India’s aggressive program to grow its aviation industry is a key element of its overall strategy for economic growth. This aviation initiative will result in India becoming the world’s third largest aviation market by 2020 with 336 million domestic and 85 million international passengers annually. India’s Ministry of Civil Aviation and Bureau of Civil Aviation Security intend to achieve state-of-the-art security consistent with their world-class aviation infrastructure in order to secure travelers, protect infrastructure investments, and help conform India’s security protocols with those of its major trading partners worldwide.

Screening passenger carry-on items, hold baggage and cargo for explosive threats is a well-established means to securing civil aviation. Computed Tomography (CT) Explosives Detection Systems (EDS) represent the state of the art for explosives screening, particularly for hold baggage. CT EDS use the same basic X-ray technology as medical CT X-ray diagnostic equipment, except that EDS utilize automated threat detection (ATD) algorithms to automatically analyze screened images to help detect improvised explosive devices (IEDs). Automatic detection combined with secondary screening, including hand searches, as required, create a comprehensive means to detect IEDs. The key elements of EDS detection are the generation of high-quality, three-dimensional (volumetric) CT X-ray images of screened items, combined with ATD analysis.

ATD is typically developed by equipment manufacturers in accordance with the requirements of a governmental security authority and is certified by that authority based on exhaustive testing with live explosives. Because ATD is software in nature, it does not degrade and, therefore, as long as a certified ATD is not changed, it does not need to be retested. However, the software version of the EDS ATD does need to be audited during acceptance testing to ensure that it is both certified and the ATD
version the buyer intended. This verification is performed as part of a configuration audit performed by the buyer’s independent acceptance testing representative during acceptance testing.

Unlike the unchangeable nature of ATD, EDS’s X-ray image quality can be affected by numerous system elements that are subject to misalignment or other mechanical failure or to various electronic failures within the EDS’s subsystems. Thus, the X-ray image must be carefully tested during acceptance to ensure that the EDS equipment produces high-quality images to meet required standards.

To address the need for a reliable and repeatable means to verify that an EDS X-ray image meets acceptable performance standards, the National Institute of Science and Technology (NIST) has adapted and published the American National Standards Institute (ANSI) N42.45 2011 standard for X-ray image quality. The international version of this standard, IEC 62945, will be published in 2017. Prior to publication, NIST collaborated with TSA, the U.S. Department of Homeland Security (DHS), equipment manufacturers and Battelle Memorial Institute (Battelle) in the United States and conducted exhaustive testing to ensure the standard’s suitability for EDS image quality verification. The ANSI standard relies on test articles (there are two) referred to as phantoms, and a mathematical formula for analyzing key parameters of images produced by the phantoms when scanned by EDS. The numerical results of the mathematical analysis can be compared to a baseline of performance parameters of known good-quality EDS to determine if the EDS being tested produces quality X-ray images that meet the standard.

Given the criticality of EDS and its high cost, which can reach $1 million USD each, Governments and airport authorities must ensure the operational suitability of EDS whether newly acquired or returned to duty following upgrade or service. The Transportation Security Administration (TSA) in the United States, the world’s largest user of EDS for explosives screening, has developed a comprehensive approach to acceptance testing of its security equipment, including use of the ANSI standard for EDS X-ray image quality verification, as published by NIST. Since it began acquiring EDS, TSA has used Battelle as its independent acceptance tester. Over the years Battelle has consistently worked with TSA to develop testing protocols and procedures and test articles, and to conduct acceptance testing on TSA’s behalf. Following is a summarized recommended approach for such acceptance testing for EDS, including the use of the ANSI N42.45 2011 standard.

EDS acceptance testing should be conducted in three phases; Factory Acceptance Testing (FAT), Site Acceptance Testing (SAT), and Integrated Site Acceptance Testing (iSAT). FAT is used to confirm that each unit meets specifications before being shipped from the manufacturer’s site. Testing at the manufacturer’s location is important because it allows any manufacturing defects to be identified and corrected quickly and cost-effectively. SAT is like FAT and ensures that, once delivered and installed/integrated, the EDS equipment is still performing according to specifications. Battelle’s Verif-IQ™ 2 Image Quality Verification System is based on the ANSI standard and provides two test phantoms and analysis software to conduct FAT in accordance with the ANSI standard. Battelle’s Verif-IQ 1 single phantom test system can be used for SAT.
FAT/SAT Test Activity | Purpose
---|---
Configuration Audit | Verifies that system hardware and software components match the configuration baseline ordered by the client
Safety Testing | Verifies that ionizing radiation levels are within acceptable limits for cabinet X-ray systems and safety interlocks and E-stops are functioning properly
Functional Testing | Verifies that system startup and shutdown, operator console, tools, interface, reporting, and operational test kit are all functioning properly
False Alarm/Throughput (FA/TP) Testing (recommended for FAT only, not for SAT) | Verifies that system is set up properly to process baggage at desired throughput speed without unacceptable levels of false alarms
Image Quality Testing | Verifies that system’s imaging performance is within established acceptance criteria following ANSI N42.45-2011
Performance Over Time Test Activity | Verifies system performance on a daily or other periodic basis and provides performance data for trend analysis to identify potential catastrophic failures and system degradation, leading to maintenance optimization

iSAT is separate testing conducted to ensure that EDS equipment integrated into a baggage handling system (BHS) works properly with the BHS. FAT and SAT are summarized below. Procedures for iSAT are specific to the actual integrated BHS system and involve exhaustive testing of the integrated EDS and BHS.

Once EDS equipment has been accepted for use, the airport/owner should conduct periodic testing of the EDS to ensure that the equipment continues to operate acceptably for proper detection performance. This periodic testing can be done with the single test phantom Verif-IQ 1 system and associated trend analysis software. In combination with the analysis software, users can collect performance data on their systems over time and analyze these data to identify performance trends. Such performance-over-time trend analyses allow users to identify potential catastrophic equipment failures before they occur and to optimize equipment maintenance, which can reduce maintenance costs.

Battelle has been TSA’s acceptance tester since it began purchasing security equipment. We have extensive experience with acceptance testing and can help Government authorities and airports develop their testing requirements and protocols and conduct testing. Battelle has also developed the Verif-IQ X-ray Image Quality Verification System, including the Verif-IQ 2 system for FAT, based on the full ANSI N42.45 standard, and the Verif-IQ 1 for SAT, daily testing, and performance-over-time analysis. Battelle provides test phantoms, analysis software and testing services for interested security organizations.
Every day, the people of Battelle apply science and technology to solving what matters most. At major technology centers and national laboratories around the world, Battelle conducts research and development, designs and manufactures products, and delivers critical services for government and commercial customers. Headquartered in Columbus, Ohio since its founding in 1929, Battelle serves the national security, health and life sciences, and energy and environmental industries. For more information, visit www.battelle.org.