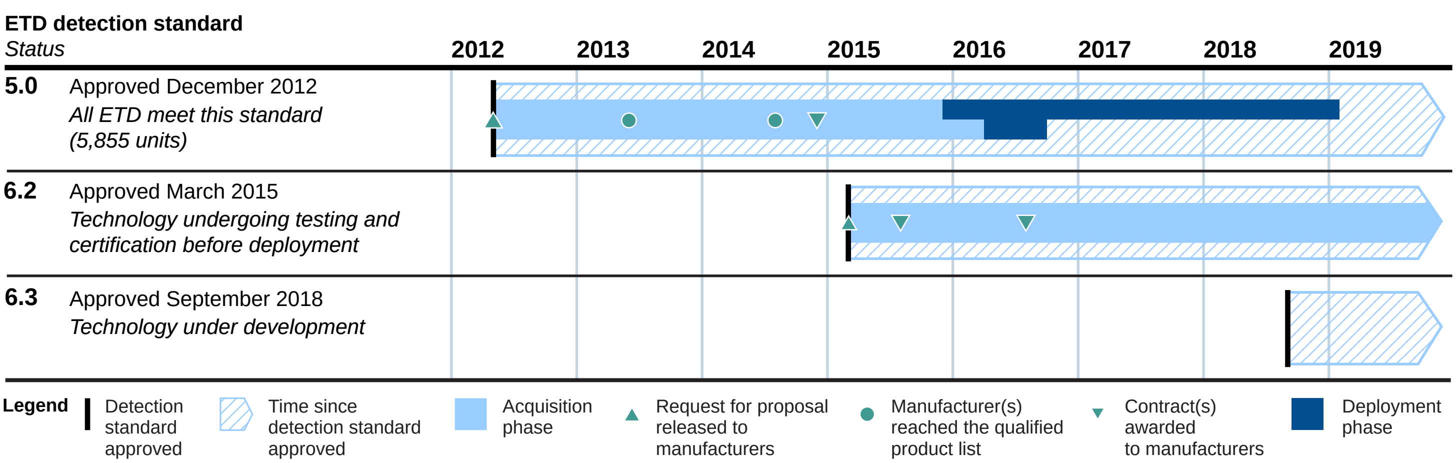
Figure 18: Number of Airports with an Explosives Trace Detection (ETD) Unit, by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

Note: According to TSA officials, TSA had removed the ETD unit and other screening equipment from one category IV airport during fiscal year 2018 because a change in air carrier operations at the airport no longer required implementation of TSA screening measures for passengers and their property.

Figure 19: Timeline for Explosives Trace Detection (ETD) Detection Standards



Source: GAO analysis of Transportation Security Administration (TSA) information. | GAO-20-56

Notes: The term "operationalize" refers to TSA's process for acquiring and deploying technologies to meet detection standards. TSA officials said they had two contracts with manufacturers—Smiths Detection and L3 Technologies—to develop technology to meet these detection standards. One manufacturer had a contract in place as of September 2008, which officials used to procure technology to meet standard 5.0. The number of units deployed was from September 24, 2018.

Walk-Through Metal Detector

Description

Walk-through metal detectors detect magnetic and mixed alloy materials across a broad range of frequencies. Walk-through metal detectors are used for primary passenger screening.

Number of Units Deployed, as of September 24, 2018

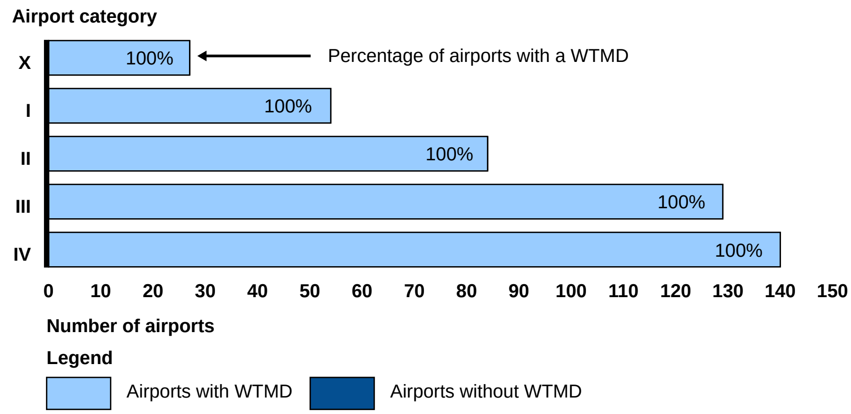
1,362

Estimated Purchase Price Per Unit (adjusted to fiscal year 2018 dollars)

$10,976

Source: GAO. | GAO-20-56

Figure 20: Airports with a Walk-Through Metal Detector (WTMD) Unit, by TSA Airport Category, as of September 24, 2018



Source: GAO analysis of Transportation Security Administration (TSA) data. | GAO-20-56

The walk-through metal detector is not subject to explosives detection standards.

Appendix II: Objectives, Scope, and Methodology

This report addresses Transportation Security Administration's (TSA) processes for developing and deploying screening technologies to airports regulated by TSA (i.e., "commercial" airports). Specifically, we examined

1. the extent to which TSA has a process for developing explosives detection standards for screening technologies in response to identified emerging threats;

2. how TSA operationalizes detection standards to update detection capabilities;

3. the extent to which TSA has considered risk when deploying screening technologies to commercial airports;

4. the extent to which TSA ensures screening technologies meet the requirements for detection standards after deployment; and

5. TSA estimated expenditures to purchase, deploy, install, and maintain its inventory of screening technologies as of the end of fiscal year 2018.

To address all of our objectives, we identified 11 screening technologies TSA used to screen passengers' identification documents, person, carry-on bags, and checked baggage at commercial airports as of September 24, 2018, as recorded in TSA's Government Property Management database.[1] The seven screening technologies in use at commercial airport passenger checkpoints were advanced imaging technology, advanced technology x-ray machine, bottled liquid scanner, boarding pass scanner, chemical analysis device, threat image projection x-ray, and walk-through metal detector.[2] The credential authentication technology and computed tomography, also used at checkpoint screening, were deployed and in use at select airports as TSA pilot projects. The two TSA screening technologies in use at commercial

[1]Specifically, we used TSA's Deployed Locations Report, which provided information on screening technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018 (the last week in fiscal year 2018), and did not include units that were deployed or in use at other locations, such as for testing or repair.

[2]The extent to which these technologies were deployed and in use or available for use at commercial airports varied. For example, the threat image projection x-ray was in use at one airport in September 2018 because that airport did not have the physical space to accommodate an advanced technology x-ray, the replacement technology.

airports for checked baggage were explosives detection systems and explosives trace detection (TSA also uses explosives trace detection for checkpoint screening).

We assessed the reliability of TSA's inventory data by interviewing agency officials and reviewing related documentation, such as the database user manual, among other things. We determined the data were sufficiently reliable to determine the type and number of TSA screening technologies deployed as of September 2018. To better understand how TSA screening technologies have been used, we reviewed reports from the U.S. Department of Homeland Security (DHS) Office of the Inspector General, the Congressional Research Service, past GAO reports, and relevant DHS and TSA documentation, such as DHS and TSA strategic documents and acquisition plans. To observe TSA screening procedures and the operation of screening technologies in the airport setting, we conducted site visits to seven commercial airports.[3] During these visits we discussed screening technology issues with TSA federal security directors or their representatives.[4] We selected these airports to reflect a range of airport categories, technologies, and geographic diversity. [5] The results of these site visits and interviews cannot be generalized to all commercial airports, but they provided us with important context about the installation, use, and maintenance of TSA screening technologies across the different types of airports that TSA secures. We also conducted a site visit to the TSA Systems Integration Facility to better understand how screening technologies are tested and evaluated prior to deployment. Further, we interviewed officials from two industry associations and one screening technology manufacturers association

[3]We visited Baltimore/Washington International Thurgood Marshall Airport, Hattiesburg-Laurel Regional Airport, Louis Armstrong New Orleans International Airport, Mobile Regional Airport, Montgomery Regional Airport, Ronald Reagan Washington National Airport, and Washington Dulles International Airport.

[4]Federal Security Directors are the ranking TSA authorities responsible for leading and coordinating TSA security activities at commercial airports.

[5]TSA classifies commercial airports into five categories (X, I, II, III, and IV) based on various factors, such as the number of take-offs and landings annually, and other security considerations. In general, category X airports have the largest number of passenger boardings and category IV airports have the smallest.

based on input from TSA and DHS Science and Technology Directorate (S&T) officials.[6]

To determine the extent to which TSA has a process for developing explosives detection standards, we examined TSA documents such as approved detection standards, action memos summarizing support for proposed detection standards, the *Detection Requirements Update Standard Operating Procedure*, and briefing slides describing TSA's process, as of August 2019, for assessing threat materials and developing detection standards.[7] We also evaluated Material Threat Assessment reports that summarized the testing and analyses performed by S&T's Homemade Explosives Characterization Program, in coordination with S&T laboratories, to characterize (identify the physical density and mass of) explosive materials for detection standards developed from fiscal years 2014 through 2018. We evaluated S&T's testing and analyses in accordance with TSA and S&T guidance to determine the extent to which these steps were consistent across materials; we did not analyze the sufficiency of the testing and analyses. We also assessed TSA and S&T processes and the extent to which they were documented in accordance with *Standards for Internal Control in the Federal Government*, and discussed the details of steps taken to develop standards with relevant TSA and S&T officials.[8] In addition, we conducted a site visit to S&T's Commercial Aircraft Vulnerability and Mitigation Program testing site at the U.S. Army Aberdeen Test Center, Maryland, to

[6]According to the two industry associations—American Association of Airport Executives and the Airports Council International-North America—their combined membership includes thousands of airport management personnel and represents approximately 95 percent of domestic airline passenger and air cargo traffic in North America. We also spoke with the Security Manufacturers Coalition, which represents companies that manufacture screening securities technologies, and which focuses on aviation and intermodal security issues in the United States and globally. According to its website, the Security Manufacturers Coalition is organized under the Airport Consultants Council, a global trade association representing private businesses involved in the development and operations of airports and related facilities.

[7]TSA, *Detection Requirements Update Standard Operating Procedure* (December 2015).

[8]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

better understand how S&T tests the vulnerability of commercial aircraft to explosive materials.[9]

To understand TSA's process and timelines for operationalizing—putting into effect—detection standards, we requested information from TSA about screening technologies subject to explosives detection standards, deployed as of September 24, 2018: advanced imaging technology, advanced technology x-ray, bottled liquid scanner, explosives detection systems, and explosives trace detection. We requested information about the detection standards that deployed screening technologies met, as of August 2019, as well as subsequently approved detection standards, including the date the standards were approved, the dates when TSA achieved certain acquisition milestones when developing and deploying the associated technologies, and the status of ongoing and upcoming efforts to update detection capabilities to meet new standards. We identified the acquisition milestones by reviewing a past GAO report on TSA's acquisition process and in consultation with GAO acquisition experts.[10] We also reviewed a classified TSA report that evaluated the performance of a particular algorithm in order to understand TSA's process for developing new screening technologies to meet detection standards. In addition, we reviewed relevant acquisition documents, such as DHS's *Acquisition Management Instruction* 102, the 2018 *Transportation Security Administration Systems Acquisition Manual*, acquisition decision memos, acquisition plans, and Operations Requirements Documents.[11] To understand TSA's process for deciding whether to operationalize detection standards, we requested and reviewed available documentation for the standards that TSA had not operationalized, such as an operational status transition memo for bottled liquid scanner, and interviewed TSA officials about those decisions.

To understand how TSA had considered risk in its approach to deploying screening technologies at airports, we reviewed available documentation related to TSA's deployment decisions. These included decision memos

[9]S&T's Commercial Aircraft Explosive Vulnerability and Mitigation Program tests the vulnerability of commercial aircraft to explosive materials placed inside various areas of an aircraft.

[10]GAO, *TSA Acquisitions: Further Actions Needed to Improve Efficiency of Screening Technology Test and Evaluation,* GAO-16-117 (Washington, D.C.: Dec. 17, 2015).

[11]DHS*, Acquisition Management Instruction*, 102-01-001 Revision 1 (May 3, 2019) and TSA, *Transportation Security Administration Systems Acquisition Manual* (August 2018).

from acquisition review board meetings and action memos to TSA leadership; risk registers for checked baggage and checkpoint acquisition programs; available deployment plans, such as the agency's Action Plan for deploying explosives trace detection units to airports in 2018; and acquisition guidance.[12] To understand how TSA assesses capability needs and gaps, we interviewed agency officials about TSA's Transportation Security Capability Analysis Process and reviewed capability analysis reports from 2018 and 2019, as well as TSA's prioritized list of capability gaps and needs. We also interviewed acquisition officials, including TSA's Component Acquisition Executive, about the role of risk in deployment decisions and requested written responses to specific questions. We assessed TSA's decision-making process for deploying and updating screening technologies, generally, against DHS risk management criteria, such as DHS's *Risk Management Fundamentals*.[13] We also reviewed related areas of risk management and decision-making to understand the context in which TSA makes deployment decisions. Specifically, we reviewed the 2017 *Transportation Sector Security Risk Assessment* and the *Cities and Airports Threat Assessment* reports to understand the risks facing the nation's aviation system.[14] We also reviewed TSA's enterprise risk management framework, such as the *Enterprise Risk Management Policy Manual*, to understand the role it played in TSA's deployment decisions.[15] We also interviewed an official from TSA's Enterprise Performance and Risk office and the Executive Risk Steering Committee. To understand how TSA categorizes airports, we reviewed a 2017 Nationwide Airport Categorization Review memo from TSA's Security Operations office and interviewed Security Operations officials.

[12] A risk register is a tool to analyze and manage the likelihood and consequence of risks to a program's cost, schedule, and performance.

[13] DHS, *Risk Management Fundamentals: Homeland Security Risk Management Doctrine* (April 2011).

[14] The *Transportation Sector Security Risk Assessment* is a report on transportation security that assesses risk within different transportation sectors by establishing risk scores for various attack scenarios. TSA issues the report annually, and the scenarios are continuously refined to reflect evolving threats and feedback from subject matter experts. TSA, *Transportation Sector Security Risk Assessment* (2017). The *Cities and Airports Threat Assessment* report provides a ranking of domestic airports based on terrorism threat indicators for each airport. It is updated monthly by TSA's Intelligence and Analysis office. TSA, Office of Intelligence and Analysis, Risk Analysis Division, *Cities and Airports Threat Assessment*, Monthly Threat Update (October 2017).

[15] TSA, *Enterprise Risk Management Policy Manual* (Washington, D.C.: February 2019).

To understand how TSA deploys screening technologies across airports and categories of airports, we analyzed TSA's Deployed Locations Report, which reported on technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018. We also reviewed TSA's standardized methodology for determining the most efficient number of screening technologies at an airport. Additionally, we reviewed TSA's Strategic Five-Year Technology Investment Plan from 2015 and the 2017 Biennial Refresh to understand TSA's plans for ongoing investment in screening technologies. We reviewed various throughput data, such as annual passenger throughput for all commercial airports for fiscal year 2018 and enplanements data for calendar year 2017, to understand and compare TSA's allocation of screening technologies with throughput data across airports and airport categories. We used this analysis to identify airports that had an unusually large or small number of screening technologies within a category, and interviewed TSA officials to understand the decisions that led to the allocation of screening technologies across airports and airport categories.

In addition, we reviewed the status of TSA's limited deployment of computed tomography units to checkpoints.[16] Specifically, we reviewed TSA's 2018 Deployment Site Selection Strategy, which described the airports to which TSA would deploy computed tomography units and the methodology it used to select them, slides from recent conferences TSA held with industry representatives where it shared its plans for transitioning to computed tomography, and relevant Operational Requirements Documents. We also interviewed agency officials about their plans for the limited deployment and TSA's transition from advanced technology x-ray to computed tomography for checkpoint screening.

To determine the extent to which TSA ensures its screening technologies continue meeting detection requirements after deploying them to airports, we reviewed TSA acquisition detection requirements for each screening technology as well as TSA guidance related to the testing and evaluation of screening technologies identified by TSA officials in interviews. We also interviewed TSA and S&T Transportation Security Laboratory officials about TSA requirements to test screening technologies, both prior to and after deployment, to determine the extent to which they meet

[16]As of September 24, 2018, TSA had deployed 11 computed tomography systems to category X and I airports for testing.

detection requirements.[17] We also observed transportation security officers and a transportation security specialist for explosives conduct verification and calibration procedures on screening technologies at the airports we visited.[18] We reviewed TSA guidance to determine the extent to which its procedures ensure that screening technologies continued to meet detection requirements in airports. We then evaluated the procedures against *Standards for Internal Control in the Federal Government* for monitoring.[19]

To identify TSA's estimated expenditures to purchase, deploy, install, and maintain its inventory of screening technologies as of the end of fiscal year 2018, we reviewed TSA programs' life-cycle cost estimates, which, for the purposes of acquisition planning, provide per unit estimates of the cost to purchase, deploy, install, and maintain passenger and checked

[17] The S&T Transportation Security Laboratory is a DHS Federal Laboratory that, among other things, provides TSA with certification and qualification tests and laboratory assessments regarding screening technologies and their ability to detect explosives.

[18] Although for the purposes of this report references to transportation security officers include both TSA-employed screening personnel and personnel employed by a private sector company contracted with TSA to perform screening services at airports participating in TSA's Screening Partnership Program, we did not visit and observe screening activities at Screening Partnership Program airports. See 49 U.S.C. § 44920.

[19] GAO-14-704G.

baggage screening technologies.[20] We chose this methodology in consultation with TSA officials and after determining that historical records of obligations and expenditures do not provided consistent and sufficient detail for the purposes of our analysis.

The life-cycle cost estimates include relevant phases for each screening technology (i.e., purchase, deploy, install, and maintain), although not all technologies have cost estimates for each phase of the life cycle.[21] For example, some screening technologies may not specify deployment costs because such costs are included in the initial purchase price of the unit. In other cases, the technology does not have a deployment cost because the unit is small and portable, and placement of the unit is therefore handled by TSA airport staff at no charge. Estimated expenditures for installation also include costs associated with site acceptance testing, which is performed when a system is installed at its operational location.[22] Unlike the purchase, deploy, and install unit prices, the maintenance unit

[20]The inventory, as reported in TSA's Deployed Locations Report, is limited to technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018, the last week of the fiscal year, and does not include units that were deployed or in use at other locations, such as for testing or repair. Deployed technologies include advanced imaging technology, advanced technology x-ray, bottled liquid scanner, boarding pass scanner, chemical analysis device, credential authentication technology, explosives detection systems, explosives trace detection, and walk-through metal detector. We do not include computed tomography and threat image projection x-ray in the inventory because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review. Because TSA officials said they do not include boarding pass scanners as part of the Deployed Locations Report (which tracks only accountability property, or property defined as anything with a procurement cost over $5,000 or has the ability to store sensitive information), the agency provided information on boarding pass scanners separately. The inventory and associated estimated costs may include technologies, such as walk-through metal detector, that were transferred from the Federal Aviation Administration to TSA when it assumed responsibility for civil aviation security, which includes implementing and overseeing security operations at commercial airports. We reviewed the life-cycle cost estimates for the Passenger Screening Program and Electronic Baggage Screening Program, which included estimates for the following technologies: advanced imaging technology, advanced technology x-ray, bottled liquid scanner, boarding pass scanner, chemical analysis device, credential authentication technology, computed tomography, explosives detection systems, explosives trace detection, and walk-through metal detector.

[21]Purchasing, deploying, installing, and maintaining are part of the produce, deploy, and support phase of TSA's acquisition life-cycle framework. The estimates do not include costs associated with earlier phases of the lifecycle, such as developmental and operational testing.

[22]The objective of the test is to ensure that the system is working prior to being placed in operation.

price is the yearly cost of maintenance for one unit, and therefore recurs every year.

We assessed the reliability of the life-cycle cost estimates by reviewing documentation on the development of the estimates and interviewing TSA officials, among other things, and determined the estimates were sufficiently reliable for the purpose of estimating the amount of funds spent on acquiring, deploying, installing, and maintaining TSA's inventory of screening technologies as of the end of fiscal year 2018. Because the life-cycle cost estimates were developed in different years, we used TSA guidelines to adjust costs for inflation and convert our estimates to 2018 dollars.[23] We multiplied these estimates against the number of screening technologies deployed to commercial airports as of September 24, 2018, using data from TSA's Government Property Management database. For computed tomography, we also obtained information on price and quantity from the technology's life-cycle cost estimate and TSA officials. We also reviewed prior GAO work on TSA cost sharing programs for airport facility modification related to installation of some of the technologies in our review.[24]

We conducted this performance audit from April 2018 to December 2019 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

[23]According to agency officials, TSA uses the gross domestic product inflation guidelines from the DHS Chief Financial Officer, which averages to 1.9 percent per year for inflation.

[24]GAO, *Transportation Security Administration: After Oversight Lapses, Compliance with Policy Governing Special Authority has been Strengthened*, GAO-18-172 (Washington, D.C.: Dec. 21, 2017).

Appendix III: Transportation Security Administration (TSA) Estimated Expenditures for Screening Technologies

We estimate that TSA spent $3.1 billion to purchase, deploy, install, and maintain its inventory of screening technologies, as of the end of fiscal year 2018, based on agency estimates of costs.[1] Tables 3 through 5 provide information on estimated TSA expenditures by screening technology, life-cycle phase, and airport category. To analyze TSA's estimated spending to purchase, deploy, install, and maintain its inventory of screening technologies as of the end of fiscal year 2018, we reviewed TSA life-cycle cost estimates, which, for the purposes of acquisition planning, provide per-unit estimates of the cost to purchase, deploy, install, and maintain passenger and checked baggage screening technologies at TSA-regulated airports (i.e., "commercial" airports). Because the life-cycle cost estimates were developed in different years, we used the same guidelines used by TSA to adjust costs for inflation to convert our estimates to 2018 dollars.[2] We multiplied these estimates against the number of screening technologies deployed to commercial airports as of September 24, 2018.

[1]To review the costs allocated or incurred by TSA to purchase, deploy, install, and maintain screening technologies, we used agency life-cycle cost estimates (LCCE) to estimate TSA spending for its fiscal year 2018 inventory of passenger and checked baggage screening technologies. The inventory, as reported in TSA's Deployed Locations Report, is limited to technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018, the last week of the fiscal year, and does not include units that were deployed or in use at other locations, such as for testing or repair. We do not include computed tomography and threat image projection x-ray in the inventory because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review. For the purposes of this report, references to TSA spending reflect the estimated amounts TSA expended to purchase, deploy, install, and maintain its fiscal year 2018 screening technology. Additionally, "purchase" refers to the per unit price of a technology; "deploy" refers to costs associated with transporting the technology to the airport; "install" refers to costs to set up the technology in the airport; and "maintain" refers to costs to keep the technology operational after installation. For more information on our methodology, see appendix II.

[2]According to agency officials, TSA uses the gross domestic product inflation guidelines from the Department of Homeland Security Chief Financial Officer, which averages to 1.9 percent per year for inflation.

Table 3: Estimated Expenditures for the Transportation Security Administration's (TSA) Inventory of Screening Technologies in Use at TSA-Regulated Airports, by Life-Cycle Phase, as of September 24, 2018

Fiscal year 2018 dollars in thousands

Technology	Purchase	Deploy[a]	Install	Maintain[b]	Total
Advanced imaging technology (949 units)	136,983	30,424	11,761	18,269	**197,438**
Advanced technology x-ray (2,211 units)	339,672	53,150	9,790	40,062	**442,674**
Boarding pass scanner (2,627 units)	4,560	n/a	722	55	**5,336**
Bottled liquid scanner (1,619 units)	51,709	7,791	765	2,219	**62,484**
Chemical analysis device (481 units)	24,574	n/a	243	2,268	**27,084**
Credential authentication technology (41 units)	1,090	n/a	22	65	**1,176**
Explosives detection system (1,658 units)	1,490,473	145,509	342,845	158,585	**2,137,413**
Explosives trace detection (5,855 units)	151,363	28,176	1,415	46,083	**227,037**
Walk-through metal detector (1,362 units)	14,949	9,637	703	1,174	**26,463**
Total	**2,215,373**	**274,687**	**368,266**	**268,779**	**3,127,105**

Legend:

n/a = not applicable.

Source: GAO analysis of TSA life-cycle cost estimates and inventory data. | GAO-20-56

Notes: Totals may not sum due to rounding. We included all TSA screening technologies used in checkpoint and checked baggage screening, as identified by TSA. The inventory is limited to technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018, the last week of the fiscal year, with the exception of computed tomography and threat image projection x-ray because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review. We used the same guidelines used by TSA to adjust costs for inflation—the gross domestic product inflation guidelines from the Department of Homeland Security Chief Financial Officer—which averages to 1.9 percent per year for inflation. The estimates do not include costs associated with earlier phases of the lifecycle, such as developmental and operational testing.

[a]Some screening technologies do not have deployment costs because, for example, the technology may be small and placement can be handled by TSA airport staff.

[b]The maintenance unit price is the yearly cost of maintenance for one unit, which recurs every year.

Table 4: Estimated Price Per Unit for the Transportation Security Administration's (TSA) Inventory of Screening Technologies in Use at TSA-Regulated Airports, by Life-Cycle Phase, as of September 24, 2018

Fiscal year 2018 dollars

Technology	Purchase	Deploy[a]	Install	Maintain[b]	Total
Advanced imaging technology	144,344	32,059	12,393	19,251	**208,048**
Advanced technology x-ray	153,628	24,039	4,428	18,119	**200,214**
Boarding pass scanner	1,736	n/a	275	21	**2,031**
Bottled liquid scanner	31,939	4,812	472	1,371	**38,594**
Chemical analysis device	51,089	n/a	505	4,714	**56,308**
Credential authentication technology[c]	26,580	n/a	527	1,578	**28,686**
Explosives detection system	898,959	87,762	206,783	95,648	**1,289,151**
Explosives trace detection	25,852	4,812	242	7,871	**38,777**
Walk-through metal detector	10,976	7,075	516	862	**19,430**

Legend:

n/a = not applicable.

Source: GAO analysis of TSA life-cycle cost estimates and inventory data. | GAO-20-56

Notes: Total may not sum due to rounding. We included all TSA screening technologies used in checkpoint and checked baggage screening, as identified by TSA. The inventory is limited to technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018, the last week of the fiscal year, with the exception of computed tomography and threat image projection x-ray because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review. We used the same guidelines used by TSA to adjust costs for inflation—the gross domestic product inflation guidelines from the Department of Homeland Security Chief Financial Officer—which averages to 1.9 percent per year for inflation. The estimates do not include costs associated with earlier phases of the lifecycle, such as developmental and operational testing.

[a]Some screening technologies do not have deployment costs because, for example, the technology may be small and placement can be handled by TSA airport staff.

[b]The maintenance unit price is the yearly cost of maintenance for one unit, which recurs every year.

[c]The unit purchase price of credential authentication technology is dependent on the quantity purchased. For this analysis, we used the unit purchase price for the first 100 units purchased.

Table 5: Estimated Expenditures for the Transportation Security Administration's (TSA) Inventory of Screening Technologies in Use at TSA-Regulated Airports, by Life-Cycle Phase and Airport Category, as of September 24, 2018

Fiscal year 2018 dollars in thousands

		Life-cycle phase				
Airport category	**Units**	**Purchase**	**Deploy[a]**	**Install**	**Maintain[b]**	**Total**
Advanced imaging technology						
X	436	62,934	13,978	5,403	8,394	**90,709**
I	233	33,632	7,470	2,888	4,486	**48,475**
II	103	14,867	3,302	1,276	1,983	**21,429**
III	106	15,301	3,398	1,314	2,041	**22,053**
IV	71	10,248	2,276	880	1,367	**14,771**
Total	**949**	**136,983**	**30,424**	**11,761**	**18,269**	**197,438**
Advanced technology x-ray						
X	1,041	159,927	25,025	4,609	18,862	**208,423**
I	579	88,951	13,919	2,564	10,491	**115,924**
II	261	40,097	6,274	1,156	4,729	**52,256**
III	190	29,189	4,567	841	3,443	**38,041**
IV	140	21,508	3.365	620	2,537	**28,030**
Total	**2,211**	**339,672**	**53,150**	**9,790**	**40,062**	**442,674**
Bottled liquid scanner						
X	694	22,165	3,340	328	951	**26,784**
I	412	13,159	1,983	195	565	**15,901**
II	208	6,643	1,001	98	285	**8,028**
III	166	5,302	799	78	228	**6,407**
IV	139	4,439	669	66	191	**5,365**
Total	**1,619**	**51,709**	**7,791**	**765**	**2,219**	**62,484**
Chemical analysis device						
X	187	9,554	n/a	95	882	**10,530**
I	148	7,561	n/a	75	698	**8,334**
II	122	6,233	n/a	62	575	**6,870**
III	23	1,175	n/a	12	108	**1,295**
IV	1	51	n/a	1	5	**56**
Total	**481**	**24,574**	**n/a**	**243**	**2,268**	**27,084**
Credential authentication technology						
X	30	797	n/a	16	47	**861**
I	11	292	n/a	6	17	**316**
II	0	n/a	n/a	n/a	n/a	**n/a**

Fiscal year 2018 dollars in thousands

Airport category	Units	Life-cycle phase: Purchase	Deploy[a]	Install	Maintain[b]	Total
III	0	n/a	n/a	n/a	n/a	**n/a**
IV	0	n/a	n/a	n/a	n/a	**n/a**
Total	**41**	**1,090**	**n/a**	**22**	**65**	**1,176**
Explosives detection system						
X	840	903,487	72,795	208,165	89,907	**1,274,355**
I	402	380,650	35,143	98,380	40,823	**554,996**
II	263	140,370	23,519	27,528	18,488	**209,904**
III	133	57,427	12,196	7,666	8,150	**85,439**
IV	20	8,539	1,856	1,107	1,217	**12,719**
Total	**1,658**	**1,490,473**	**145,509**	**342,845**	**158,585**	**2,137,413**
Explosives trace detection						
X	2,722	70,369	13,099	658	21,424	**105,550**
I	1,409	36,425	6,780	341	11,090	**54,636**
II	797	20,604	3,835	193	6,273	**30,905**
III	539	13,934	2,594	130	4,242	**20,901**
IV	388	10,031	1,867	94	3,054	**15,045**
Total	**5,855**	**151,363**	**28,176**	**1,415**	**46,083**	**227,037**
Walk-through metal detector						
X	601	6,596	4,252	310	518	**11,677**
I	327	3,589	2,314	169	282	**6,353**
II	155	1,701	1,097	80	134	**3,012**
III	139	1,526	983	72	120	**2,701**
IV	140	1,537	991	72	121	**2,720**
Total	**1,362**	**14,949**	**9,637**	**703**	**1,174**	**26,463**

Legend:

n/a = not applicable.

Source: GAO analysis of TSA life-cycle cost estimates and inventory data. | GAO-20-56

Notes: Totals may not sum due to rounding. We included all TSA screening technologies used in checkpoint and checked baggage screening, as identified by TSA. The inventory is limited to technologies that were in use or available for use at commercial airports from September 24 through September 30, 2018, the last week of the fiscal year, with the exception of computed tomography and threat image projection x-ray because these technologies were in the early phase of deployment or were being phased out as legacy technology, respectively, at the time of our review. We used the same guidelines used by TSA to adjust costs for inflation—the gross domestic product inflation guidelines from the Department of Homeland Security Chief Financial Officer—which averages to 1.9 percent per year for inflation. The estimates do not include costs associated with earlier phases of the lifecycle, such as developmental and operational testing.

[a]Some screening technologies do not have deployment costs because, for example, the technology may be small and placement is be handled by TSA airport staff.

[b]The maintenance cost is the estimated yearly cost of maintenance for one unit, which recurs every year.

Appendix IV: Comments from the Department of Homeland Security

U.S. Department of Homeland Security
Washington, DC 20528

Homeland Security

November 22, 2019

W. William Russell
Director, Homeland Security and Justice
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

RE: Management Response to Draft Report GAO-20-56, "AVIATION SECURITY: TSA Should Ensure Screening Technologies Continue to Meet Detection Requirements after Deployment"

Dear Mr. Russell:

Thank you for the opportunity to review and comment on the subject draft report. The U.S. Department of Homeland Security (DHS) appreciates the U.S. Government Accountability Office's (GAO) work in planning and conducting its review and issuing this report.

The Transportation Security Administration's (TSA) work to implement and oversee security operations at roughly 440 commercial airports, to establish detection standards, and to deploy security screening technologies are an important part of its mission to protect the nation's civil aviation system.

As a leader in the transportation security network, TSA continuously strives to work collaboratively with others and raise the global baseline of aviation security. However, securing the transportation system mission that requires a "whole of community" approach. TSA remains committed to maintaining the strong partnerships across governments, industry, and with others that are integral to success in this shared security mission.

The draft report contained five recommendations, with which the Department concurs. Attached find our detailed response to each recommendation. DHS previously submitted technical comments under a separate cover.

Again, thank you for the opportunity to review and comment on this draft report. Please feel free to contact me if you have any questions. We look forward to working with you again in the future.

Sincerely,

JIM H. CRUMPACKER, CIA, CFE
Director
Departmental GAO-OIG Liaison Office

Attachment

2

Attachment: Management Response to Recommendations Contained in GAO-20-56

GAO recommended that the TSA Administrator:

Recommendation 1: Update TSA guidance for developing and approving screening technology explosives detection standards to reflect designated procedures, the roles and responsibilities of stakeholders, and changes in the agency's organizational structure.

Response: Concur. On September 30, 2019, TSA Office of Acquisitions and Program Management (APM) completed an update to the detection standard process to reflect organizational changes. The update is incorporated into the Requirements Engineering Integrated Process Manual (RE IPM) and provides the process for developing and approving screening technology explosives detection standards, including designated procedures and roles and responsibilities of stakeholders. TSA will maintain the RE IPM to ensure the process is consistent with approved changes to the TSA organizational structure. TSA previously provided GAO a copy of the REI IPM under a separate cover. We request that GAO consider this recommendation resolved and closed, as implemented.

Recommendation 2: Require and ensure that TSA officials document key decisions, including testing and analysis decisions, used to support the development and consideration of new screening technology explosives detection standards.

Response: Concur. The updated RE IPM provides the process for documenting key decisions, including testing and analysis decisions, used in the development of new screening technology explosives detection standards. We request that GAO consider this recommendation resolved and closed, as implemented.

Recommendation 3: Require and ensure that TSA officials document their assessments of risk and the rationale—including the assumptions, methodology, and uncertainty considered—behind decisions to deploy screening technologies.

Response: Concur. APM instituted an improved process for documenting elements contributing to deployment decisions across the stakeholders, including assumptions, risk, applicability, and logistical factors. These decisions are documented in the associated capability's deployment plan, an example of which was provided in July 2019 to GAO in the Computed Tomography deployment plan. This level of documentation will continue in all future deployment plans for screening technologies. We request that GAO consider this recommendation resolved and closed, as implemented.

Recommendation 4: Develop a process to ensure that screening technologies continue to meet all detection requirements after deployment to commercial airports.

3

Response: Concur. APM will develop individual Post Implementation Reviews (PIRs) for all screening technologies in accordance with DHS Directive 102-01, "Acquisition Management," to assess multiple aspects of system performance following deployment, including detection over time. Because the operational environment typically prohibits the use of live explosives in the threat mass necessary, and simulants use has limitations, TSA intends to examine the component performance of the detection chain instead of a direct measure of detection requirements. As the logistics data and detection chain for each system is unique and will require its own individual PIR, TSA is developing a policy on the PIR development process. Estimated Completion Date (ECD): March 31, 2020.

Recommendation 5: Implement the process it develops to ensure that screening technologies continue to meet all detection requirements after deployment to commercial airports.

Response: Concur: APM will develop a PIR for each technology, subject to the availability of funds, to include the performance of the detection chain. The PIR will typically measure performance of system components within the detection chain, as opposed to directly measuring detection requirements. TSA will implement the PIR process on the first screening technology by the end of 2020. ECD: December 31, 2020.

Appendix V: GAO Contact and Staff Acknowledgments

GAO Contact

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Staff Acknowledgments

In addition to the contact named above, Kevin Heinz (Assistant Director), Barbara Guffy (Analyst in Charge), Kelsey Burdick, Jonathan Felbinger, Tyler Kent, Thomas Lombardi, Erin O'Brien, Kya Palomaki, Rebecca Parkhurst, and Dina Shorafa made key contributions to this report. In addition, key support was provided by Chuck Bausell, Richard Cederholm, Dominick Dale, Aryn Ehlow, Michele Fejfar, Eric Hauswirth, Richard Hung, and Alexis Olson.

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