SCIENCE & SECURITY Issue 33

CASRA NEWSLETTER

Since 2012, we have been publishing newsletters in which we present results from our research, address trends, and provide information for security practitioners.

The first article of this issue describes a recently published study with 1'437 airport security screeners and nearly four million behavioural responses from threat image projection data that investigated how night shifts and circadian rhythm affect screening performance.

The second article discusses the risk of improvised incendiary devices (IIDs) and presents our new X-Ray Tutor training package on IIDs, which will be released in the second half of September 2025.

We hope you enjoy reading these new articles and as always, we are looking forward to receiving any feedback you might have as well as your input on topics you would like us to address in upcoming newsletters.

With best wishes,

Dr. Diana Hardmeier
Director

Prof. Dr. Adrian Schwaninger
Chairman

TOPICS IN THIS ISSUE:

RESEARCH PUT ACROSS

NIGHT SHIFTS, CIRCADIAN RHYTHM, AND SCREENING PERFORMANCE: INSIGHTS FROM A FIELD STUDY WITH AIRPORT SECURITY SCREENERS

Airport security screeners often work night or early morning shifts at many airports around the world. But what happens when the body's natural rhythms are challenged by irregular working hours? This article provides a summary of a recently published study that analyzed threat image projection data from 1'437 airport security screeners to examine the effects of night shifts and circadian rhythm on their screening performance.

SECURITY IN PRACTICE

ADDRESSING THE RISK OF IMPROVISED INCENDIARY DEVICES

Items like lithium batteries and electronic devices pose new dangers due to their high energy density and potential misuse. This article discusses incidents with IIDs that prompted regulatory responses. In the second part, it presents our new X-Ray Tutor training package that addresses the risk of improvised incendiary devices (IIDs) and helps ensure compliance with new regulatory requirements regarding the training of screeners.

NIGHT SHIFTS, CIRCADIAN RHYTHMS, AND SCREENING PERFORMANCE: INSIGHTS FROM A FIELD STUDY WITH AIRPORT SECURITY SCREENERS

Text: Stefan Michel

Airport security screeners often work night or early morning shifts at many airports around the world. But what happens when the body's natural rhythms are challenged by irregular working hours? Maintaining alertness is crucial in airport security, where screeners are responsible for visual inspection of X-ray images of passenger baggage to detect threats such as guns, knives, improvised explosive devices (IEDs), and other prohibited articles. In a study with 1'437 airport security screeners and nearly four million behavioural responses from threat image projection data, we investigated how circadian rhythms and night shifts affect screening performance.

Every day and night, airport security screeners are responsible for ensuring the security of passengers by X-ray screening their baggage. At some airports, air travel never stops - so neither does airport security. Some airports operate 24/7, while others with night flight bans still have early morning shifts that begin before 06:00. For instance, a shift may start at 04:00 to prepare for an early flight departure. But working during the night goes against the human body's natural rhythm, which is designed for activity during the day and rest at night. The job of airport security screeners requires constant alertness and quick, accurate decisions. Any drop in performance could have serious consequences.

The human body follows a natural 24-hour cycle known as the circadian rhythm, which regulates sleep, alertness, and cognitive function [4]. Disruptions to this rhythm — such as those caused by night shifts — can impair attention and cognitive performance [2].

Our attention follows a daily pattern (circadian rhythm) during a typical working day [4]. Attention is lowest in the first few hours after waking up, then increases to a first peak. There is a dip in attention around midday or lunchtime. Attention rises again to a second peak and then drops rapidly before going to sleep. This pattern indicates periods of higher and lower alertness throughout the 24-hour cycle.

Figure 1: Plane on Runway at Night.

SETUP OF THE FIELD STUDY AT THE AIRPORT

Our field study took place at a large European airport security checkpoint and included night, early morning and standard morning shifts [3]. Three types of shifts were compared in this study, categorized by their starting times: night shifts (00:00–02:59), early morning shifts (03:00–05:59), and standard morning shifts (06:00–07:59). The study addressed the question on how the internal body clocks and unusual working hours of screeners influence detection performance and processing time by analyzing about four million behavioral responses from 1'437 screeners. Performance during the screening of passenger baggage X-ray images was examined — an activity that combines visual search and decision-making and is considered more demanding than many standardized laboratory tests, which were used to investigate the circadian rhythm in previous studies. The behavioral responses examined in this study were recorded using threat image projection (TIP) at an international European airport that employed single-view X-ray machines and matrix screening [1].

We controlled for several key variables to ensure that performance differences were not wrongly attributed to the natural circadian rhythm. Moreover, we matched early and night shifts by comparing performance during the same hours of the day, effectively controlling for time of day. We also controlled for season (month of the year), checkpoint (five different screening areas), and task load at the checkpoint (measured by the number of baggage events in 15-minute intervals).

THREAT IMAGE PROJECTION (TIP)

At airport security checkpoints, real threat items are rare, which can reduce screeners' motivation and alertness. To counter this problem, a method called threat image projection (TIP) is used: prerecorded X-ray images of fictional threat items (FTIs) are randomly inserted into X-ray images of passenger baggage being screened, giving screeners regular practice in spotting threat items. Furthermore, screeners' motivation benefits from the regular feedback they receive. The airport in this study uses a different TIP system, where fictional threat items are added to bags in advance as one single image and then shown to screeners at the security checkpoint as combined threat images (CTIs).

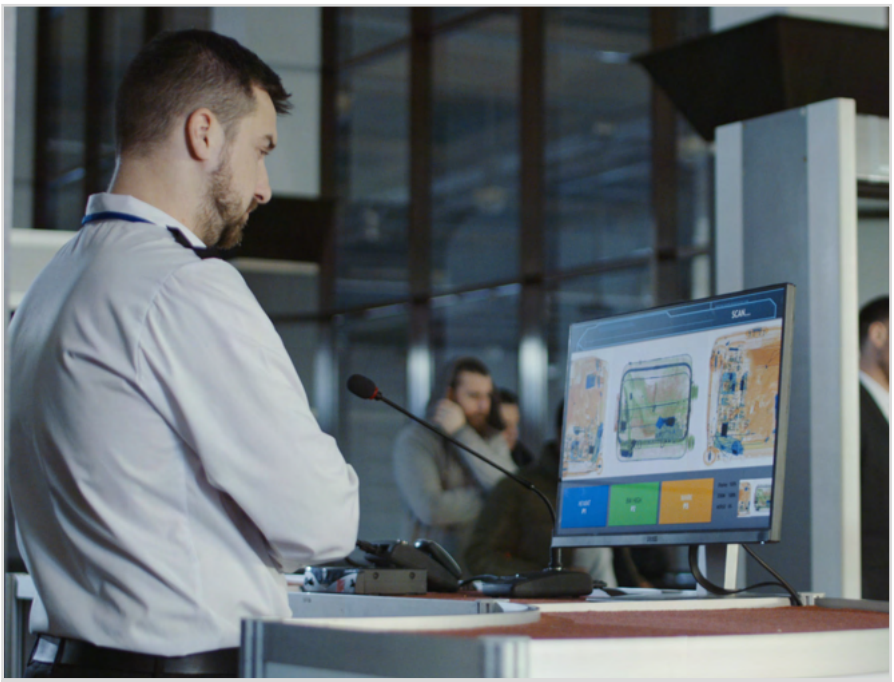

Figure 2: X-ray Image Analysis at the Security Checkpoint

NIGHT AND EARLY MORNING SHIFTS INCREASES FALSE ALARM RATE

Regarding shift work, this study showed that night and early morning shifts had an impact on the false alarm rate. During these shifts, screeners were more likely to incorrectly indicate that a threat item was present compared to standard morning shifts. While the increase was slight (approximately 2% in night shifts and 3% in early morning shifts), it was statistically significant. However, the false alarm rate was not significantly different between the night and early morning shifts.

NIGHT SHIFTS AND HIT RATE: NO NEGATIVE IMPACT OBSERVED

Crucially, the study found that the detection of threat items (hit rate) was not significantly influenced by the type of shift — whether it was a night shift, early morning shift, or standard morning shift. Security, in terms of detecting prohibited items, appeared consistent during the investigated work shifts. Additionally, there was no evidence that threat detection followed a circadian rhythm, meaning that screeners' ability to detect threats did not systematically vary depending on the time of day or night.

TIME OF DAY AFFECTS SCREENERS PROCESSING TIME

Processing time was not significantly affected by shift type (night, early morning, or standard morning). However, a

circadian rhythm in processing speed was found: performance varied depending on the time of day. Screeners processed X-ray images slower during the early day drowsiness phase than during the early day peak, faster during the early day peak than during the post-midday dip, and slower during the post-midday dip compared to the late day peak. These findings align with the circadian patterns of attention [4].

PRACTICAL IMPLICATIONS FOR AIRPORT SECURITY

The study's most important finding for airport security is that neither the circadian rhythm nor the examined night and early morning shifts appear to compromise security, as the threat detection rate (hit rate) was not negatively impacted. However, the slight increase in false alarm rates during night and early morning shifts could slightly reduce the efficiency of screening, due to more manual bag searches. For airport operations, which often include night and early morning flights, this might be acceptable.

CONCLUSION

This large-scale field study provides valuable insights extending beyond previous laboratory findings. It confirms that the circadian rhythm can influence the speed of work execution (processing time) in a real-world setting. Simultaneously, it shows that night and early morning shifts can slightly increase the false alarm rate in airport security screening without compromising the detection of actual threats (hit rate), thus not endangering security.

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ADDRESSING THE RISK OF IMPROVISED INCENDIARY DEVICES

Text: Adam Troczynski

This article discusses the risk of improvised incendiary devices (IIDs) and presents our new X-Ray Tutor training package on IIDs, which will be released in the second half of September 2025. Many of the items now considered high risk, such as lithium batteries, did not exist in the past, or at least not at the scale seen today. The proliferation of personal electronic devices, power banks, and consumer goods containing high-density energy sources has introduced substantial change in risk. In many cases, these items are not only safety concerns but can also be repurposed or manipulated into components of IIDs. This article discusses incidents with IIDs that prompted regulatory responses. In the second part, it presents our new X-Ray Tutor training package that addresses the risk of IIDs and helps ensure compliance with new regulatory requirements regarding the training of screeners.

Among the most pressing concerns are incidents involving IIDs and the concealment of dangerous goods, particularly lithium batteries. These items, when improperly handled or maliciously modified, have caused serious safety and security incidents, some of which have resulted in aircraft fires or emergency diversions. The cases below illustrate the nature of these risks. They refer to incidents where suspected or confirmed IID or flammable substances resulted in increased security risks in aviation. They emphasize the need for effective risk assessment mechanisms to evaluate emerging threats and guide adjustments to training, security processes and regulatory measures:

- On February 2015, media reported the risk of thermite-based fire referencing various US sources [1]
- On July 2024, a fire was reported in the air cargo warehouse in Birmingham, United Kingdom, based on an investigation by the UK Counter-Terrorism Police [2]
- On July 2024, several fires were caused by incendiary devices concealed in parcels handled by the air freight warehouse in Leipzig, Germany, as reported due to ongoing investigation by German authorities [3]
- On July 2024, at least one fire of a truck transporting air cargo in Poland near Warsaw was reported, as confirmed by the National Prosecutor's Office due to the joint investigation with the National Security Agency of Poland [4]

These incidents prompted regulatory responses that led to updates in security processes and the implementation of targeted security enhancements, including:

- The US Transportation Security Administration introduced restrictions on powders in cabin baggage [5]
- The US Transportation Security Administration and Transport Canada implemented emergency measures [6]
- The European Union amended the regulation on common basic standards on aviation security [7]

Beyond these changes in security processes and regulatory changes, the above-mentioned incidents brought renewed attention to the transport of materials that, either alone or when combined with other items, may ignite and cause fires in the cabin or cargo hold, such as:

- Fire of the Air Busan aircraft at Gimhae International Airport in South Korea in January 2025. According to the interim investigation the fire was caused by a broken insulation in a power bank located in an overhead bin, leading to the complete destruction of the aircraft [8]. As a consequence, some airlines introduced additional restrictions in carrying and using spare power sources.

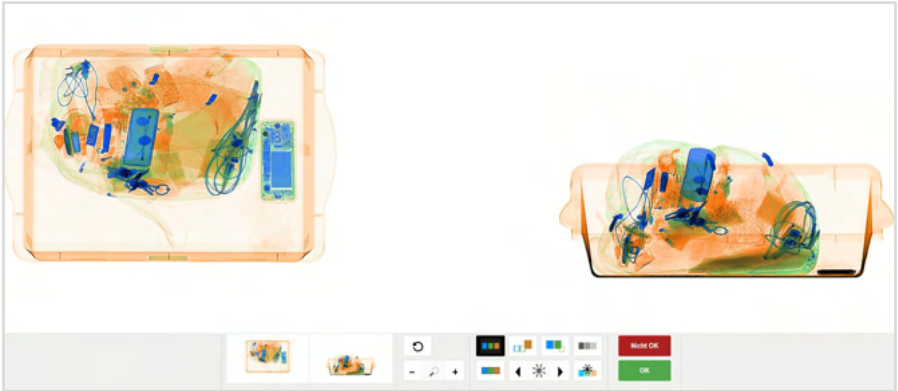

Figure 1: Screenshot of X-Ray Tutor training for detecting IIDs.

- Explosion of checked baggage containing dry ice at Warsaw Chopin Airport [9]
- Detection of brake fluid during passenger screening concealed in a medical bottle, as reported by the US TSA in March 2025. According to the report this substance can be highly flammable if it reacts with certain other substances [10]
- Results of the European Union Aviation Safety Agency project on the detection of lithium batteries using security screening equipment [11]

PREVENTION AND DETECTION: SAFETY AND SECURITY INTERRELATION

The current aviation framework in many countries, while robust in detecting explosives and weapons, faces now more risks related to the detection of dangerous goods. Security screening procedures are not consistently mandating screeners to actively search for dangerous goods.

Dangerous goods handling protocols, rely instead heavily on voluntary declaration and proper documentation. This creates regulatory and operational challenges, where there is a risk that potentially dangerous or manipulated goods may pass undetected if they do not meet the conventional threat profile. As evidenced in recent events, dangerous goods can be weaponised, either as standalone incendiary hazards (e.g. thermal runaway) or as integral parts of improvised devices. Security screeners may not be trained or equipped to recognize such threats if their focus remains limited to traditional prohibited articles.

IID TRAINING PACKAGE

To address these new challenges and risks, a more integrated approach between safety and security is recommended. This is especially important as IIDs evolve and may involve using common, commercially available components, often falling within the dangerous goods category. In this context, CASRA designed an IID training package which includes:

Figure 2: CASRA has developed a training package on IIDs containing a theoretical part, a practical part, and a standardised image interpretation test

- Theoretical part that explains the principles behind IIDs, how they work, and how they can be detected. This includes guidance on image analysis that provides real-world scenarios and visual cues to help screeners identify IIDs in various settings.
- Practical part for training the X-ray image interpretation skills. Screeners can choose the appropriate modules - cabin baggage, hold baggage, cargo and supplies screening.
- Standardized image interpretation test with realistic target present and target absent images.

Our training package has been developed in collaboration with industry stakeholders and the release is planned for the second half of September 2025.

This IID focused training package serves as a supplementary tool and can be incorporated into existing training processes or used as stand-alone training.

At the same time, as our standard training modules in the X-Ray Tutor are regularly updated based on systematic threat assessment; threat item libraries already include several IIDs, and we continue to expand this content.

Using these complementary training methods, we are able to offer flexible solutions to meet the varying needs of aviation security entities.

SUPPORTING THE AVIATION SECURITY COMMUNITY

We believe that staying ahead of evolving security threats requires constant communication and collaboration. That is why we actively engage with stakeholders across the aviation security community to share insights, gather feedback, and ensure our solutions reflect the latest developments.

Our ongoing efforts are designed to help aviation security partners to:

- Increase their capability to address growing concerns - equip your team with the knowledge, skills, and abilities needed to counteract the evolving modus operandi of malicious actors.
- Enhance operational security - address new threats and ensure your team is always ready to

respond to new challenges.

- Ensure compliance with new regulatory requirements in Europe and stay ahead of potential regulatory changes in other regions.

As part of this commitment, we are proud to introduce our latest targeted training solutions, tailored to reflect the realities of today's aviation security environment, including the growing risks associated with incendiary devices. This training is shaped by operational insights, real-world scenarios, and close alignment with industry needs.

We are aware that real readiness goes beyond compliance, it requires continuous learning, practical insight, and proactive adaptation. That's why our training evolves in step with the threat environment, helping your team stay capable. Whether you're responding to new risks or preparing for regulatory shifts, we're here to help you build lasting operational resilience.

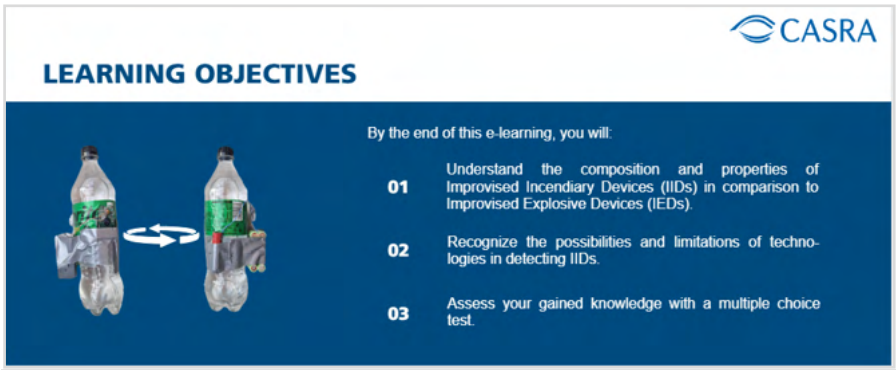

Figure 3: Learning objectives of the e-learning of CASRA's training package on IIDs.

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