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ASSESSMENT REPORT ON THE RELEVANCE OF THE EXISTING DETECTION REQUIREMENTS FOR SCREENING EQUIPMENT TO MITIGATE THREATS TO AIRCRAFT STRUCTURE - D-3.1.2

Impact of Security Measures on Safety

Research conducted by:

UK Civil Aviation Authority International

apave Aeroservices

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An Agency of the European Union

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DELIVERABLE NUMBER AND TITLE: [Assessment report on the relevance of the existing detection requirements for screening equipment to mitigate threats to aircraft structure – D-3.1.2]

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Apave's core business is to help companies and government services managing their technical, environmental and human risks in the areas of Oil & Gas / Nuclear / Industry / Transportation. In aviation, Apave is committed to offering a range of civil and military aviation safety services, covering oversight authority tasks, audits, technical control, training and consulting services, through specialised and dedicated entities. Apave's staff in aviation enjoy extensive knowledge of the International and European regulatory framework, with a focus on Airworthiness, Flight Operations and Safety Management Systems In 2022 Apave has strengthened its portfolio through the acquisition of Oppida a cyber-security specialist in many highly regulated domains and safety and security exposed businesses. Apave has organised its civil and military aviation risk management consulting services around a unique value proposition with a dedicated entity: Apave Aeroservices (hereafter referred to as ''Apave") has been designated in 2009 as the Group centre of excellence to provide risk management solutions to the Aviation community, including aviation authorities, Air Operators, Industry, Maintenance Organisations (MROs - Maintenance, Repair & Overhaul) and Training Organisations.

APSS Software & Services Ltd is part of the Centre for Adaptive Security Research and Applications (CASRA), which was founded in 2008. CASRA emerged from the Visual Cognition Research Group of the University of Zurich, which was founded by Adrian Schwaninger in 1999. Today, CASRA APSS has a workforce of around 35 people, comprising of psychologists, economists, computer scientists, imaging specialists, software developers, aviation security experts, and more, most of which have an academic degree. The main objective of CASRA is to increase security and facilitation at airports and other environments involving people and technology. Through their studies and research on human – machine interaction, it was identified that visual abilities and training determine largely screeners' performance. As such CASRA has been working with a number of aviation security authorities and airports on selection, training and competency assessment processes providing advisory and research as well as their solutions globally.

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ABBREVIATIONS

ACRONYM	DESCRIPTION
2D	2-Dimensional
3D	3-Dimensional
AI	Artificial Intelligence
Air OPS	Air Operations
AMC	Acceptable Means of Compliance
APIDS	Automated Prohibited Item Detection System
ASIA	Aviation Security Improvement Act
CAA	Civil Aviation Authority
CASRA	Center for Adaptive Security Research and Applications
CBS	Cabin Baggage Screening
CIR	Commission Implementing Regulation
CO_2	Carbon Dioxide
CT	Computer Tomography
D	Deliverable
DfT	Department for Transport
DGP	Dangerous Goods Panel
DGs	Dangerous Goods
EASA	European Union Aviation Safety Agency
EC	European Commission
ECAC	European Civil Aviation Conference
EDD	Explosive Detection Dogs
EDS	Explosive Detection System
EDSCB	Explosive Detection System for Cabin Baggage
EDSHB	Explosive Detection System for Hold Baggage
ETD	Explosive Trace Detection
EU	European Union
EVD	Explosives Vapour Detection
GM	Guidance Material
HBS	Hold Baggage Screening
HHMD	Hand-Held Metal Detector
IEDs	Improvised Explosive Devices
ICAO	International Civil Aviation Organization
LAGs	Liquids, Aerosols and Gels
LEDS	Liquid Explosive Detection Systems
MD	Metal Detector
MDE	Metal Detection Equipment
mmW	Millimeter Wave

PAs	Prohibited Articles
SARPs	Standards and Recommended Practices
SED	Spectral Energy Distribution
SMD	Shoe Metal Detector
SWR	Single Wire Resolution
TIP	Threat Image Projection
UN	United Nations
WTMD	Walk Through Metal Detector

1. Executive summary

Problem area

The general objective of the project *Impact of security measures on safety* is to understand the nature and extent of interdependencies between safety and security. Through the research within this project, an attempt is made to produce the comprehensive knowledge base describing these interdependencies.

Task 3 focuses on the analysis of certification standards with subtasks 3.1.2 investigation area related to detection requirements related to threats against the aircraft structure.

Executive Summary

This report is the deliverable D-3.1.2 of task 3: "*Assessment of the relevance of the existing detection requirements for screening equipment to mitigate threats to aircraft structure*".

The objective of this document is to investigate and assess how the state-of-the-art screening technology supports mitigation of critical threats (those which can damage aircraft structure) through their detection.

This report investigates regulatory and operational challenges as well as the relationship between screening equipment and the human element within the screening process. Furthermore, this report looks into interdependencies between safety and security - particularly when it comes to the prevention the transport of dangerous goods (DGs). In this context, this report is related to another EASA project *Detection of Lithium Batteries Using Security Screening Equipment*[1]

To illustrate progress due to ongoing enhancements in the technology and the evolution of the regulatory framework this report presents incremental changes or improvements in the scope of screening equipment requirements. These changes aim at increasing the overall security posture by providing for detection standards of screening equipment in response or reaction to serious security incidents and in relation to current and anticipated threats.

The output of this document shows the overall progress in detection capabilities. Several challenges however still remain and are related to elements like: automation, human – machine interdependencies and the role of the human in the process.

Additionally, the interdependency between safety and security related to security threats (PAs) and safety hazards (high consequence DGs) is confirmed and therefore continuous collaboration between the two domains is encouraged as the negative consequences on the aircraft structure might be equally serious if not effectively prevented.

Finally, evidence exists that it is technically possible to expand existing screening detection equipment capabilities to some DGs which may not be PAs. This can be achieved using multiple implementation methods. Proper consideration and stakeholder consultation should be however given to:

- Regulatory framework
- Impact on screening operations
- Effect on operations

[1] https://www.easa.europa.eu/en/research-projects/detection-lithium-batteries-using-security-screening-equipment

- Assignment of responsibilities

Discussion and assessment contained in this report could be helpful in building the overall understanding of safety and security correlations in relation to the aircraft from the perspective of screening equipment. In this context, this report should be analysed in combination with deliverable D-3.1 as it helps to provide a comprehensive overview of screening as a preventive measure.

This approach will enable a holistic and comprehensive analysis of the positive or detrimental impact security measures are having on overall safety and the identification of opportunities for improvement.

2. Introduction

This chapter first provides the context and background of the project (Section 2.1) and then objectives of the document are presented (Section 2.2).

2.1. Context and background

The European Union Aviation Safety Agency (hereinafter "EASA") is an agency of the European Union, which has been given specific regulatory and executive tasks in the field of aviation safety. The Agency constitutes a key part of the European Union's strategy to establish and maintain a high uniform standard of safety and environmental protection in civil aviation at European level.

As part of the Horizon Europe Work Programme 2021-2022 on Cluster 5 Climate, Energy and Mobility, the European Commission has entrusted EASA with the management of one specific research action entitled "Impact of security measures on safety".

As a result, EASA has awarded a public contract to a consortium of three companies:

- CAA International
- Apave Aeroservices
- CASRA

The contract details the four main tasks which are specified in order to achieve the expected outcome which is to understand the nature and extent of the interdependencies between safety and security in order to assess the impact of security measures on safety. In doing so, the research project should identify which processes and job roles are affected by safety–security interdependencies and which certification requirements and licensing activities are affected. In the medium term, safety risk management techniques that can be applied to security will produce harmonised risk assessment methods and support integrated policy and decision-making processes at national and EU level.

The project aims at developing a comprehensive knowledge base for the evaluation of the potential impact of security measures on the safety performances of aviation systems, personnel and operations, including the leading indicators for measuring such an impact (positive or negative) as well as the main factors playing a role in such safety - security dependencies.

The four main tasks are:

- Task 1: Identify the interdependencies between security and safety
- Task 2: Assessment of the impact of security measures on safety
- Task 3: Analysis of certification standards

- Task 4: Integrated risk management

The intention of this activity is to provide a basis for better understanding of where security threats have safety consequences in a more granular way than is currently understood.

2.2. Objectives of the document

The present report is an output of task 3.

Task 3 covers the analysis of certification standards in the context of safety-security interdependencies and the assessment of the impact of security measures on safety.

Subtask 3.1 focuses on the impact of security threats on aircraft design standards and best practices.

The present report is the deliverable D-3.1.2: "*Assessment of the existing detection requirements for screening equipment to mitigate threats to aircraft structure*".

The objective of this document is to:

- Collect information on the following topics:
  - Detection requirements for screening equipment
  - Changes or improvements in the scope of screening equipment requirements
  - Regulatory and operational challenges as well as the relationship between screening equipment and the human element within the screening process
  - Prevention of the transport of dangerous goods (DGs)
- Combine studies in form of:
  - Assess the relevance of screening equipment in the context of threats to aircraft structure

This report investigates regulatory and operational challenges as well as the relationship between screening equipment and the human element within the screening process. Furthermore, this report looks into interdependencies between safety and security - particularly when it comes to the prevention of the transport of DGs.

Discussion and assessment contained in this report could be helpful in building the overall understanding of safety and security correlations in relation to the aircraft from the perspective of screening equipment. In this context, this report should be analysed in combination with the deliverable D-3.1 as it helps to provide a comprehensive overview of screening as a preventive measure. In the DG context, this report is related to another EASA project *Detection of Lithium Batteries Using Security Screening Equipment*[1]

This approach will enable a holistic and comprehensive analysis of the positive or detrimental impact security measures are having on overall safety and the identification of opportunities for improvement.

3. Methodology

This chapter outlines the process of work conducted for the creation of this report in the scope of subtask 3.1.2.

Subtask 3.1.2 focuses on interdependencies between security and safety in the context of screening equipment and how they mitigate threats to aircraft structure. In the context of the definition of these threats, the report

looks into items that are introduced either as Prohibited Articles or Dangerous Goods and can put the aircraft structure at risk (see Figure 1).

Certain Prohibited Articles (PAs) and Dangerous Goods (DGs) pose significant risk due to their potential to cause damage or interfere with aircraft structure. Explosives, corrosives, and flammable materials can directly harm the fuselage, while intentional acts involving these items jeopardise aviation safety.

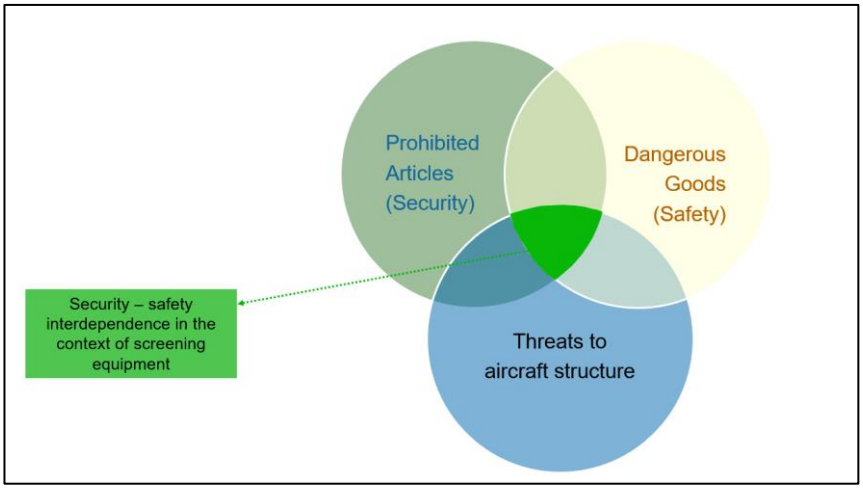


Figure 1 – Prohibited articles (security) versus dangerous goods (safety) that pose a threat to aircraft structure

Figure 2 shows the process that was conducted in order to assess screening equipment to mitigate threats to the aircraft structure.

The following elements were studied:

- Terminology and regulatory considerations in terms of PAs and DGs
- Evolution of screening equipment for PAs and DGs (in terms of regulations and operation)
- Screening equipment technology and the human factor

The studies are described in Chapter 4 whereas Chapter 5 covers collected, analysed and collated information to determine the evolution and relevance of screening equipment in the context of threats to aircraft structure.

A conclusion can be found in Chapter 6.

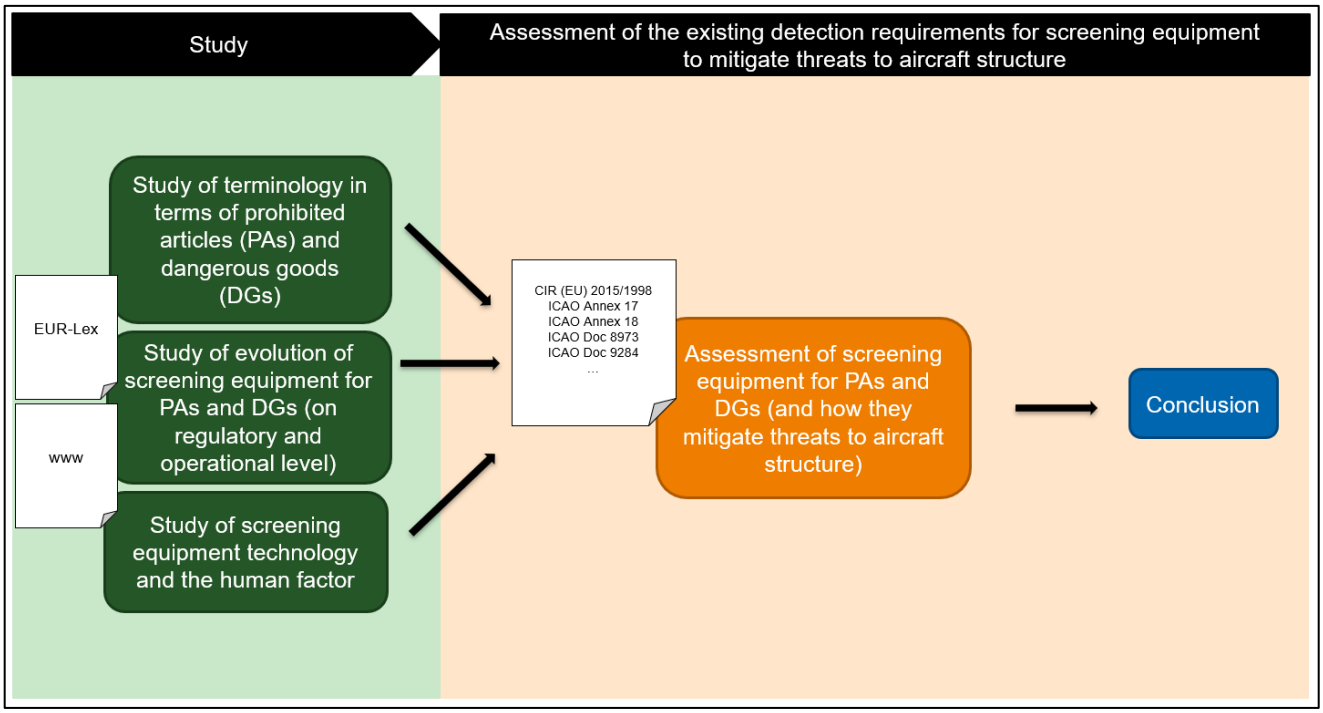


Figure 2 – Process of work

4. Terminology and regulatory considerations of prohibited articles and dangerous goods

4.1. Study of terminology and regulatory framework

At the initial stage of this research, the applicable regulatory framework needed to be identified by establishing an understanding of the topic. As such, the following terms needed to be defined:

- **Aircraft structure** - defined as a set of structural components of an aircraft including fuselage, wings, empennage, flight control surfaces and landing gear
- **Threats** – in line with safety terminology, and as described in D-3.1, threat describes events that can potentially cause, through several pathways, the occurrence of the identified top event if preventative controls (prevention barriers) fail. There can be one or multiple threats leading to the top event[2]

[2] Definition developed for the purpose of this report based on collation of different existing safety and security definitions. Both safety and security domains define threat slightly differently. ICAO defines threat in security domain as the probability or likelihood that an act of unlawful interference is attempted, based on an adversary's intentions and capabilities but not taking into account current security measures. In safety, a threat is referred to as a possible direct cause that will potentially release a hazard by producing a top event (UK CAA). Additionally, in Crew Resource Management, threat means events or errors that occur beyond the influence of the flight crew, increase operational complexity and must be managed to maintain the margin of safety (EASA, Annex I to ED Decision 2015/012/R).

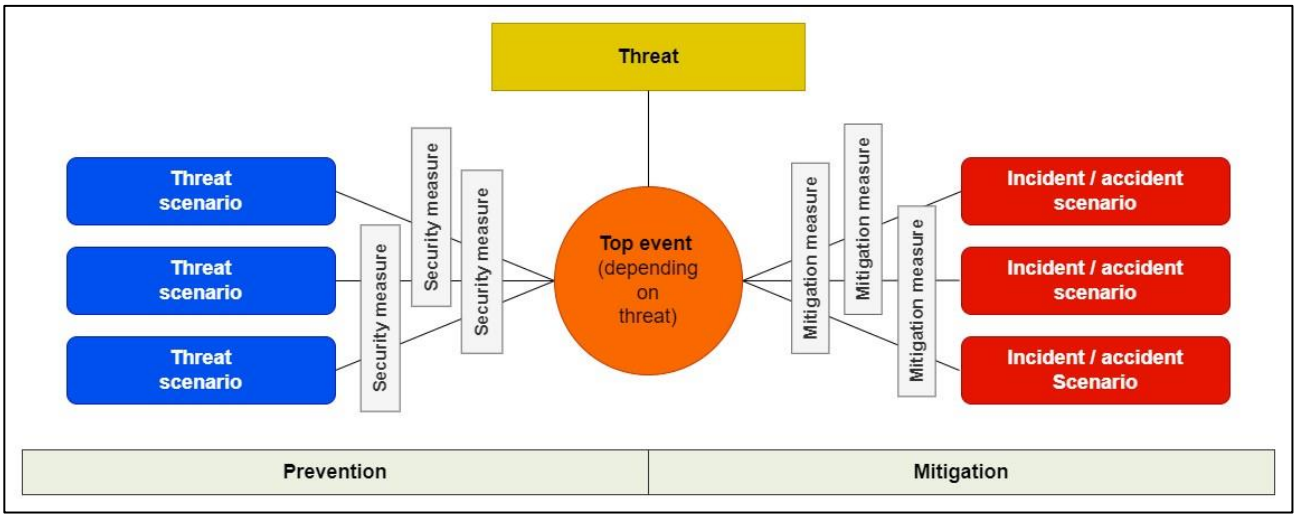


Figure 3 – Generic bowtie model for security

- **Screening equipment** – devices used with the intention to identify and/or detect weapons, explosives or other dangerous devices, articles or substances which may be used to commit an act of unlawful interference
- **Detection requirements** – determined capabilities of equipment that establish baseline for finding weapons, explosives or other dangerous devices, articles or substances which may be used to commit an act of unlawful interference.

In the context of the definition of threat described above, the report looks into events caused by either the intentional or unintentional introduction of items that can put the aircraft structure at risk. These items are defined as:

- **Prohibited Articles** – "weapons, explosives or other dangerous devices, articles or substances that may be used to commit an act of unlawful interference that jeopardizes the security of civil aviation"[3]
- **Forbidden Dangerous Goods** – "articles or substances which are capable posing a risk to health, safety, property or the environment".[4] Further in ICAO Doc 9284 "Any article or substance which, as presented for transport, is liable to explode, dangerously react, produce a flame or dangerous evolution of heat or dangerous emission of toxic, corrosive or flammable gases or vapours under conditions normally encountered in transport must not be carried on aircraft under any circumstance"[5]
- **High consequence Dangerous Goods** – "dangerous goods that have the potential for misuse in a terrorist incident and that may as a result produce serious consequences such as mass casualties or mass destruction."[6]

The following sections briefly introduce the framework for the screening of PAs (Section 4.1.1) and prevention of DGs (Section 4.1.2) as a baseline for the assessment in Chapter 5.

4.1.1. Prohibited articles (PAs)

[3] Regulation (EC) No 300/2008
[4] ICAO Annex 18
[5] ICAO Doc 9824, Part 1, Chapter 2, 2.1
[6] ICAO Doc 8973, Attachment D to Appendix 12

Regulation (EC) No 300/2008 establishes **common rules** to protect civil aviation against acts of unlawful interference that jeopardise the security of civil aviation.

Aviation security is defined in Article 3 as: "*the combination of measures and human and material resources intended to safeguard civil aviation against acts of unlawful interference that jeopardize the security of civil aviation.*" Civil aviation is defined as: "*any air operation carried out by civil aircraft, excluding operations carried out by State aircraft referred to in Article 3 of the Chicago Convention on International Civil Aviation.*"

It should be noted here that the security framework contextualises PAs from the perspective of intentional action aimed at the introduction of an item that can cause harm or endanger safety of the flight.

The common basic standards for safeguarding civil aviation against acts of unlawful interference that jeopardise the security of civil aviation (Article 4) are laid down in the annex. The ones concerning this report are listed below:

- **Screening of persons other than passengers and items carried:** "Persons other than passengers, together with items carried, shall be screened on a continuous random basis upon entering security restricted areas in order to prevent prohibited articles from being introduced into these areas." (1.3.1) and "All person other than passengers, together with items carried, shall be screened upon entering critical parts of security restricted areas in order to prevent prohibited articles from being introduced into these parts" (1.3.2)
- **Examination of vehicles:** "Vehicles entering a security restricted area shall be examined in order to prevent prohibited articles from being introduced into these areas." (1.4)
- **Screening of passengers and cabin baggage (CBS)**: "All originating, transfer and transit passengers and their cabin baggage shall be screened in order to prevent prohibited articles from being introduced into security restricted areas and on board an aircraft" (4.1.1)
- **Screening of hold baggage (HBS):** "All hold baggage shall be screened prior to being loaded onto an aircraft in order to prevent prohibited articles from being introduced into security restricted areas and on-board aircraft" (5.1.1)
- **Screening of cargo and mail:** "All cargo and mail shall be subjected to security controls prior to being loaded on an aircraft" (6.1)
- **Screening of in-flight supplies**: "In-flight supplies, including catering, intended for carriage or use on board an aircraft shall be subjected to security controls and thereafter protected until loaded onto the aircraft in order to prevent prohibited articles from being introduced on board an aircraft" (8.1)
- **Staff recruitment and training:** "Persons implementing, or responsible for implementing, screening, access control or other security controls shall be recruited, trained and, where appropriate, certified so as to ensure that they are suitable for employment and competent to undertake the duties to which they are assigned" (11.1)
- **Security equipment:** "Equipment used for screening, access control and other security controls shall comply with the defined specifications and be capable of performing the security controls concerned" (12)

Screening is defined as "*means the application of technical or other means which are intended to identify and/or detect prohibited articles*" where prohibited articles are "*weapons, explosives or other dangerous devices, articles or substances that may be used to commit an act of unlawful interference that jeopardizes the security of civil aviation.*"

A summary of currently existing EU standards of screening is provided in Annex 1. An overview of PAs for the screening of different items is provided in Table 1.

PAs differ between the hold and cabin baggage as it depends if a passenger may or may not have access to it during the flight. As a consequence, procedures require different detection methods, but the most common PAs fall into several categories: sharp and blunt objects, firearms, and explosives, flammables and incendiary materials (Vukadinovic & Anderson, 2022).

Table 1: List of PAs

Screening of	Prohibited articles
Persons other than passengers Persons and their items carried by persons other than passengers shall be screened	› (a) guns, firearms and other devices that discharge projectiles: • devices capable, or appearing capable, of being used to cause serious injury by discharging a projectile, including: ▪ firearms of all types, such as pistols, revolvers, rifles, shotguns ▪ toy guns, replicas and imitation firearms capable of being mistaken for real weapons ▪ component parts of firearms, excluding telescopic sights ▪ compressed air and CO_2 guns, such as pistols, pellet guns, rifles and ball bearing guns ▪ signal flare pistols and starter pistols ▪ bows, cross bows and arrows ▪ harpoon guns and spear guns ▪ slingshots and catapults › (b) stunning devices: • devices designed specifically to stun or immobilize, including: ▪ devices for shocking, such as stun guns, tasers and stun batons ▪ animal stunners and animal killers ▪ disabling and incapacitating chemicals, gases and sprays, such as mace, pepper sprays, capsicum sprays, tear gas, acid sprays and animal repellent sprays › (c) explosives and incendiary substances and devices: • explosives and incendiary substances and devices capable, or appearing capable, of being used to cause serious injury or to pose a threat to the safety of aircraft, including: ▪ ammunition ▪ blasting caps ▪ detonators and fuses ▪ replica or imitation explosive devices ▪ mines, grenades and other explosive military stores ▪ fireworks and other pyrotechnics,

Screening of	Prohibited articles
	▪ smoke-generating canisters and smoke-generating cartridges ▪ dynamite, gunpowder and plastic explosives. › (d) any other article capable of being used to cause serious injury and which is not commonly used in security restricted areas, e.g. martial arts equipment, swords, sabres, etc.
Passengers Cabin baggage	› (a) guns, firearms and other devices that discharge projectiles — devices capable, or appearing capable, of being used to cause serious injury by discharging a projectile, including: • firearms of all types, such as pistols, revolvers, rifles, shotguns • toy guns, replicas and imitation firearms capable of being mistaken for real weapons • component parts of firearms, excluding telescopic sights • compressed air and CO2 guns, such as pistols, pellet guns, rifles and ball bearing guns • signal flare pistols and starter pistols • bows, cross bows and arrows • harpoon guns and spear guns • slingshots and catapults › (b) stunning devices — devices designed specifically to stun or immobilise, including: • devices for shocking, such as stun guns, tasers and stun batons • animal stunners and animal killers • disabling and incapacitating chemicals, gases and sprays, such as mace, pepper sprays, capsicum sprays, tear gas, acid sprays and animal repellent sprays › (c) objects with a sharp point or sharp edge — objects with a sharp point or sharp edge capable of being used to cause serious injury, including: • items designed for chopping, such as axes, hatchets and cleavers • ice axes and ice picks • razor blades • box cutters • knives with blades of more than 6 cm

Screening of	Prohibited articles
	• scissors with blades of more than 6 cm as measured from the fulcrum • martial arts equipment with a sharp point or sharp edge • swords and sabres › (d) workmen's tools — tools capable of being used either to cause serious injury or to threaten the safety of aircraft, including: • crowbars • drills and drill bits, including cordless portable power drills • tools with a blade or a shaft of more than 6 cm capable of use as a weapon, such as screwdrivers and chisels • saws, including cordless portable power saws • blowtorches • bolt guns and nail guns › (e) blunt instruments — objects capable of being used to cause serious injury when used to hit, • baseball and softball bats • clubs and batons, such as billy clubs, blackjacks and night sticks • martial arts equipment › (f) explosives and incendiary substances and devices — explosives and incendiary substances and devices capable, or appearing capable, of being used to cause serious injury or to pose a threat to the safety of aircraft, including: • ammunition • blasting caps • detonators and fuses • replica or imitation explosive devices • mines, grenades and other explosive military stores • fireworks and other pyrotechnics • smoke-generating canisters and smoke-generating cartridges • dynamite, gunpowder and plastic explosives
Hold baggage	› (a) explosives and incendiary substances and devices — explosives and incendiary substances and devices capable of being used to cause serious injury or to pose a threat to the safety of aircraft, including:

Screening of	Prohibited articles
	• ammunition • blasting caps • detonators and fuses • mines, grenades and other explosive military stores • fireworks and other pyrotechnics • smoke-generating canisters and smoke-generating cartridges • dynamite, gunpowder and plastic explosives

4.1.2. Dangerous goods (DGs)

The international transport of dangerous goods by air is regulated by ICAO Annex 18 to the Convention on International Civil Aviation. The broad provisions of this Annex are amplified by the detailed specifications of the Doc 9284 *Technical Instructions for the Safe Transport of Dangerous Goods by Air*.

Standard 8.1 of Annex 18 states that *an operator shall not accept dangerous goods for transport by air:*

- *a) unless the dangerous goods are accompanied by a completed dangerous goods transport document, except where the Technical Instructions indicate that such document is not required; and*
- *b) until the package, overpack or freight container containing the dangerous goods has been inspected in accordance with the acceptance procedures contained in the Technical Instructions.*

Also, ICAO Annex 17 in the note under the definition of screening mentions: "*Certain dangerous articles or substances are classified as dangerous goods by Annex 18 and the associated Technical Instructions for the Safe Transport of Dangerous Goods by Air (Doc 9284) and must be transported in accordance with those instructions.*"

Technical Instructions for Safe transport of Dangerous Goods by Air in Chapter 4 about DGs training states:

- *4.1.1 The employer of personnel that perform functions aimed at ensuring that dangerous goods are transported in accordance with these Instructions must establish and maintain a dangerous goods training programme.*
    - *Note 1.— An approach to ensuring personnel are competent to perform any function for which they are responsible is provided in Guidance on a Competency-based Approach to Dangerous Goods Training and Assessment (Doc 10147).*
    - *Note 2.— Security personnel who are involved with the screening of passengers and crew and their baggage and cargo or mail are required to be trained irrespective of whether the operator on which the passenger or cargo is to be transported carries dangerous goods as cargo.*
- *4.1.2 All operators must establish a dangerous goods training programme regardless of whether or not they are approved to transport dangerous goods as cargo.*

Furthermore:

- The transport of dangerous goods by air shall be forbidden except as established in this Annex and Doc 9284 (4.1)
- Dangerous goods shall be packed in accordance with provisions of this chapter and as provided by Doc 9284 (5.1)
- Each package of dangerous goods shall be labelled with the appropriate labels […] (6.1)
- Each package of DGs shall be marked with the proper shipping name of its contents and, when assigned, the UN number […] (6.2)

It should also be noted that the previous version of Technical Instructions classified 12 categories of personnel with "security screeners" as the last of them. This category was required to have specific training on recognising dangerous goods, understanding the regulations that apply to them, and knowing how to respond appropriately if such goods are identified. The training was to include familiarisation with the types of dangerous goods, the hazards they pose, how to recognise labels and markings, and the procedures for handling incidents involving dangerous goods. Currently, training on DGs should follow the *Competency-based approach* with guidance contained in the ICAO Doc 10147.

Following the standards of Technical Instructions, Doc 10147 states "*that personnel must be trained commensurate with the functions for which they are responsible. These responsibilities are determined by the specific functions the personnel perform and not by their job titles. Concentrating on functions and responsibilities rather than a job title or job description ensures that a person is competent to perform the function in compliance with the Technical Instructions.*" This approach removes categories and relates training to the mapping between tasks and knowledge.

Chapter 5 of the Doc 10147 lists seven tasks none of which is "screening" for DGs.

European rules regarding the transport of dangerous goods can be found in the Commission Regulation (EU) No 965/2012 on Air Operations (Air OPS) laying down technical requirements and administrative procedures related to air operations pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council.

Annex IV provides the following about the transport of DGs for commercial air transport:

- An operator shall establish procedures to ensure that all **reasonable measures** are taken to prevent dangerous goods from being carried on board inadvertently.
- The operator shall provide personnel with the necessary information enabling them to carry out their responsibilities, as required by the technical instructions.
- The operator shall ensure that passengers are provided with information about dangerous goods in accordance with the technical instructions.

Additionally, EASA has published Acceptable Means of Compliance (AMC) and Guidance Material (GM) that are published as EASA Decisions (namely Decisions 2013/017/R through to 2013/022/R).

Furthermore, national aviation authorities must approve the dangerous goods training programs within their respective countries, necessitating the establishment of the conditions for such approval. For comprehensive information regarding training requirements, including whether the training will be classroom-based or computer-based, each operator should reach out to the national aviation authority in the country where they are registered.

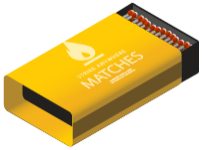
It should be mentioned here that the DGs regulatory framework does not assume, conversely to security, a malicious intention to introduce items with the purpose of causing harm or endangering the safety of flight. The assumption is rather that occurrences like this may happen because of a lack of awareness or neglect, therefore the focus should be on awareness and information.

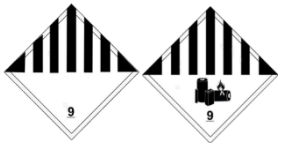
Nevertheless, ICAO Annex 18 recognises scenarios where DGs could be used with malicious intent and states that "*Each Contracting State shall establish dangerous goods security measures, applicable to shippers, operator and other individuals engaged in the transport of dangerous goods by air, to be taken to minimize theft or misuse of dangerous goods that may endanger persons, property or the environment. These measures should be commensurate with security provisions specified in other Annexes and the Technical Instructions".*

An overview of DGs is provided in Table 2.

Table 2: List of DGs (from https://www.easa.europa.eu/en/domains/air-operations/dangerous-goods#group-easa-downloads)

Hazard Class	Hazard Class Label	Common Examples	Example Products
Class 1, Explosives Divisions 1.1, 1.2, 1.3, 1.4, 1.5, and 1.6		Ammunition, fireworks	
Class 2, Gases Divisions 2.1, 2.2, 2.3		Aerosols (e.g., spray paint, household cleaners, hair products, deodorants, cosmetics, cooking sprays), lighters, butane cans, oxygen, CO_2 cartridges, flammable gas powered machinery & equipment, fire extinguishers	
Class 3, Flammable Liquids		Paints, paint-related materials (e.g., paint thinners, stains, sealants, coatings), extracts/flavouring liquids, perfumes/fragrances, adhesives, hand sanitizers, flammable liquid powered machinery/equipment	

Hazard Class	Hazard Class Label	Common Examples	Example Products
Class 4, Flammable Solid, Spontaneously Combustible, and Dangerous When Wet Divisions 4.1, 4.2, and 4.3		Strike-anywhere matches	
Class 5, Oxidizer, Organic Peroxide Divisions 5.1 and 5.2		Oxygen generators, cleaners/chemicals (such as higher concentrations of hydrogen peroxide), adhesive activators, curing products, resin kits	
Class 6, Poison (Toxic), Poison Inhalation Hazard, Infectious Substance Divisions 6.1 and 6.2		Insecticides/pesticides, regulated medical waste, infectious substances	
Class 7, Radioactive Material		Radiopharmaceuticals, radioactive sources (such as those found in certain smoke detectors and medical devices)	

Hazard Class	Hazard Class Label	Common Examples	Example Products
Class 8, Corrosives		Cleaners and chemicals (e.g., swimming pool supplies like chlorine), many acids (e.g., sulfuric, hydrochloric, potassium/sodium hydroxide), wet batteries and battery acid, paint strippers	
Class 9, Miscellaneous Hazardous Materials and Lithium Batteries		Lithium batteries, electronics containing lithium batteries (including cargo tracking devices), dry ice, machinery/equipment containing miscellaneous hazardous materials integral components (e.g. compressed gas accumulators, safety devices)	

4.2. Areas of interdependencies

Regardless of overlaps or ambiguities, the most evident area described in previous sections is the detection of PAs which are at the same time DGs and which are a threat to the aircraft structure – which meet the definition of “high consequence dangerous goods”.

This was confirmed by a cross-check-analysis of the PAs list[7] against classes of DG that identifies explosives and explosive devices as being the most evident examples.

A stakeholder survey supported this observation where more than 60% agreed that screening equipment detects some DGs (provided they are PAs). Therefore, the screening of items carried by persons, cabin baggage, hold baggage, cargo and in-flight/airport supplies as well as company mail and materials is instrumental in its preventive function and detecting these. Additionally, the concept of unpredictability and randomness could also help in the detection of DGs, especially when this would lead to hand-search (thus potential roles of training in recognising DGs by screeners).

The workflow in Figure 3 sourced from ICAO Doc 8973 adequately describes the standard procedure which prioritises security screening.

[7] Attachment 4-C of the Regulation 2015/1998

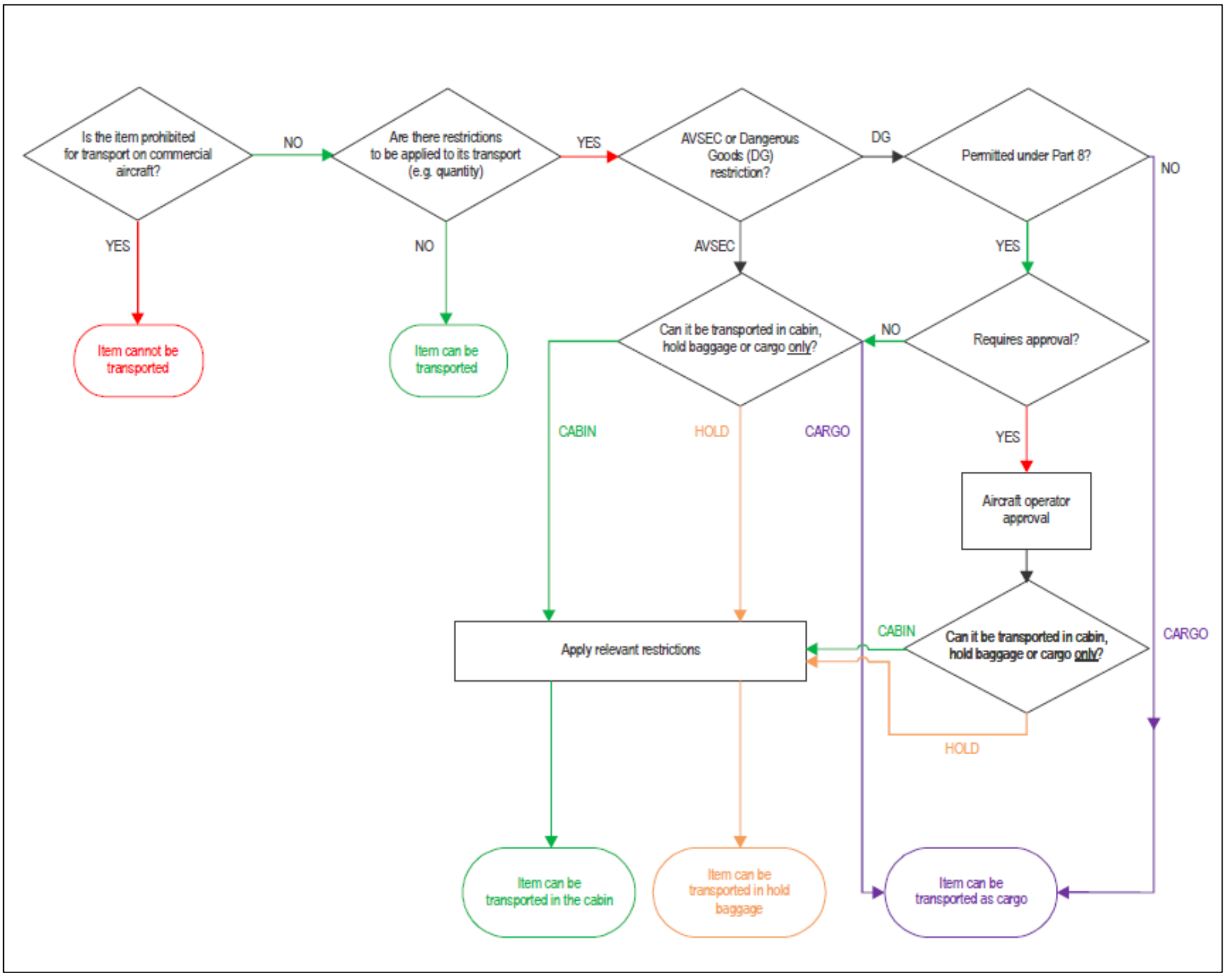


Figure 3 – Workflow of standard procedure which prioritizes security screening

As both forbidden DGs and PAs shall be prevented, the consultation with stakeholders and research investigated commonalities and differences in both approaches (see Table 3).

Table 3: Commonalities and differences of DGs and PAs

Commonalities	Differences
Some PAs and DGs can negatively impact safety by endangering aircraft structure (high consequence DGs)	Responsibilities for prevention are assigned typically to different entities. In case of PAs, it is usually airport operator or State authority, while for DGs it is air operators
Transport of PAs and forbidden DGs (especially high consequence DG) shall be prevented	PAs shall be actively searched for (screening) while DGs shall be prevented from transport if detected
Personnel involved in operations shall be aware of PAs and DGs and undergo training	Dedicated process exists with equipment and personnel deployed to actively search (screen) for PAs while this is not the case for DGs
Information about both PAs and DGs is publicly available and actively communicated by airports, air operators and authorities	There are detection and procedural standards for PAs screening. In case of DGs, there are procedures for permitted transport or handling of identified or undeclared DGs
It is possible that PAs and DGs are unintentionally transported by passengers	Identification of PAs takes place during screening based on recognition of its shape by the screener, or by detection of chemical composition by the equipment. Identification of DGs takes place through labelling and marking on the packaging
Technology developments in screening equipment can help in detection of some PAs and DGs and in both cases there are certain challenges related to false positives and false negatives	Training requirements for PAs and DGs have different focus areas and related or expected skills are targeting different audience

5. Assessment of screening equipment detection standards

This chapter provides the analysis in form of evolution of screening equipment (Section 5.1) as well as the relevance of screening equipment technology and the human factor (Section 5.2).

5.1. Evolution of screening equipment standardisation

This section is focused on the evolutionary process related to screening equipment detection requirements for PAs and does not relate to the facilitation component of the process. As such, analysis of elements like throughput and passenger satisfaction remains out of scope.

The framework for the detection of PAs is a component of the overall aviation security system. As such, it originates from ICAO Annex 17. As mentioned before, this Annex defines "screening" as the process (application of technical or other means) to *identify and/or detect weapons, explosives or other dangerous devices, articles or substances which may be used to commit an act of unlawful interference*.

The definition implies the possibility of using equipment for the purpose of PAs detection.

This section is focused on the **evolutionary process related to screening equipment detection requirements**.

Price and Forrest (2016) recall several significant facts and milestones in the evolution of screening pre-9/11 in the United States since the deployment of walk through metal detectors (WTMD) and X-ray machines at airports in mid-1970s:

- Prior to 9/11 in the United States, the volume of screened hold baggage was below 5% and HBS was introduced only in 2002
- Canada and the United Kingdom introduced HBS in mid- to late-1980s as an aftermath of security events
- Already in the 1990s, initiatives were submitted to deploy better screening technology: Aviation Security Improvement Act (ASIA) in 1990 which required the deployment of better screening technology by the end of 1993 or Core Commission recommendations (1996) concerning the deployment and use of explosive detection systems (EDS), explosive trace detection (ETD) and computer tomography (CT)

In the European Union, the topic of aviation security was not covered by any of the common EU policies until after 9/11 (see Figure 4 for some milestones).

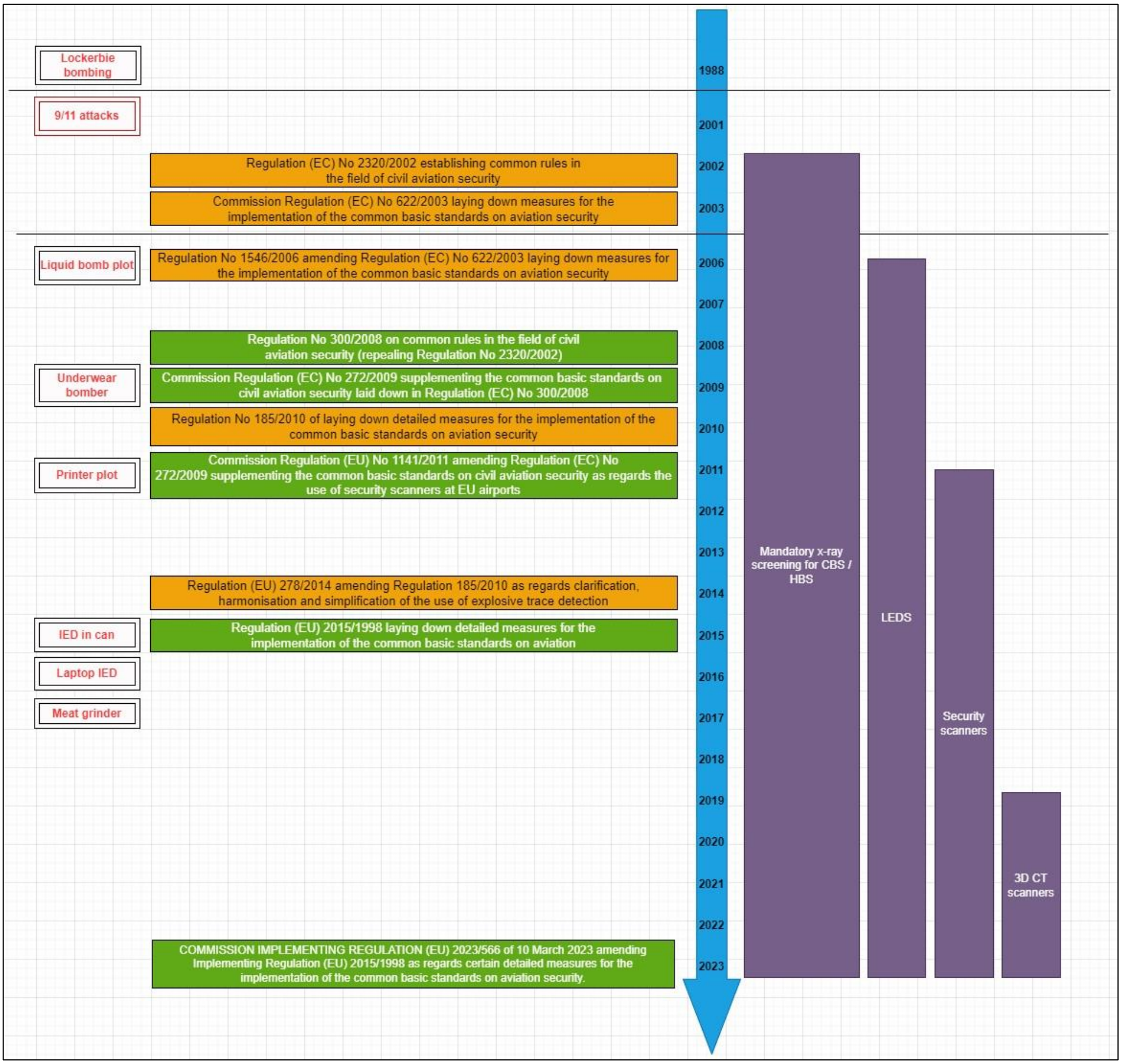


Figure 4 – EU legislation milestones

The first regulation concerning aviation security including detection standards was adopted only in December 2002 as the Regulation (EC) 2320/2002 of the European Parliament and of the Council establishing common rules in the field of civil aviation security. Its article 4 clearly indicates it was based on recommendations of the European Civil Aviation Conference (ECAC) Document 30 *Policy statement in the field of civil aviation facilitation*.

The Regulation 2320/2002 then established for the first time in EU standardized methods of screening for the following:

- Staff, including crew together with items carried – all or if not practicable, screening done on "*continuous random basis*" at the frequency indicated by the risk assessment. The regulation did not specify technical methods of screening for this category
- Passengers – all shall be screened by one of the following methods: hand-search or WTMD supported by the secondary and random hand searches with support of a hand-held metal detector (HHMD)
- Cabin baggage – all items screened by one of following methods: hand-search, or X-ray equipment with supplementary use of hand-search supported by the ETD
- Hold baggage – all items screened by one of the following methods: hand search, or EDS or X-ray, or ETD
- Cargo – screening using one of the methods: hands/physical check, X-ray, simulation chamber, other technical and bio-sensory means (e.g. explosive trace detection or explosive detection dogs) except for cargo received via the "secure supply chain"[8]
- Mail – same methods as for cargo

The Regulation (EC) 2320/2002 did not specify screening methods for air carrier mail and materials and did not require screening of air carrier catering stores and supplies or air carrier cleaning, stores and supplies. Airport supplies were not covered by the initial regulation at all. The Regulation (EU) No 185/2010 laying down detailed measures for the implementation of the common basic standards on aviation security introduced the requirement to screen airport and in-flight supplies, air carrier mail and materials but without specifying methods of screening. These provisions were only introduced in the Commission Implementing Regulation (EU) No 278/2014.

Equipment specification in the Regulation (EC) 2320/2002 were established for following technologies: WTMD, HHMD, and X-ray. The requirements included can be found in Table 4.

Table 4: Requirements for WTMD, HHMD, and X-ray.

Type of equipment	Requirements
WTMD	• Capability of detecting small items of different metal • Capability to detect metal objects regardless of the orientation and location within the frame • Uniform sensitivity within the whole frame • Automatic metal detection indication • Calibration and periodic checks
HHMD	• Capability of detecting small items of different metal • Indication of the metal object position

[8] Air Cargo Secure Supply Chain as explained in the Appendix 30 of the ICAO Doc. 8973 allows the air operator to accept cargo from entities approved as "Known Consignor" if certain security controls were applied and the consignments were protected against unauthorized access.

	• Automatic metal detection indicator
X-ray / EDS in the indicative mode	• Detection measured by resolution, penetration and discrimination • Display time and quality • Visual indication of non-penetrable materials (dark alarms) • Colour discrimination for organic and non-organic materials

Although very useful, all these requirements are more equipment operational specifications rather than specific detection standards (especially for X-ray and EDS equipment). WTMD and HHMD were required to detect metal objects regardless of the fact if they could or could not pose a threat. In the context of threat for the aircraft, the equipment did not differentiate real and false alarms e.g. coins and the metal knife would be equally detected if they exceed the threshold for metal mass. X-ray/EDS equipment requirements refer to image quality and features (again, all organic materials regardless if harmful or not would be displayed in the same colour if they have the same density). In either case, these were features which equipment shall have to assist the operator (screener) in the determination if an item could pose a threat and therefore shall be rejected during screening.

Regulation (EC) 2320/2002 was repealed in 2008 by the Regulation (EC) No 300/2008 of the European Parliament and of the Council of 11 March 2008 on common rules in the field of civil aviation security and its implementing acts: Commission Regulation (EC) No 272/2009 of 2 April 2009 supplementing the common basic standards on civil aviation security laid down in the Annex to Regulation (EC) No 300/2008 of the European Parliament and of the Council and Commission Regulation (EU) No 185/2010 of 4 March 2010 laying down detailed measures for the implementation of the common basic standards on aviation security. These public acts were supplemented by Commission Decision which contains sensitive security measures regarded as EU classified information within the meaning of Commission Decision 2001/844/E and as such is not published. Due to the public nature of this report the content of this document is therefore out of scope.

Annex to the Regulation (EC) 272/2009 contains an updated list of screening equipment, which can be used in line with common basic standards of aviation security (see Table 5).

Table 5: Updated list of screening equipment I

Area of screening	Authorised technology (equipment)
Persons (passengers and non-passengers)	• WTMD • HHMD • EDD (Explosive detection dogs) • ETD • Security scanners
Cabin baggage, items carried, air carrier mail and materials, in-flight supplies, airport supplies	• X-ray • EDS • EDD • ETD • Liquid explosive detection systems (LEDS)[9]
Hold baggage, cargo and mail	• X-ray • EDS • EDD • ETD

[9] These systems are used to screen liquids, aerosols, and gels (LAGs) to ensure they do not contain explosives.

	• MD (Metal detector) • Simulation chamber[10]

Regulation (EU) No 185/2010 contained over time more details about the requirements for screening equipment. The overview can be found in Table 6.

[10] Simulation chambers removed as a method at the later stage

Table 6: Updated list of screening equipment II

Screening equipment type	Regulatory specification	Date of introduction	Regulation
WTMD	Capability to detect ferrous and non-ferrous metallic items. Standard 2 level since 2011. Details on non-published Commission Decision (attachment 12-A)	2010	Commission Regulation (EU) No 185/2010 of 4 March 2010 laying down detailed measures for the implementation of the common basic standards on aviation security
	Standard 1 WTMD reintroduced for screening of persons other than passengers	2012	Commission Implementing Regulation (EU) No 711/2012 of 3 August 2012 amending Regulation (EU) No 185/2010 laying down detailed measures for the implementation of the common basic standards on aviation security as regards the methods used for screening persons other than passengers and items carried
	Introduction of four (4) WTMD standards with details in the non-published Commission Decision. All WTMD installed as of July 2023 of Standard 1.1. or 2.1	2022	Commission Implementing Regulation (EU) No 2022/1174 of 7 July 2022 amending Regulation (EU) No 2015/1998 as regards certain detailed measures for the implementation of the common basic standards on aviation security
HHMD	Capability to detect ferrous and non-ferrous metallic items	2010	Commission Regulation (EU) No 185/2010 of 4 March 2010 laying down detailed measures for the implementation of the common basic standards on aviation security
X-ray	Details on non-published Commission Decision	2010	Commission Regulation (EU) No 185/2010 of 4 March 2010 laying down detailed measures for the implementation of the common basic standards on aviation security
	All X-ray used for cargo and air carrier mail and materials multi-view as of January 2023 unless qualifies for extension until December 2025 or latest December 2027	2021	Commission Implementing Regulation (EU) 2021/255 of 18 February 2021 amending Implementing Regulation (EU) 2015/1998 laying down detailed measures for the implementation of the common basic standards on aviation security
EDS	Capable to detect and to indicate by means of alarm specified (and higher) quantities of explosive material contained in baggage/consignments. Standard 3 mandatory as of September 2018. Alarm in following circumstances: - detection of explosive material	2010	Commission Regulation (EU) No 185/2010 of 4 March 2010 laying down detailed measures for the implementation of the common basic standards on aviation security

Screening equipment type	Regulatory specification	Date of introduction	Regulation
	- dense alarms - presence of an item preventing detection of explosive material Details on non-published Commission Decision (attachment 12-B)		
	Capability to detect expanded and includes specified and higher individual quantities of explosive or chemical material contained in baggage/ consignments	2023	Commission Implementing Regulation (EU) 2023/566 of 10 March 2023 amending Implementing Regulation (EU) 2015/1998 as regards certain detailed measures for the implementation of the common basic standards on aviation security
	Alarm in following circumstances: - detection of explosive or chemical material - dense alarms - presence of an item preventing detection of explosive or chemical material	2023	Commission Implementing Regulation (EU) 2023/566 of 10 March 2023 amending Implementing Regulation (EU) 2015/1998 as regards certain detailed measures for the implementation of the common basic standards on aviation security
	Moving the applicability dates for Standards 1, 2 and 3. Standard 1 expiration in September 2012 (conditional until January 2014), Standard 2 between September 2012 until September 2020 (conditional until September 2022), Standard 3 as of September 2014, with all EDS meeting standard 3 by September 2020	2011	Commission Implementing Regulation (EU) No 1087/2011 of 27 October 2011 amending Regulation (EU) No 185/2010 laying down detailed measures for the implementation of the common basic standards on aviation security in respect of explosive detection systems
	Modification of EDS standards applicability. Removal of Standard 1.	2014	Commission Implementing Regulation (EU) No 687/2014 of 20 June 2014 amending Regulation (EU) No 185/2010 as regards clarification, harmonisation and simplification of aviation security measures, equivalence of security standards and cargo and mail security measures
	Modification of Standard 2 expiration – to September 2021 and applicability of Standard 3 – also as of September 2021	2020	Commission Implementing Regulation (EU) 2020/910 of 30 June 2020 amending Implementing Regulations (EU) 2015/1998, (EU) 2019/103 and (EU) 2019/1583 as regards the re-designation of airlines, operators and entities providing security controls for cargo and mail arriving from third countries, as well as the postponement

Screening equipment type	Regulatory specification	Date of introduction	Regulation
			of certain regulatory requirements in the area of cybersecurity, background check, explosive detection systems equipment standards, and explosive trace detection equipment, because of the COVID-19 pandemic
	Introduction of Standards 3.1 and 3.2 and further specification of timeframes for different EDS Standards where equipment installed: - before September 2014 must be of at least Standard 2 with Standard 2 expiring in September 2021 unless the airport qualifies to any of the extension conditions allowing use until March 2023, September 2023 or March 2024; - between September 2014 and August 2022 must be of at least Standard 3 - between September 2022 and August 2026 must be of at least Standard 3.1 - after September 2026 must be of at least Standard 3.2	2021	Commission Implementing Regulation (EU) 2021/255 of 18 February 2021 amending Implementing Regulation (EU) 2015/1998 laying down detailed measures for the implementation of the common basic standards on aviation security
	Standard 2 EDS maintained for screening of cargo, air carrier mail and materials until September 2022	2022	Commission Implementing Regulation (EU) 2022/421 of 14 March 2022 amending Implementing Regulation (EU) 2015/1998 laying down detailed measures for the implementation of the common basic standards on aviation security
	Cabin baggage standards introduced C1, C2, C3. All EDS for cabin baggage needs to be at least C1. C2 for screening of cabin bags with portable computers and large electronics inside the bag, and C3 for the portable computers, large electronics and LAGs in the bag	2015	Commission Implementing Regulation (EU) 2015/187 of 6 February 2015 amending Regulation (EU) No 185/2010 as regards the screening of cabin baggage
	Alignment of cabin baggage EDS C3 with LEDS Standard 2	2021	Commission Implementing Regulation (EU) 2021/255 of 18 February 2021 amending Implementing Regulation (EU) 2015/1998 laying down detailed measures for the implementation of the common basic standards on aviation security

Screening equipment type	Regulatory specification	Date of introduction	Regulation
APID	APID use with EDS. Capability to detect and to indicate by means of an alarm prohibited items contained in baggage or other consignments. 3 Standards of APID. Details on non-published Commission Decision (attachment 12-M)	2023	Commission Implementing Regulation (EU) 2023/566 of 10 March 2023 amending Implementing Regulation (EU) 2015/1998 as regards certain detailed measures for the implementation of the common basic standards on aviation security
ETD	Indication by means of alarm of the presence of traces of explosives	2010	Commission Regulation (EU) No 185/2010 of 4 March 2010 laying down detailed measures for the implementation of the common basic standards on aviation security
	Expanded requirement for ETD to collect trace levels of particles or vapour. Standardizing particulate and vapour sampling. Details on non-published Commission Decision (attachment 12-L)	2014	Commission Implementing Regulation (EU) No 278/2014 of 19 March 2014 amending Regulation (EU) No 185/2010 as regards clarification, harmonisation and simplification of the use of explosive trace detection
	Indication by means of alarm of the presence of traces of explosives or chemicals	2023	Commission Implementing Regulation (EU) 2023/566 of 10 March 2023 amending Implementing Regulation (EU) 2015/1998 as regards certain detailed measures for the implementation of the common basic standards on aviation security
	Standard for the detection of explosives that uses particulate sampling applicable to ETD deployed as of September 2014. Standard for the detection of chemicals, that uses particulate sampling applies as of July 2024 to ETD deployed as of September 2014	2023	Commission Implementing Regulation (EU) 2023/566 of 10 March 2023 amending Implementing Regulation (EU) 2015/1998 as regards certain detailed measures for the implementation of the common basic standards on aviation security
LEDS	Indication by means of alarm of specified (and higher) individual quantities of threat material in Liquids, Aerosols and Gels (LAGs). Detection independent of the shape or material of the LAG container. Standard 2 starting 2016. Details on non-published Commission Decision (attachment 12-C)	2010	Commission Regulation (EU) No 185/2010 of 4 March 2010 laying down detailed measures for the implementation of the common basic standards on aviation security

Screening equipment type	Regulatory specification	Date of introduction	Regulation
	Introduction of Standard 3 for LEDS	2013	Commission Implementing Regulation (EU) No 246/2013 of 19 March 2013 amending Regulation (EU) No 185/2010 as regards the screening of liquids, aerosols and gels at EU airports
EDD	Indication by means of a passive response of specified (and higher) individual quantities of explosive material. Detection independent of the shape, position or orientation of explosive materials. Standard 1 for screening of persons, cabin baggage, items carried, aircraft, in-flight supplies and airport supplies. Standard 2 for hold baggage, air carrier mail, materials, cargo and mail. Details on non-published Commission Decision (attachment 12-D and 12-I)	2010	Commission Regulation (EU) No 573/2010 of 30 June 2010 amending Regulation (EU) No 185/2010 laying down detailed measures for the implementation of the common basic standards on aviation security
Security scanners	Capability of detecting metallic and non-metallic objects, distinct from the human skin, carried on the body or within clothes. Indication by means of alarm at least specified metallic and non-metallic items including explosives both individually and in combination. Standard 1 expired in January 2022. Standard 2 applicable as of January 2019. Details on non-published Commission Decision (attachment 12-K)	2011	Commission Implementing Regulation (EU) No 1147/2011 of 11 November 2011 amending Regulation (EU) No 185/2010 implementing the common basic standards on civil aviation security as regards the use of security scanners at EU airports
MDE	Detailed on non-published Commission Decision (attachment 12-K, which in 2014 was moved as attachment 12-J)	2013	Commission Implementing Regulation (EU) No 1116/2013 of 6 November 2013 amending Regulation (EU) No 185/2010 as regards clarification, harmonisation and simplification of certain specific aviation security measures
SMD (shoe metal detection)	Ability to detect and to indicate by means of an alarm at least specified metallic items. Two Standards, Standard 1 for screening of persons other than passengers, Standard 2 for passengers. Details on non-published Commission Decision	2019	Commission Implementing Regulation (EU) 2019/103 of 23 January 2019 amending Implementing Regulation (EU) 2015/1998 as regards clarification, harmonisation and simplification as well as strengthening of certain specific aviation security measures

Screening equipment type	Regulatory specification	Date of introduction	Regulation
SED (shoe explosive detection)	Ability to detect and indicate by means of an alarm at least specified explosives items. Two Standards, Standard 1 for screening of persons other than passengers, Standard 2 for passengers. Details on non-published Commission Decision	2019	Commission Implementing Regulation (EU) 2019/103 of 23 January 2019 amending Implementing Regulation (EU) 2015/1998 as regards clarification, harmonisation and simplification as well as strengthening of certain specific aviation security measures
EVD	EVD equipment used for the screening of hold baggage or cargo shall meet at least standard 1, while the one used for screening of persons or cabin baggage shall meet at least Standard 3. Details on non-published Commission Decision	2019	Commission Implementing Regulation (EU) 2019/103 of 23 January 2019 amending Implementing Regulation (EU) 2015/1998 as regards clarification, harmonisation and simplification as well as strengthening of certain specific aviation security measures
	Capability to collect samples of air and analyse the collected sample for vapour, aerosols and/or airborne particles indicating the presence of explosives and explosive related materials.	2023	Commission Implementing Regulation (EU) 2023/566 of 10 March 2023 amending Implementing Regulation (EU) 2015/1998 as regards certain detailed measures for the implementation of the common basic standards on aviation security

The diagram below illustrates the timeline of evolution of detection standards at EU and ICAO regulatory level against major successful of failed plots in aviation between 2005 and 2020 (Figure 5). It is worth noting that the wording "*capable of detecting the presence of explosives and explosive devices*" started in Annex 17 in 2018 with the Amendment 16 (4.4.2 – cabin baggage screening), followed in 2020 by Amendment 17 (4.2.6 – persons other than passengers screening) and finally in 2022 by the Amendment 18 (4.5.2 – hold baggage screening).

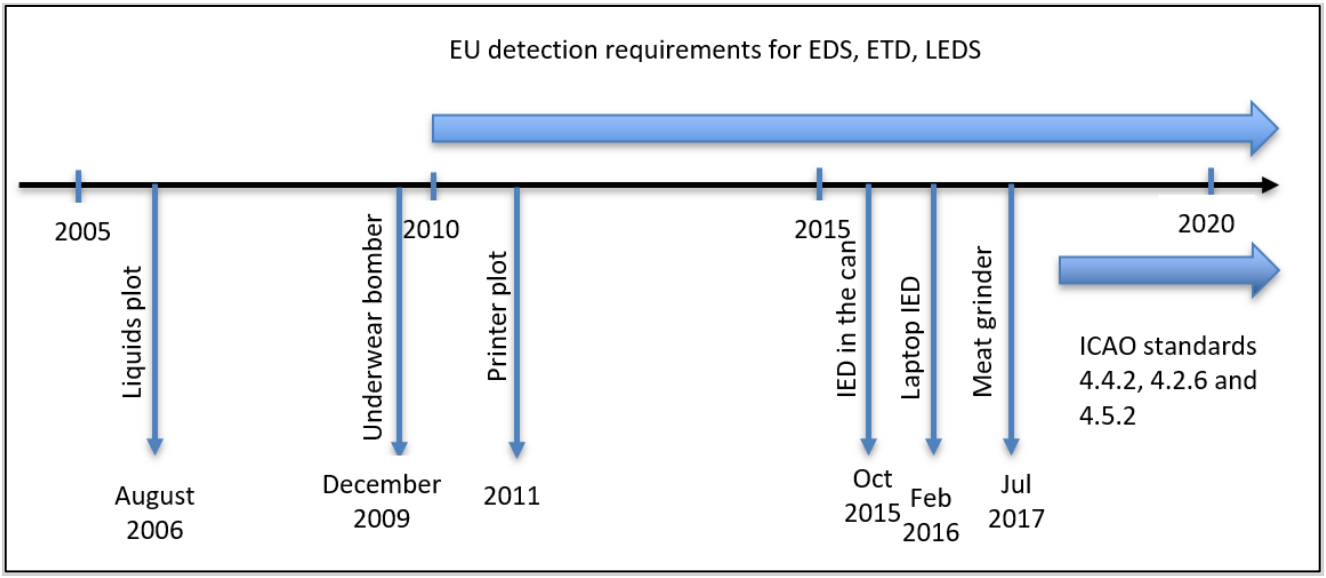


Figure 5 – Evolution of detection standards at EU and ICAO regulatory level against major successful of failed plots in aviation between 2005 and 2020

The European Commission document *Working towards an enhanced and more resilient aviation security policy*[11] presents the improvements identified with a view to engaging further with Member States and stakeholders in defining a way forward towards an enhanced EU aviation security framework that is more resilient, innovative, and fit for the future. These are:

> "*New detection standards are usually developed as a response to new technologies. For example, the Commission adopted new security rules after the new detection standards for security scanners became available. The same concerns the ongoing development of detection standards for the automated detection of prohibited items, thanks to the significant progress made by artificial intelligence technologies. The rules are also changed when there is a change to the threat picture. Developing detection standards for liquid explosive detection equipment is an example of where new detection standards were driven by the change to the threat picture.*
>
> *When it comes to new detection standards, new technologies and new threats, those rely on different development mechanisms. Tackling new threats requires a more comprehensive analysis to assess threats before developing new standards. On the contrary, enabling new technologies like the automated detection of prohibited items with artificial intelligence is more a question of achieving the right security outcome in relation to existing threats and ensuring that new vulnerabilities are not introduced or that they are dealt with more efficiently.*
>
> *Although the current EU aviation security framework has been successful in rolling out new technologies, stakeholders generally emphasise the need to further improve the innovation-friendliness of the regulatory environment, so it can become a key enabler to increase research and development as well*

[11] SWD(2023) 37 final. https://www.eraa.org/sites/default/files/st-6124-2023-init_en.pdf

as a basis to plan future investments. They call for more planning in relation to developing new detection standards."

The aspirational goal of this European Commission document seems to be supported by the views of stakeholders. Responses collected during the survey suggest that the development of standards is appreciated. Over 80% of respondents agreed that "*Standardization achieved by introduction of detection standards helps in effective deployment on new technology*". Still, some space for improvements can be equally observed. Data collected show almost equal (50%) distribution between those agreeing with the statement "*Screening detection standards are evolving at the right pace*" and those with the opinion between "*somehow disagree*" and "*neither agree nor disagree*".

5.2. Relevance of screening equipment technology and the human factor

The relevance of currently applicable screening measures is shared between the regulators and industry stakeholders. Only 8.8% and 14.7% of respondents to the survey assessed risk areas of *IEDs in passenger cabin* and *IEDs in aircraft hold* respectively faced with major gaps. Moreover, 14.7% in indicated "*there are no gaps*" in each of these areas.

Sections below look deeper into some screening solutions. Most of the information is based on a publication by Vukadinovic & Anderson (2022) that reviews artificial intelligence (AI) in security screening.

5.2.1. X-ray technologies for baggage

The most basic method for screening baggage is radiographic X-ray imaging where two methods exist.

5.2.1.1. 2D X-ray equipment

The detection of illicit materials using (dual-energy)[12] X-ray technology is based on chemical composition (atomic number, Z_{eff}) and density (Figure 6). Assistance for manual detection is provided by enhancing the image through various image processing methods or by using pseudo colours.

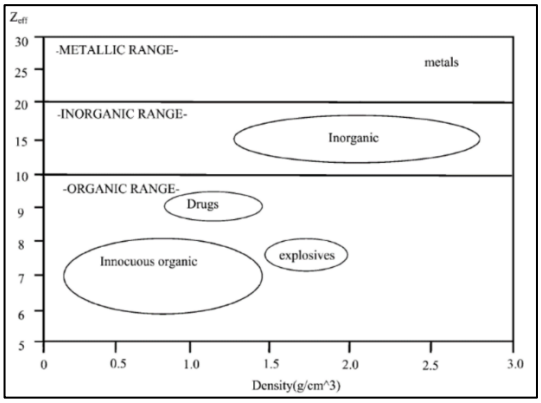


Figure 6 – Z_{eff} and density for commonly seen innocuous materials and for illicit materials (Vukadinovic & Anderson, 2022)

Pseudo colours - Different materials can be directly distinguished on X-ray images by applying pseudo colours linked to different atomic Z-numbers, which represent different materials in different colours (see Figure 7).

[12] Single-energy X-ray scanners are based on density only.

Low-density organic materials are orange, high density non-organic materials are blue, and medium density (or overlapping) mid-Z materials are green in colour. The capability of this type of equipment is limited to indicating shapes of items through colours (e.g. metal knife would be visible because the material it is made of will be dark blue).

Material class	Examples	Threads
Background		
Light organic	Wood, Fabric	Explosives C4, Trotyl
Heavy organic	Plastics, Glass	Drugs, Heroin, Cocaine
Non-organic	Aluminium, Salt	Gunpowder
Metals	Iron, Steel, Brass	Guns, Bullets
Heavy metals	Silver, Gold	Jewellery contraband
Not-penetrable	Lead	Threat hiding

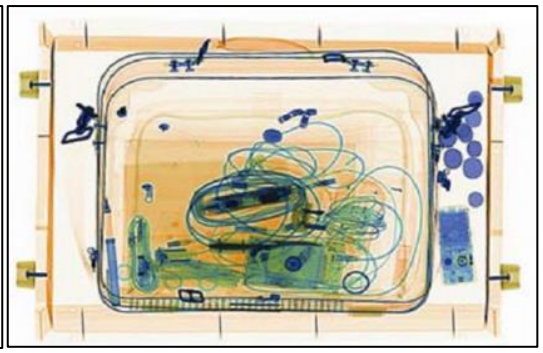


Figure 7 – Material pseudo-colours and its classes used widely in the X-ray security scanners (Vukadinovic & Anderson, 2022) and an X-ray image example

Different views - Colour information assists screeners in identifying objects within X-ray images more easily. However, single-view and dual-view 2D X-ray technologies encounter challenges in target visibility because the nature of X-ray imaging, which collapses a 3-dimensional volume into a 2-dimensional image, makes it difficult to discern prohibited items. This difficulty is enhanced when items are depicted from unconventional viewpoints, obscured by other objects, or situated in visually complex bags.

In order to improve target visibility, multi-view X-ray systems are currently the norm in aviation security as they produce two or more images of scanned objects from different viewpoints. Hence, objects posing a threat may be more easily identified with the availability of an additional orthogonal view.

5.2.1.2. 3D CT equipment

Even better visibility is achieved with CT scanners, which create a three-dimensional reconstructed image using multiple X-ray measurements taken from different angles. These systems allow a 360-degree rotation of the bag image to inspect objects from various angles and viewpoints. They also enable a slice view to look through objects of interest, reducing the need for security personnel to open baggage. Technically, this has better automated explosive detection, higher baggage throughput, and 3D-rotatable images.

However, CT scanners have several downsides: they are generally slower than 2D screening due to the rotating and slicing processes, and the images often suffer from significant noise, metal-streaking artifacts, and lower voxel resolution, making them poorer in quality compared to older 2D imaging technology.

5.2.2. Automated detection systems for baggage

Automated detection can be implemented to the above-mentioned X-ray technologies. Alarm-based assistance for screeners is provided by using automated detection methods with two distinct systems:

- EDS – classify materials based on their density and effective atomic number Z_{eff}
- APIDS – classify items based on shape

In both scenarios, human screeners observe highlighted areas in X-ray images that may contain prohibited items.

5.2.2.1. Explosive detection systems (EDS)

This type of technology equips machine with an alarm-based type of assistance where the reaction of the automated system is based on classification of materials by their density and effective atomic number (Z_{eff}). Hence, colour information can be used as an extra feature for automatic recognition systems to achieve higher recognition rates. This solution is undoubtedly a step forward compared to conventional X-ray. Alarm function would typically signal to the screener the area which may contain explosives by coloured frames (see Figure 8).

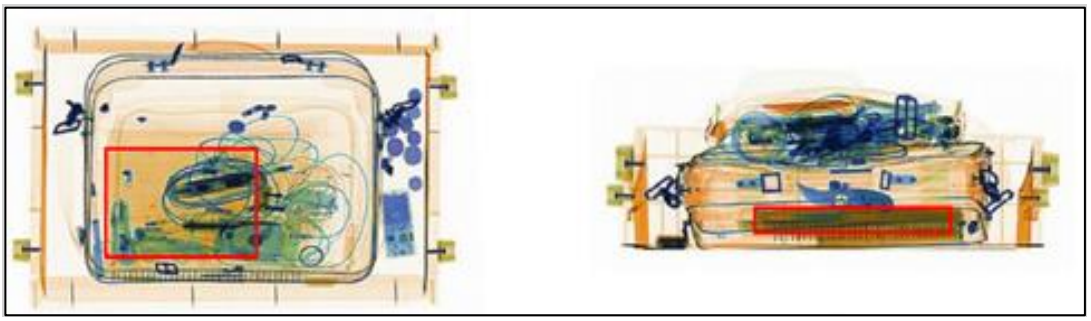


Figure 8 – Example X-ray image with EDS alarm

Research analysis indicate however, parameters of Z_{eff} and density result in a challenge of almost overlapping between harmless items and explosives (Iovea et al., 2007).

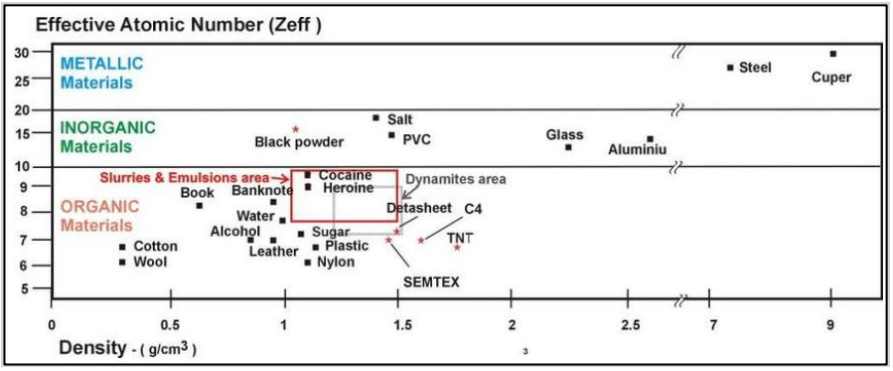


Figure 9 – Z_{eff} and Density values for some explosives and other domestic materials (Iovea et al., 2007)

EDS use a combination of CT and other advanced imaging technologies to screen baggage and detect explosives. These systems analyse various properties of the scanned objects, including density and effective atomic number (Z_{eff}), to identify potential threats.

Density range - The density of materials is a crucial factor in explosive detection. EDS are designed to detect a wide range of densities that could indicate the presence of explosive materials. Generally, the density range that these systems are calibrated to detect can span from very low-density materials to high-density ones:

- **Low-Density Materials:** These could be materials like plastics or certain organic materials
- **High-Density Materials:** These include metals and other dense materials that might be used to shield or encase explosives

The specific density range can vary depending on the manufacturer and model of the EDS, but a typical range might be: **0.7 g/cm³ to 2.0 g/cm³**. This range allows the detection of a wide variety of potential explosive compounds and materials used in their construction.

Z_{eff} range - Z_{eff} is a measure that reflects the overall atomic composition of a material. Different materials, including explosives, have characteristic Z_{eff} values. EDS analyze Z_{eff} to distinguish between benign and potentially hazardous materials:

- **Low Z_{eff}:** Corresponds to materials with lighter elements (e.g., hydrogen, carbon, nitrogen, oxygen), which are common in many explosives.
- **High Z_{eff}**: Corresponds to materials with heavier elements (e.g., metals), which might be used to construct bombs or as part of their components.

Typical Z_{eff} values for explosives range approximately between: **Z_{eff} of 6 to 9**. Many common explosive materials, like TNT (Trinitrotoluene) and PETN (Pentaerythritol tetranitrate), have Z_{eff} values in this range due to their molecular composition.

Lithium Batteries - Lithium batteries, specifically lithium-ion batteries, have specific density and Z_{eff} characteristics that are relevant for safety and detection purposes, particularly in aviation where the transportation of these batteries is a concern.

- **Density range**: The density of lithium-ion batteries can vary depending on their design, chemistry, and packaging. However, typical values are: approximately 2.0 to 3.5 g/cm³. This range covers the common types of lithium-ion batteries used in consumer electronics, electric vehicles, and other applications. The density is influenced by the materials used in the electrodes (like lithium cobalt oxide, lithium iron phosphate, etc.), the electrolyte, and the casing.
- **Z_{eff} range**: The effective atomic number (Z_{eff}) is a weighted average of the atomic numbers of the elements in the material, reflecting its interaction with X-rays or other penetrating radiation. For lithium-ion batteries, Z_{eff} can be calculated based on the primary constituent materials:
  - **Anode**: Typically made of graphite (carbon), with an atomic number (Z) of 6.
  - **Cathode**: Materials vary but often include lithium cobalt oxide ($LiCoO_2$), lithium iron phosphate ($LiFePO_4$), or lithium manganese oxide ($LiMn_2O_4$). These elements have atomic numbers of lithium (3), cobalt (27), iron (26), phosphorus (15), and manganese (25).
  - **Electrolyte**: Usually composed of lithium salts in organic solvents, with lithium (3) and common elements in solvents like carbon (6), oxygen (8), and fluorine (9).
  - **Casing and Conductors**: Often made of aluminium (13) and other metals.
  - Given the mixture of these materials, the Z_{eff} of lithium-ion batteries can be approximated as approximately 12 to 22. This range is an estimate based on the relative proportions of light elements like lithium and carbon and heavier elements like cobalt, iron, and manganese in typical lithium-ion batteries.

5.2.2.2. Automated prohibited item detection system (APIDS)

APIDS use artificial intelligence-based algorithms to automatically detect items determined to be a security risk at airport security checkpoints. In the project "TRAI – *Target Recognition using Artificial Intelligence*", CASRA analyzed commercially available APIDS and their applications by interviewing multiple APIDS providers (see Sterchi & Simonetti, 2023 for a report). Results showed that APIDS are capable of detecting guns, knives, and other sharp objects. Many providers also highlight their ability to detect gun parts like magazines and ammunition, as well as tools. Additionally, some APIDS can identify objects such as (e-)cigarettes, power banks, hand grenades, and large electronics. For more detailed information on each provider's capabilities, refer to the report. Reported detection rates for almost all item categories are above 80%, and often exceed 90%. However, it's important to note that these detection rates are based on varying sets of prohibited items and are not directly comparable; they should be viewed as rough estimates of current capabilities. False alarms, where the APIDS incorrectly identifies a harmless item, range from nearly 0% to 10%, with average rates below 5%. It is expected that the false alarm rate will decrease as APIDS technology continues to develop. Like human

screeners, APIDS performance can be affected by the characteristics of the X-ray image, such as strong superposition.

According to EU regulations, airports must ensure that all screened baggage meets specific requirements, like no large electronics or liquids for EDS C1, for their APIDS to be able to clear a portion of the baggage without human intervention.

5.2.3. Technologies for persons

5.2.3.1. Security scanners

Security scanners have significantly advanced over the past decade, driven by AI and machine learning innovations. Historically, checkpoint security relied on X-ray scanners for baggage and walk-through metal detectors and physical pat-downs for people screening. These methods were limited to detecting concealed metallic items and could not identify person-borne explosives, ceramic knives, printed weapons, or contraband. The introduction of millimetre wave (mmW) security scanners over 15 years ago revolutionized threat detection, enabling the identification of a broader range of prohibited items. The uniformity of the human body aids AI algorithms in distinguishing between biological structures and potential threats, allowing operators to focus on anomalies.

Currently, three types of security scanners are used in airports:

- Backscatter X-ray Units[13]: These scanners use low-energy X-rays that penetrate clothing but scatter upon hitting dense objects. The scattered radiation is detected and forms an image of the subject's body, revealing items concealed under clothing.
- Transmission X-ray Units: These scanners use higher energy X-rays that pass through the body, detected by a system on the opposite side of the X-ray source. The resulting image, similar to medical radiographs, shows the subject's skeletal structure and any contraband items swallowed or hidden under clothing, provided they have sufficient X-ray absorption contrast.
- Non-ionizing Radiation Units: This category includes active and passive scanners. Active scanners emit radio waves to create an image, while passive scanners detect natural radiation emitted by the person. These technologies are being developed and assessed for their efficacy in security screening.

5.2.4. Human role in X-ray screening

5.2.4.1. Non-automation

As the machine itself essentially only generates the image, there need to be humans (screeners) deployed to analyse it. There are no detection requirements per se applicable to this type of equipment and it is the screener's job to visually inspect the image searching for prohibited items.

Surveyed stakeholders confirmed this approach over 90% of the agreeing with the statement "*Detection requirements for screening equipment should be looked at in combination with other elements of the system (e.g. human factor and other security measures)*".

The human role therefore encompasses the following tasks:

- **Analysing X-ray images:** Identify prohibited items within the scanned luggage (requires training and expertise to distinguish between harmless everyday items and prohibited items)

[13] Technology no longer permitted in the EU

- In this context, training of screeners, especially using simulators (solutions able to present many images of different complexity and with a range of prohibited articles) appears critical. It is one of the most effective methods to increase and maintain the competence of screeners so that they are able to detect threats effectively while generating acceptable amount of false alarms.
    - For untrained person it can be difficult to recognize prohibited items because:
    - They may not be familiar with the appearance of the item
    - Many objects look very different in X-ray image compared to real life
    - Some prohibited items will look very similar to everyday objects
    - Recognizing prohibited items will be more difficult when they appear in unusual viewpoints
    - Moreover, some threats that are critical to aircraft structure (explosive devices) do not have the typical shape like other items (e.g. guns). Their shape and appearance can and will vary.

- **Decision-making:** Based on the analysis, screeners make decisions regarding the contents of the baggage (i.e. further inspection or cleared for transport) and resolution of any alarms where required.

5.2.4.2. Automation

EDS

As the machine itself generates the image with a potential alarm to resolve, there need to be humans (screeners) deployed to analyse it. There are no detection requirements per se applicable to this type of equipment and it is the screener's job to visually inspect the image searching for prohibited items.

EDS is different depending on the area of screening (CBS versus HBS). **EDSCB -** Human-machine interaction during cabin baggage screening at checkpoints tends to be low-level automation systems. The automated detection system provides alerts, alarms, or warnings to support human operators by cueing attention to areas of a display that might contain a target. These types of systems support screeners by indicating areas in X-ray image that might contain target, usually by framing them with red colour boxes. **EDSHB -** High-level automation systems in airports are currently deployed for hold baggage scanning. During the flight, passengers cannot access items stored in the hold of an aircraft, so guns or knives do not pose a threat. Therefore, at hold baggage screening checkpoints, high-level automation systems are deployed using CT scanners targeting fully functioning IEDs with automated EDS. Lately, automated detection of lithium batteries could be incorporated in hold baggage CT scanners[14].

The human role encompasses the following tasks:

- **Analysing X-ray images (EDSCB):** Identify IEDs within the scanned luggage (requires training and expertise to distinguish between harmless everyday items and prohibited items)
- **Decision-making:** Based on the analysis, screeners make decisions regarding the contents of the baggage (i.e. further inspection or cleared for transport)
- **Alarm resolution (EDSHB):** If machine detects an anomaly in the bag it raises an alarm. Only the alarmed bags are further examined by screeners. This approach is called alarm-only viewing.

APIDS

[14] Research project Detection of lithium batteries using security screening equipment (EASA.2022.HVP.22)

For APIDS, it is anticipated that integrating full system capabilities with EDSCB screening could achieve automation levels similar to HBS. [15]

The human role therefore might encompass the following tasks:

- **Alarm resolution:** If machine detects an anomaly in the bag it raises an alarm. Only the alarmed bags are further examined by screeners. This approach is called alarm-only viewing.

Body scanner

AI systems have inherent limitations, primarily dictated by the parameters of their training data. If an AI model is not trained to identify specific threats, it may fail to trigger an alarm even in the presence of a threat. While technology, particularly AI, holds promise in streamlining security screening processes, its implementation hinges on the complexity of the task at hand. AI's effectiveness is most pronounced when tasked with aspects of the screening process where it can deliver close to 100% probability results with a negligible false alarm rate. This does not necessarily translate to a reduction in personnel numbers but rather a refinement in the qualifications required. AI can effectively guide operators, simplifying their tasks and enhancing overall efficiency. However, it's premature to rely solely on machine vision algorithms given current technological limitations.[16]

6. Conclusions

This chapter outlines the conclusion for this report.

The focus of this report is on threats to aircraft structures. In our analysis, we examined the interdependencies between security and safety, specifically focusing on the prevention and detection of prohibited articles (PAs) and the prevention of dangerous goods (DGs). While recommendations may be further expanded in deliverable D-3.1.4, several key points are worth highlighting here.

General Remarks

Both safety and security aim to protect passengers, crew, and aircraft from threats, but they do so through different yet complementary approaches:

- **Safety** focuses on preventing accidental harm by ensuring DGs are properly identified, labelled, and transported to avoid incidents such as fires, explosions, or leaks, which can jeopardize the safety of the aircraft and its occupants.
- **Security** focuses on preventing deliberate, malicious acts through the detection and interception of explosives, weapons, or other harmful items that could jeopardize the safety of the aircraft and its occupants.

Identified areas of interrelationship between safety and security include screening equipment, human roles, operational procedures, risk management, and training. The technology (equipment) should not be analysed separately. Instead, the screening process should be looked at holistically, as a sociotechnical system.

Furthermore, although there is common concern over the threats related to Dangerous Goods, there is no clear consensus on how this could be integrated within the existing security screening process. Additionally, any consideration of additional screening for DGs is not feasible and unrealistic. Key issues raised include:

Operational Level:

[15] https://www.pointfwd.com/news/tag/APIDS

[16] Airport Body Scanner Trends: A TSI Industry Expert Roundtable, April 2024

- Some DGs are also PAs and are actively screened for, while other DGs that are not PAs are not. Thus, screening equipment is an effective tool for only certain items.
- DGs which are not PAs are not required to be actively searched for. Involving screeners in the active search for such DGs goes beyond their authority and may have a detrimental effect on current security screening, if not carefully designed. All stakeholders involved would need to align on any changes related to these processes. Unauthorized DGs may still be prevented from transport, if identified during screening.
- The ultimate decision to reject an item for transport is at the discretion of screeners. There is overlap with DG prevention in the ability to interpret and act upon information provided by the screening equipment. If a screener detects a Dangerous Good item during security screening, similar steps as for a Prohibited Article would be involved, including rejection for transport, isolation of the item, and notification of relevant authorities (airport, airline, or appropriate national authority).
- Despite advancements in automation, screening equipment primarily serves as an aid to screeners rather than a replacement for human judgment. Equipment such as X-ray, WTMD, or security scanners do not detect threats directly; they detect anomalies. X-rays show materials in different colours, WTMD signals an anomaly indicating a metallic item, and even EDS only indicates anomalies based on programmed rules. Although screening equipment continues to evolve, certain limitations persist, including its ability to help with DG identification.
- Any automation in detection (whether for PAs or DGs) must balance the trade-off between detection rates and false alarm rates. Equipment manufacturers are technically capable of introducing new algorithms to detect some DGs, but the concept of operations must be carefully investigated with precise needs and standards established, and all stakeholders must agree on the consequences of these processes.
- Any new item potentially added to the screening process must address the same challenges outlined for security screening of PAs, including operational implications on throughput.

Regulatory Level:

- More work is needed to ensure that regulatory requirements for the prevention of PAs and DGs are developed coherently and that authorities are consistently assigned. Currently, airports are typically responsible for screening for PAs while prevention of DG transport is assigned to aircraft operators, who have no authority over the screening process.
- Due to the above, there are differences in understanding responsibilities and their assignment to different groups of personnel, with a low level of acceptance of this duty being assigned to screeners.
- Training requirements for DG prevention and PA detection are well established, but differences in approaches and assignment of responsibilities result in a situation where there is no consistent approach to the implementation of DG training for screeners. Because screeners are typically not responsible for searching for DGs, their training does not cover this scope.
- Consideration should be given to an integrated risk assessment through the joint review of the PAs list and DG classes. This holistic approach can help ensure that all possible risks are considered and addressed in an integrated manner.

It appears through the study that safety and security domains remain disjointed to a certain degree on the topic of DGs. More alignment opportunities should be explored to synchronize the prevention of DGs and PAs, prioritizing similarities in the worst-possible outcome rather than focusing on differences related to intentional (for security) or unintentional (for safety) behaviour.

6.1. Implementation of screening processes for (non-)prohibited DGs

Section 5.1 showed that DGs shall be prevented from transport (see Table 7). The regulatory framework does not require however that passengers and their baggage is screened to detect these items.

Moreover, the regulatory framework assigns responsibilities in a manner that seems not aligned. Whereas responsibilities for "security" screening will be assigned based on the National Aviation Security Program (typically to airport operator or State authority), responsibilities for prevention of dangerous good transport are directed to operators (meaning air operators).

Table 7: DGs prevented from transport

Security – Prohibited articles	Safety – Dangerous Goods (source IATA DG Manual)
General rule: Without prejudice to applicable safety rules, passengers are not permitted to carry the following articles into security restricted areas and on board an aircraft: • Explosive substances • Explosive devices • Incendiary substances • Incendiary devices	Any article or substance which, as presented for transport, is liable to explode, dangerously react, produce a flame or dangerous evolution of heat or dangerous emission of toxic, corrosive or flammable gases or vapours under conditions normally encountered in transport must not be carried on aircraft under any circumstances: • Explosives (Class 1) • Flammable gas (Class 2, Div 2.1) • Flammable Liquids (Class 3) • Oxidizers (Class 5)

Although DGs should be prevented from transportation unless they are permitted, there is no standard requiring an active search in the form of screening aimed specifically at DG detection. Consequently, some aviation security regulators may be dismissive of the safety obligations stated by ICAO and resist requiring appropriate DG safety training and assessment, as this appears to be outside their competencies.

This misalignment could escalate beyond issues of competency and result in poor coordination of operational measures, where both DGs and Prohibited Articles (PAs) may pose a serious risk to the aircraft. The research identified several key points:

- The temporary addition of an item to the list of PAs allowed in the cabin could cause an additional safety hazard if placed in the hold.
- The potential removal of certain restrictions, due to advancements in PA detection, may increase safety hazards.
- Some DGs are not proactively searched for, making the rate of prevention through detection and the performance of screeners (including detection challenges) unquantifiable.

Changes in technical instructions, especially the transition to competency-based training, could have added to the confusion about what screeners should be trained on in relation to DGs.

6.2. Human operator and its interactions with screening equipment

Focusing solely on screening equipment when discussing threat detection can lead to oversimplified conclusions. While the equipment is crucial, it is not the only element of the overall screening process. Equally important is the human element—the operator. Section 5.1 highlighted that initially, the aviation security system faced challenges in establishing clear detection standards for threats. Instead, standardization was aimed at processes that confirm the "lack of anomalies" or detect "anomalies" rather than threats. Many of these inherited elements are still present today. Ultimately, the decision stays with human operators, and therefore, considering human factors, screeners should always be included in the analysis of the screening process. The discussion on whether DGs should be actively searched for should consider how to ensure a balanced approach between the roles of machines and human operators.

Section 5.2 demonstrated that screening equipment should not be viewed in isolation but rather in conjunction with human operators. Security checkpoints should be regarded as sociotechnical systems where humans and machines interact. The system performance of an airport security checkpoint depends on technology, humans, and the processes defining their interaction. As screening technology advances from conventional X-ray to 3D CT and more automated systems like EDS and APIDS, the nature of the screener function evolves. Screeners move from manual interpretation and decision-making to more supervisory roles, where they confirm and resolve alerts generated by the systems:

- low-level automation (decision support by the human operator with input in the form of recommendations provided by the system) → EDSCB
- high-level automation (human operator checks only the bags that are alarmed by the automated system) → EDSHB
- full automation (with no operator interaction)

While the primary inspection of X-ray or CT images of carry-on baggage is increasingly being automated by technologies such as EDSCB and APIDS, the secondary inspection is becoming more important. The shift to automation and 3D CT technology reduces the likelihood of human error but requires screeners to have a different skill set, focusing on understanding and managing advanced detection technologies. While technology can automate certain tasks, human judgment remains essential for handling unique scenarios. Human screeners provide flexibility and adaptability, which is crucial in dynamic security environments. In this context, training of screeners is critical so as to increase and maintain their competence.

In summary, the role of operator (screener) will need to be adjusted depending on the equipment operated. This combination provides robust conditions for detection of PAs.

To conclude, it is technical possible to expand existing process to include some of DGs which are not PAs into current processes. This can be achieved using multiple implementation methods. Proper consideration should be given however to:

- Regulatory framework
- Impact on screening operations
- Effect on operations
- Assignment of responsibilities

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ANNEX

The annex lists existing security measures and equipment (as of right now) based on Annex 1 of Commission Implementing Regulation (EU) 2015/1998 and Commission Implementing Regulation (EU) 2023/566.

Persons other than passengers and carried items

Screening persons other than passengers and carried items

Section 1.3.1.1 lays down that **persons** other than passengers shall be screened by one of the following means:

- (a) hand search
- (b) X-ray equipment
- (c) explosive detection systems (EDS)
- (d) automated prohibited items detection (APID) software in combination with EDS
- (e) explosive detection dogs (EDD)
- (f) explosive trace detection (ETD) equipment

EDDs and ETD equipment may only be used as a supplementary means of screening of persons other than passengers or in unpredictable alternation with hand searches, WTMD or security scanners (Section 1.3.1.2).

Section 1.3.1.4 lays down that items carried by persons other than passengers shall be screened by one of the following means:

- (a) hand search;
- (b) X-ray equipment;
- (c) EDS equipment;
- (d) EDD;
- (e) ETD equipment.

EDDs and ETD equipment may only be used as a supplementary means of screening of items carried by persons other than passengers or in unpredictable alternation with hand searches, X-ray equipment or EDS equipment (Section 1.3.1.6).

The screening of persons other than passengers and items carried shall also be subject to the additional provisions laid down in Commission Implementing Decision C(2015) 8005 (Section 1.3.1.8).

Vehicles

Vehicles entering critical parts

Section 1.4.1.1 lays down that all vehicles shall be examined before entering critical parts.

Section 1.4.1.2 lays down that the driver and any other occupants of the vehicle shall not be in the vehicle when the examination takes place and that they shall be required to take their personal belongings out of the vehicle with them for **screening**.

Section 1.4.3.2 lays down that the following methods may only be used as a supplementary means of examination additional to an obligatory hand search (1.4.3.1):

- (a) EDD
- (b) ETD equipment

Vehicles entering security restricted areas other than critical parts

Section 1.4.2.1 lays down that the driver and any other occupants of the vehicle shall not be in the vehicle when the examination takes place and that they shall be required to take their personal belongings out of the vehicle with them for **screening**.

Section 1.4.3.2 lays down that the following methods may only be used as a supplementary means of examination additional to an obligatory hand search (1.4.3.1):

- (a) EDD
- (b) ETD equipment

Passengers and cabin baggage

Section 4.0.4 specifies that:

- (a) "liquids, aerosols and gels (LAGs) shall include pastes, lotions, liquid/solid mixtures and the contents of pressurised containers, such as toothpaste, hair gel, drinks, soups, syrups, perfume, shaving foam and other items with similar consistencies"; and
- (b) "liquid explosive detection systems (LEDS) equipment" is a piece of equipment capable of detecting threat materials that meets the provisions of point 12.7 of the Annex to Commission Implementing Decision C(2015) 8005".

Screening of passengers and cabin baggage

Screening of passengers

Section 4.1.1.2 lays down that **passengers** shall be screened by at least one of the following methods:

- (a) hand search
- (b) WTMD
- (c) EDD
- (d) ETD
- (e) security scanners which do not use ionising radiation
- (f) ETD equipment combined with HHMD equipment

Before screening, outer wear shall be taken off and shall be screened as cabin baggage, unless the concept of operations of equipment allows for outer wear to be kept on. The screener may request the passenger to undertake further divesting as appropriate (Section 4.1.1.1).

4.1.1.4 When WTMD equipment alarms, the cause of the alarm shall be resolved.

4.1.1.5 Hand-held metal detection (HHMD) equipment may only be used as a supplementary means of screening. It shall not replace the requirements of a hand search.

4.1.1.6 Where a live animal is permitted to be carried in the cabin of an aircraft, it shall be screened either as a passenger or as cabin baggage.

4.1.1.10 When a security scanner with a human reviewer, as defined under the second paragraph of point 12.11.1, is used for screening of passengers, all of the following minimum conditions shall be complied with: (a) security scanners shall not store, retain, copy, print or retrieve images. However, any image generated during the screening can be kept for the time needed for the human reviewer to analyse it and shall be deleted as soon as the passenger is cleared. Any unauthorised access and use of the image is prohibited and shall be prevented; (b) the human reviewer analysing the image shall be in a separate location so that he/she cannot

see the screened passenger; (c) any technical devices capable of storing, copying or photographing or otherwise recording images shall not be allowed into the separate location where the image is analysed; (d) the image shall not be linked to any data concerning the screened person and his/her identity shall be kept anonymous; (e) a passenger may request that the image of his/her body is analysed by a human reviewer of the gender of his/her choice; (f) the image shall be blurred or obscured to prevent the identification of the face of the passenger. Paragraphs (a) and (d) shall also apply to security scanners with automatic threat detection.

4.1.1.11 Explosive trace detection (ETD) equipment in combination with hand held metal detection (HHMD) equipment may only be used in cases where the screener considers a hand search of a given part of the person to be inefficient and/or undesirable.

The screening of passengers shall also be subject to the additional provisions laid down in Commission Implementing Decision C(2015) 8005 (Section 4.1.1.8).

Screening of cabin baggage

Section 4.1.2.3 lays down that **cabin baggage** shall be screened by at least one of the following methods:

- (a) a hand search
- (b) X-ray equipment
- (c) EDS equipment
- (d) APID software in combination with (c)
- (e) EDD in combination with point a hand search
- (f) ETD equipment

Before screening, portable computers and other large electrical items shall be removed from cabin baggage and shall be screened separately, unless the cabin baggage is to be screened with EDS equipment meeting standard C2 or higher (Section 4.1.2.1).

4.1.2.5 Where X-ray equipment is used, each image shall be viewed by the screener. Where EDS equipment is used, each image shall be viewed by the screener or analysed by automated prohibited items detection (APID) software.

4.1.2.7 Where X-ray or EDS equipment is used, any item whose density impairs the ability of the screener to analyse the contents of the cabin baggage shall be taken out of the baggage. The bag shall be screened again and the item shall be screened separately as cabin baggage.

4.1.2.8 Any bag that is found to contain a large electrical item shall be screened again with the item no longer in the bag and the electrical item screened separately, unless the cabin baggage was screened with EDS equipment meeting standard C2 or higher.

4.1.2.9 Explosive detection dogs and explosive trace detection (ETD) equipment may only be used as a supplementary means of screening.

4.1.2.11 Persons screening cabin baggage by X-ray or EDS equipment shall normally not spend more than 20 minutes continuously reviewing images. After each of these periods, the screener shall not review images for at least 10 minutes. This requirement shall only apply when there is an uninterrupted flow of images to be reviewed. There shall be a supervisor responsible for screeners of cabin baggage in order to assure optimum team composition, quality of work, training, support and appraisal.

The screening of cabin baggage shall also be subject to the additional provisions laid down in Commission Implementing Decision C(2015) 8005 (Section 4.1.2.12).

LAGs

Before screening, LAGs shall be removed from cabin baggage and shall be screened separately from other items of cabin baggage, unless the equipment used for the screening of cabin baggage is also capable of screening multiple closed LAGs containers inside baggage (Section 4.1.2.2). Additionally, all LAGs should be contained in individual containers with a capacity not greater than 100 millilitres or equivalent in one transparent resealable plastic bag of a capacity not exceeding 1 litre, whereby the contents of the plastic bag fit comfortably and the bag is completely closed.

The screening of LAGs shall also be subject to the additional provisions laid down in Commission Implementing Decision C(2015) 8005 (Section 4.1.3.3).

Hold baggage

Section 5.1.1 lays down that the following methods, either individually or in combination, shall be used to screen **hold baggage**:

- (a) a hand search
- (b) X-ray equipment
- (c) EDS equipment
- (d) ETD equipment
- (e) EDD

5.1.3 Where X-ray or EDS equipment is used, any item whose density impairs the ability of the screener to analyse the contents of the baggage shall result in it being subject to another means of screening.

5.1.4 Screening by explosive trace detection (ETD) equipment shall consist of the analysis of samples taken from both the inside and the outside of the baggage and from its contents. The contents may also be subjected to a hand search.

5.1.5 The appropriate authority may create categories of hold baggage that, for objective reasons, shall be subject to special screening procedures or may be exempted from screening. The Commission shall be informed of the categories created.

5.1.7 Persons screening hold baggage by X-ray or EDS equipment shall normally not spend more than 20 minutes continuously reviewing images. After each of these periods, the screener shall not review images for at least 10 minutes. This requirement shall only apply when there is an uninterrupted flow of images to be reviewed. There shall be a supervisor responsible for screeners of hold baggage in order to assure optimum team composition, quality of work, training, support and appraisal.

The screening of hold baggage shall also be subject to the additional provisions laid down in Commission Implementing Decision C(2015) 8005 (Section 5.1.6).

Cargo and mail

Section 6.2.1.5[17] lays down that **cargo and mail** shall be screened by a regulated agent (6.1.1) by at least one of the following methods:

- (a) hand search
- (b) X-ray equipment

[17] COMMISSION IMPLEMENTING REGULATION (EU) 2023/566

- (c) EDS equipment
- (d) EDD
- (e) ETD equipment
- (f) visual check
- (g) MDE
- (h) explosives vapour detection (EVD) equipment

The screening of cargo and mail shall also be subject to the additional provisions laid down in Commission Implementing Decision C(2015) 8005 (Section 6.2.1.3).

In-flight supplies

Section 8.1.2.3 lays down that **in-flight supplies** shall be screened by the following means or method of screening, either individually or in combination:

- (a) visual check
- (b) hand search
- (c) X-ray equipment
- (d) EDS equipment
- (e) ETD equipment in combination with visual check
- (f) EDD in combination with visual check

The screening of cargo and mail shall also be subject to the additional provisions laid down in Commission Implementing Decision C(2015) 8005 (Section 8.2.2.2).

Security equipment

12.0.2 There shall be routine testing of each piece of security equipment.

Staff recruitment and training

11.0.2 For the purpose of this Chapter, 'certification' means a formal evaluation and confirmation by or on behalf of the appropriate authority indicating that the person has successfully completed the relevant training and that the person possesses the necessary competencies to perform assigned functions to an acceptable level.

11.0.4 For the purposes of this Chapter, 'competency' means being able to demonstrate suitable knowledge and skills.

11.1.1 Persons being recruited to implement, or to be responsible for the implementation of, screening, access control or other security controls in a security restricted area shall have successfully completed a background check.

11.1.2 Persons being recruited to implement, or to be responsible for the implementation of, screening, access control or other security controls elsewhere than a security restricted area shall have successfully completed a background or pre-employment check.

11.1.5 Background or pre-employment checks shall be completed before the person undergoes any security training involving access to information which is not publicly available. Background checks shall be repeated at regular intervals not exceeding five years.

11.1.7 Persons being recruited to implement security controls shall have the mental and physical abilities and aptitudes required to carry out their designated tasks effectively and shall be made aware of the nature of these requirements at the outset of the recruitment process.

Training

Basic

11.2.1.1 Persons shall have successfully completed relevant training before being authorised to implement security controls unsupervised.

Job-specific

11.2.3.1 Job specific training of persons implementing **screening of persons, cabin baggage, items carried and hold baggage** shall result in all of the following competencies:

- (a) understanding of the configuration of the screening checkpoint and the screening process;
- (b) knowledge of how prohibited articles may be concealed;
- (c) ability to respond appropriately to the detection of prohibited articles;
- (d) knowledge of the capabilities and limitations of security equipment or screening methods used;
- (e) knowledge of emergency response procedures.

In addition, where the designated tasks of the person concerned so require, training shall also result in the following competences:

- (f) interpersonal skills, in particular how to deal with cultural differences and with potentially disruptive passengers;
- (g) knowledge of hand searching techniques;
- (h) ability to carry out hand searches to a standard sufficient to reasonably ensure the detection of concealed prohibited articles;
- (i) knowledge of exemptions from screening and special security procedures;
- (j) ability to operate the security equipment used;
- (k) ability to correctly interpret images produced by security equipment; and
- (l) knowledge of protection requirements for hold baggage.

11.2.3.2 Training of persons implementing **screening of cargo and mail** shall result in all of the following competencies:

- (a) knowledge of previous acts of unlawful interference with civil aviation, terrorist acts and current threats;
- (b) awareness of the relevant legal requirements;
- (c) knowledge of the objectives and organisation of aviation security, including the obligations and responsibilities of persons implementing security controls in the supply chain;
- (d) ability to identify prohibited articles;
- (e) ability to respond appropriately to the detection of prohibited articles;
- (f) knowledge of the capabilities and limitations of security equipment or screening methods used;
- (g) knowledge of how prohibited articles may be concealed;
- (h) knowledge of emergency response procedures;

- (i) knowledge of protection requirements for cargo and mail; following competences:
- (j) knowledge of screening requirements for cargo and mail, including exemptions and special security procedures;
- (k) knowledge of screening methods appropriate for different types of cargo and mail;
- (l) knowledge of hand searching techniques;
- (m) ability to carry out hand searches to a standard sufficient to reasonably ensure the detection of concealed prohibited articles;
- (n) ability to operate the security equipment used;
- (o) ability to correctly interpret images produced by security equipment;
- (p) knowledge of transportation requirements.

11.2.3.3 Training of persons implementing **screening of air carrier mail and materials, in-flight supplies and airport supplies** shall result in all of the following competencies:

- (a) knowledge of previous acts of unlawful interference with civil aviation, terrorist acts and current threats;
- (b) awareness of the relevant legal requirements;
- (c) knowledge of the objectives and organisation of aviation security, including the obligations and responsibilities of persons implementing security controls in the supply chain;
- (d) ability to identify prohibited articles;
- (e) ability to respond appropriately to the detection of prohibited articles;
- (f) knowledge of how prohibited articles may be concealed;
- (g) knowledge of emergency response procedures;
- (h) knowledge of the capabilities and limitations of security equipment or screening methods used; In addition, where the designated tasks of the person concerned so require, training shall also result in the following competences:
- (i) knowledge of hand searching techniques;
- (j) ability to carry out hand searches to a standard sufficient to reasonably ensure the detection of concealed prohibited articles;
- (k) ability to operate the security equipment used;
- (l) ability to correctly interpret images produced by security equipment;
- (m) knowledge of transportation requirements.

Certification or approval

11.3.1 Persons performing tasks as listed in points 11.2.3.1 to 11.2.3.5 shall be subject to:

- (a) an initial certification or approval process; and
- (b) for persons operating X-ray or EDS equipment or for human reviewers of security scanners, recertification at least every 3 years; and
- (c) for all other persons, recertification or reapproval at least every 5 years.

11.3.2 Persons operating X-ray or EDS equipment or human reviewers of security scanners shall, as part of the initial certification or approval process, pass a standardised image interpretation test.

11.3.3 The recertification or reapproval process for persons operating X-ray or EDS equipment or for human reviewers of security scanners shall include both the standardised image interpretation test and an evaluation of operational performance.

11.3.4 Failure to undertake or successfully complete recertification or reapproval within a reasonable timescale, not normally exceeding 3 months, shall result in the related security entitlements being withdrawn.

Recurrent training

11.4.1 Persons **operating X-ray or EDS equipment** shall be subject to recurrent training consisting of image recognition training and testing. This shall take the form of:

- (a) classroom and/or computer based training; or
- (b) on-the-job TIP training, on condition that a TIP library of at least 6 000 images, as specified below, is employed on the X-ray or EDS equipment used and the person works with this equipment during at least one third of his working hours.

For classroom and/or computer based training, persons shall be subject to image recognition training and testing for at least 6 hours in every 6 month period, using either: — an image library containing at least 1 000 images of at least 250 different threat articles, including images of component parts of threat articles, with each article captured in a variety of different orientations, and arranged to provide an unpredictable selection of images from the library during the training and testing; or — the most frequently missed TIP images from the TIP library in use combined with images of recently captured threat articles relevant for the type of screening operation and covering all types of relevant threat articles if only used once for the training of a given screener over a three-year period. For on-the-job TIP training, the TIP library shall consist of at least 6 000 images of at least 1 500 different threat articles, including images of component parts of threat articles, with each article captured in a variety of different orientations.

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