SCIENCE & SECURITY March 2013

CASRA NEWSLETTER – ISSUE 3

So far, 2013 has been a busy, but successful year for CASRA. We hope that our third newsletter finds you in a similar position. In this issue, we are pleased to present you with two rather contrasting topics which demonstrate very well the broad range of content we aim to reflect in our newsletters.

A permanent hot topic in the aviation business regards the screening of laptops which equally concerns airport professionals as well as airline passengers. The first article raises the question whether laptops should really be screened separately or not. The authors examine the issue in detail and will try to shed some light on this controversial question.

As a stark contrast to the scientific laptop study, we present you a down-to-earth report on X-ray security screening in the Swedish nuclear power plant Oskarshamn in the section "Security in Practice".

We hope that both articles will provide you with one or the other new insight and that you will enjoy reading!

Prof. Dr. Adrian Schwaninger

Dr. Diana Hardmeier

TOPICS IN THIS ISSUE:

RESEARCH PUT ACROSS

SECURITY CHECKPOINTS: SHOULD LAPTOPS REALLY BE SCREENED SEPARATELY?

Whether travelling on business or privately, a large number of passengers using air transport carry laptops and similar electronic devices such as tablets. Most of us are familiar with the procedure of having to remove these items from our bags at security checkpoints, so they can be screened separately. But what is the actual reason for this? And is this really necessary? One goal of the scientific study described in this article is to shed light on these questions.

SECURITY IN PRACTICE

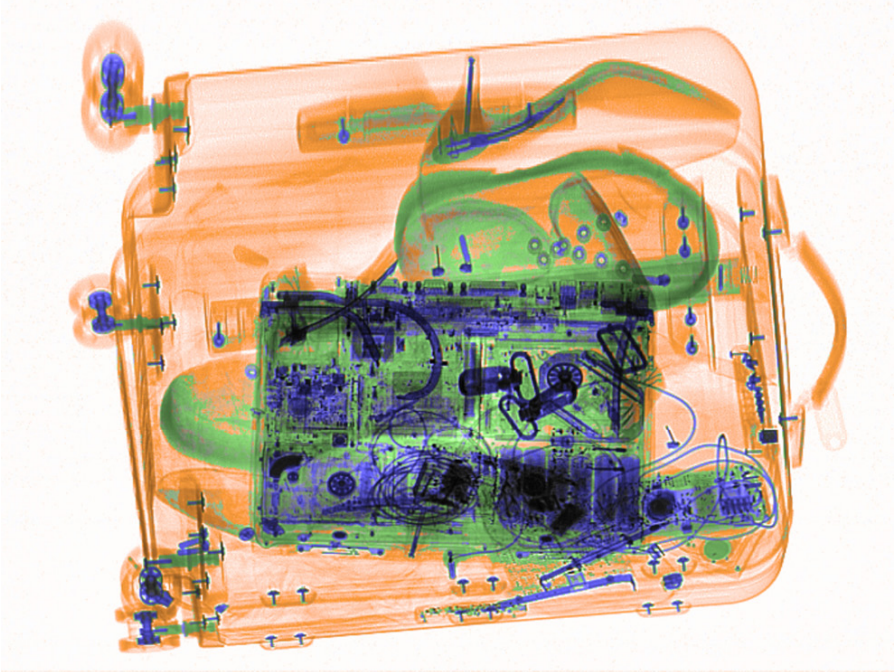
X-RAY SCREENING TO ENSURE NUCLEAR FACILITY SECURITY - A REPORT FROM OSKARSHAMN

Due to the potentially high impact of theft, sabotage, unauthorized access, or other malicious acts involving nuclear material, nuclear facility security is a topic of high importance. X-ray security screening is employed at many nuclear power plants as a crucial layer of security. Our report from the Swedish nuclear power plant Oskarshamn delivers insight into the business of X-ray security screening in a different environment than air transportation security.

SECURITY CHECKPOINTS: SHOULD LAPTOPS REALLY BE SCREENED SEPARATELY?

Text: Marcia Mendes & Stefan Michel

Whether travelling on business or privately, a large number of passengers using air transport carry laptops and similar electronic devices such as tablets. Most of us are familiar with the procedure of having to remove these items from our bags at security checkpoints, so they can be screened separately. But what is the actual reason for this? And is this really necessary? One goal of the scientific study described in this article is to shed light on these questions.



To begin with, X-ray screening at security checkpoints is a process that relies not only on technology but also heavily on human operators (screeners). Even though screening technologies are constantly evolving, offering new and enhanced security applications, it is still the human operator who has to spot potential threat items based on the images provided by the X-ray machines. One technical factor determining how well the different objects in the luggage are visible on an X-ray image is material density. In security X-ray screening, the amount to which X-rays are able to penetrate the contents of a bag will vary with regard to the density of these contents. **Due to their compact construction, electronic devices such as laptops are comparably dense and, consequently, hard to penetrate with X-ray technology. The result is that objects in front of or behind the laptop are more difficult to see on the X-ray image**. Therefore, bags containing laptops are hard to inspect for screeners: The already challenging task of detecting threat items becomes even more demanding when a laptop, tablet, etc. "blocks" the X-rays. In this light, it becomes evident why currently most international and national regulations specify that portable computers shall be removed from passenger bags and be screened separately at security checkpoints (e.g. the current regulation of the European Commission, No 185/2010, [1]).

Nevertheless, having to remove specific items (e.g. laptops) from bags at the security checkpoints can lead to longer waiting times and provoke annoyance amongst passengers who do not understand the necessity of this regulation. Furthermore, a reduced passenger throughput is not in the interest of airports. With state-of-the-art X-ray screening equipment offering high image resolution and being able to provide high quality images that distinguish between different materials ([2]), the question arises of how big the advantage of separate screening actually is. **Not having to unpack the baggage would certainly increase comfort for passengers and possibly also increase throughput at security checkpoints**.

To date, scientific evidence to support one or the other position with regard to laptop screening is scarce. **Thus, a scientific study was conducted to examine to what extent the detection of threat items by screeners is impaired when laptops are left inside passenger bags for security screening**. For this study, state-of-the-art technology providing single view X-ray images without automatic explosive detection was used. This image standard was chosen as, currently, most machines deployed at airports worldwide provide single view images for cabin baggage screening. In security X-ray screening, a human operator will only be able to identify a threat item if the threat can be recognized in the provided single view image. Objects which are in front of or behind electronic devices become difficult for screeners to see and hence, they could conceal parts of the luggage or could also be used to intentionally hide prohibited items (e.g.

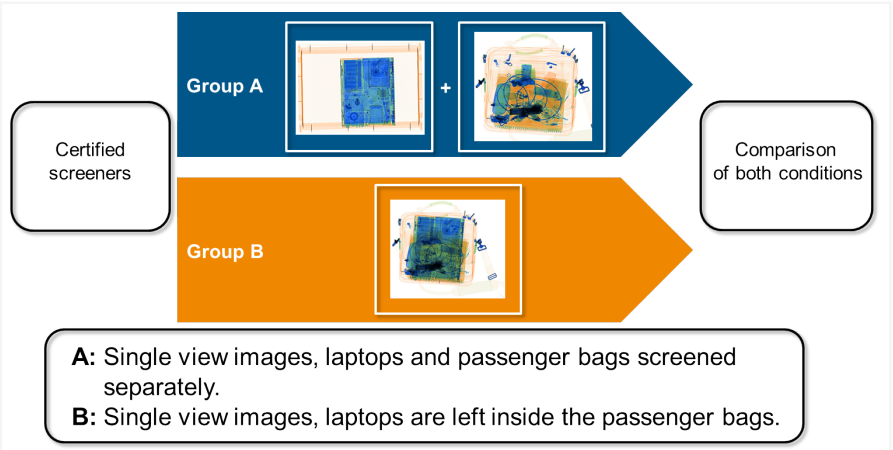


Figure 1: Experimental design of the study

an improvised explosive device [IED]). Moreover, research in X-ray screening has shown that three image-based factors influence the difficulty for screeners to detect threat items in X-ray images (e.g., see [3]). These are: 1) view difficulty, referring to the viewpoint of a threat item (rotated items become more difficult to recognize); 2) superposition, referring to the position of a threat item inside a bag and its superimposition by other objects; and 3) bag complexity, which is dependent on the number and types of items inside a bag (see [4]). Devices with high material density (e.g. laptops) in carry-on bags can influence these factors and can thus make image interpretation and threat detection more challenging.

SCIENTIFIC STUDY: COMPARISON OF TWO PACKING CONDITIONS

To investigate the effect that laptops, which are not removed from bags, can have on threat detection, an experiment was conducted allowing a scientific comparison of two different packing conditions. For this, a computer-based image interpretation test containing bags and laptops was created in two different versions: in test condition A, images of bags and laptops were displayed separately, while in test condition B, the laptops were left inside the bags and displayed as one X-ray image. Figure 1 shows the experimental design with the two different test conditions (A and B).

For both test conditions the same bag set was used to create the images, which consisted of a representative sample of 96 passenger bags (defined by airport security screening experts).

In test condition A, the laptops were removed from the bags and screened separately, while in test condition B, the laptops were left inside the bags and screened as a whole. Furthermore, each bag/laptop-combination was used twice, once with a threat item included in either the bag or the laptop, and once without any threat item. The included threat items consisted of a representative sample of objects, which could be divided into four threat categories: guns, IEDs, knives and other threat items (e.g. electric shock devices). For all categories except guns, in half of the cases the threat items were placed inside the bags, while in the other half of the cases the threat items were placed inside the laptops. Due to their size it would not have been realistic to place a gun inside a laptop.

To collect realistic data, forty certified and experienced screeners from an international European airport were recruited to participate in the study. These screening officers were randomly assigned to one of the two groups (A and B). Each group conduct-

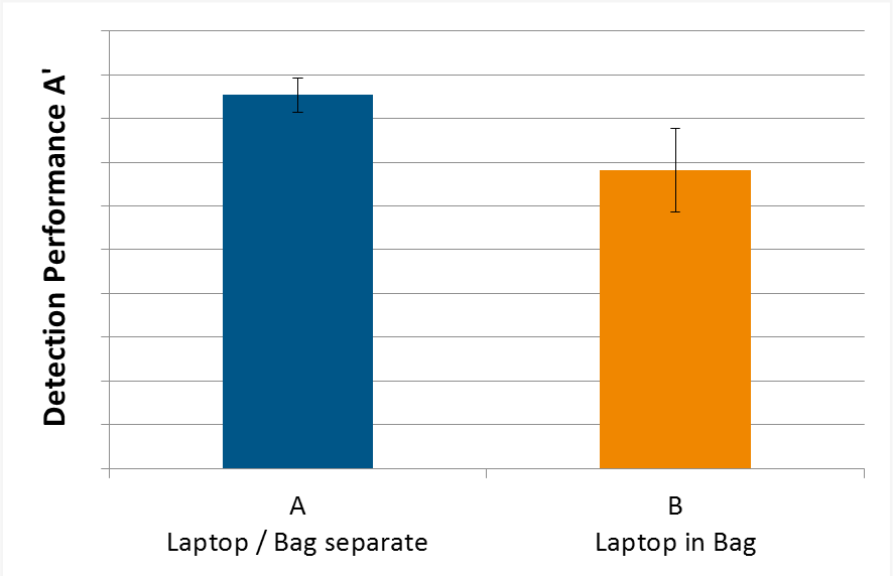


Figure 2: Comparison of the overall detection performance of both groups (A and B)

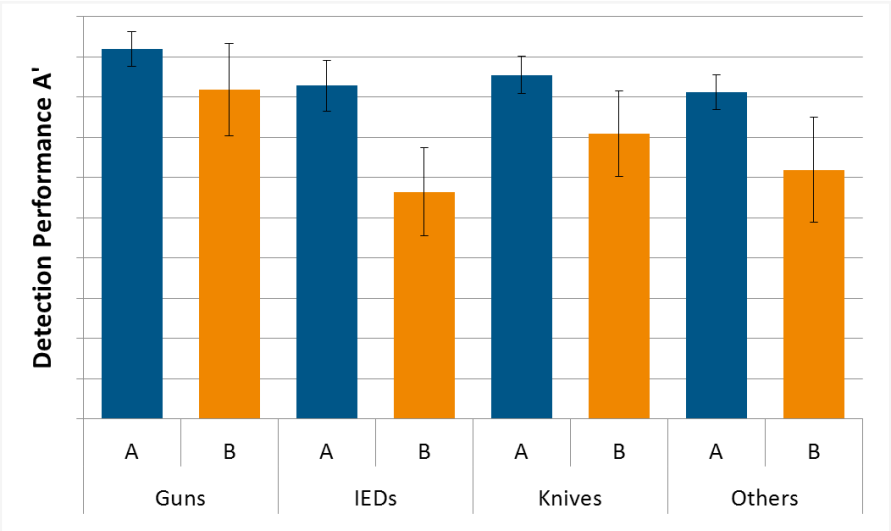


Figure 3: Comparison of the overall detection performance of both groups (A and B) and each threat category (guns, knives, IEDs and others)

ed one of the two test versions. During the test, the participants had to analyze every X-ray image and decide whether the bags and laptops could be regarded as harmless (OK) or whether they contained a threat item (NOT OK). Detection performance scores (A', for details see [5]) and reaction times (the amount of time necessary for a screening officer to come to a decision, after the image is fully displayed on the screen) of all participants were measured to evaluate the effect of the two packing conditions.

RESULTS: LAPTOPS IN BAGS IMPAIR THREAT DETECTION

Interesting results were found as outcomes from our experiment. Figure 2 displays a comparison of the overall detection performance scores of both groups (A and B). **The results show that detection performance was significantly lower when laptops were left inside the bags**. Thus, detecting threat items in passenger bags was more difficult when laptops were not removed from the bags for screening. Moreover, we looked at detection performance scores for each of the four threat categories separately (i.e. guns, IEDs, knives, and other threat items). As can be seen in figure 3, for each threat category detection performance was lower when the laptops were kept inside the bags. Differences between both groups were particularly high for IEDs, indicating that especially for the detection of explosive devices it is helpful to screen laptops and bags separately

Figure 4 shows the comparison of both groups for each threat category with regard to the average reaction times. **For all threat categories, significantly more time was needed to inspect the images when the laptops and bags were screened together.** These results imply that when laptops are kept inside bags, the contents become more difficult to visually search for threat items and thus, more time is needed to assess these bags.

SEPARATE SCREENING OF LAPTOPS JUSTIFIED

The results of this experiment demonstrate that detection performance in X-ray screening is substantially impaired when technology providing single-view images is applied and laptops are not removed from passenger bags. This effect was found for all four threat categories. **Hence, the scientific evidence we gathered in our study supports the requirement that laptops should be screened separately at security checkpoints**. However, it has to be mentioned that new technological developments, such as advanced cabin baggage screening systems, feature

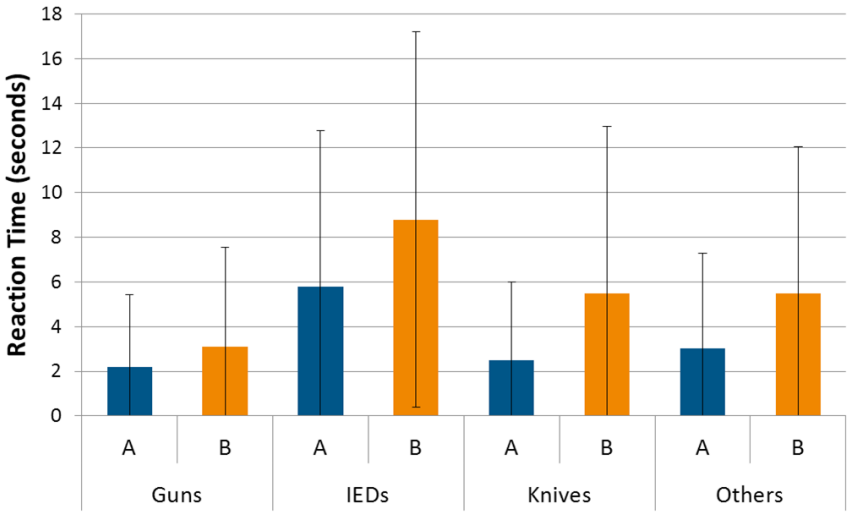


Figure 4: Comparison of average reaction times of both groups and each threat category

automated explosive detection and multi-view or even 3D imaging. **With such technology it might be possible to leave laptops in bags without a security risk. However, this assumption would have to be verified with a specifically designed scientific study**.

With regard to checkpoint throughput, our results revealed that more time was needed to inspect the images when the laptops were kept inside the bags. Thus, it is not clear if combined screening would actually help to speed up the X-ray screening process. While time might be saved in the pre-screening zone, for less unpacking, possibly more time will be needed for the thorough visual inspection of the X-ray images, manual bag search or rescreening in case of doubt.

Altogether, we can conclude from our findings that leaving laptops inside passenger bags can substantially impair detection performance when using conventional single view X-ray systems without automatic threat detection. Thus, for such conventional systems, the outcomes of this study underline the appropriateness and importance of current regulations specifying that portable computers shall be removed from passenger bags for X-ray screening.

For an in-depth description of this study please see the detailed paper [Download PDF] or contact Marcia Mendes [marcia.mendes@casra.ch].

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X-RAY SCREENING TO ENSURE NUCLEAR FACILITY SECURITY: A REPORT FROM OSKARSHAMN (SWEDEN)

Text: Sandrina Ritzmann

Due to the potentially high impact of theft, sabotage, unauthorized access, or other malicious acts involving nuclear material, nuclear facility security is a topic of high importance. X-ray security screening, known to most people as a security measure at airports, is employed at many nuclear power plants as a crucial layer of security. Our report from the Swedish nuclear power plant Oskarshamn delivers insight into the business of X-ray security screening in a different environment than air transportation security.

Oskarshamn is a nuclear power plant operated by the company OKG about 350 kilometers south of Stockholm with three reactor units. The three reactors account for ten percent of the total electricity generation in Sweden. Today, the Swedish Radiation Safety Authority (SSM) is the governmental body responsible for security regulations concerning the Swedish nuclear power plants and also conducts regular security inspections. All nuclear facilities must have a plan for physical protection and security that needs to be approved by the SSM. The regulations require that certain prohibited objects shall not be brought into the premises of nuclear power plants. X-ray screening is not mandatory, but highly recommended in the general advice accompanying the regulations as a means to fulfill this requirement.

At Oskarshamn, X-ray security screening was introduced into the security concept at the plant in 2006, following the issuing of regulations by the Swedish authorities. Due to the lack of appropriate infrastructure at that time, the screening initially took place in tents outside the fences of the power plant. Later on, the set-up and layout of the entry-areas was changed to incorporate the checkpoints. Every person who enters the premises of Oskarshamn has to undergo X-ray security screening: personnel, contractors, and visitors alike. "We screen more or less 1'500 people every day", says Christian Holm, security supervisor and group leader for Svensk Bevakningstjänst AB at Oskarshamn. Svensk Bevakningstjänst is the third biggest authorized security company in Sweden with about 2'200 employees and has been contracted to do the X-ray security screening at the nuclear power plant since 2010. Other layers of security concerning the entry to Oskarshamn are gates and fences around the power plant. Entrances and exits are equipped with alarm systems and various staff card readers. "Additionally, there are of course other security measures in place, but detailed information about them is classified", Mr. Holm explains to us.

All persons, vehicles and goods have to be searched and/or screened before given entry to nuclear facilities to detect unauthorized objects and prevent that they are brought into the secure area. X-ray screening is one of the main measures to achieve this. Furthermore, the employees of Svensk Bevakningstjänst work side by side with a company that deploys dogs for the detection of explosives. According to Mr. Holm, a wide variety of bags, goods, and items is searched and/or screened every day: "To me, nothing is strange anymore", he tells us. The objects listed below are prohibited and shall not be taken into the plant. According to the Swedish regulations, every nuclear power plant is required to define such a list and to take measures to prevent them from being brought into the facility:

- All kinds of firearms, dummy weapons, bows, or tasers
- Military weapons and explosives such as grenades, ammunition, detonating caps, or detonators
- Knives
- Brass knuckles, bats, clubs, maces, etc.
- Alcoholic drinks

Figure 1: Examples of prohibited objects

› Cameras, mobile phones with camera function and other equipment with camera function

If the work tasks require it, special permissions can be obtained for objects such as civilian explosives, cameras, and knives. Goods such as flammable liquids, chemicals, pressure containers, acids and so on have to be handled by the goods receiving department of the nuclear power plant.

A peculiarity of X-ray security screening at a nuclear facility, compared to passenger screening in aviation security, is that mainly the same people are screened every day. "We see the same faces week in and week out, but the only destination we can offer is into the power plant", Mr. Holm tells us with a smile. Asked whether it is possible to screen the same people with the same diligence every day, he answers that this is a matter of professionalism. "My colleagues and I take pride in our work. Everyone gets the same treatment, whether we know the person or not." He adds that a quiet and smooth passage through the screening area is a central aim of the X-ray screening team: "Our goal is to have a very high standard of security without posing a distraction from safety and from the actual work activities at the power plant".

Regarding training of security personnel, everyone who has "guard duties" has to undergo security guard training as stipulated by the National Police Board and has to be certified by the county administrative board. However, no specific requirements for training and certification of X-ray screening competencies exist yet, although X-ray screening is highly recommended in the Swedish regulations to control persons, vehicles and goods. At Oskarshamn, new X-ray screening officers who start working for Svensk Bevakningstjänst receive two days of initial training in image interpretation that has been outsourced to a specialized, authorized company. After that, they start their individual, computer-based image interpretation training using X-Ray Tutor[1] (XRT). Two versions of the XRT are in use: XRT covering smaller carry-on baggage items (XRT CBS) and XRT specifically developed to train the interpretation of cargo goods (XRT Cargo). "The new operators have to work their way up to a certain level of performance. A supervisor is assigned to every operator to check their progress", Mr. Holm explains. As soon as they fulfill all performance criteria, the new employees need to undergo a certification test. After they have passed the test, they are allowed to work on their own as X-ray security screeners on behalf of Svensk Bevakningstjänst. X-ray screening operators have to do monthly recurrent training using XRT. Furthermore, they undergo recurrent certification in regular intervals.

For the future, Mr. Holm anticipates a number of possible developments in the security screening at Oskarshamn. For example, the acquisition of a vehicle screener, so that cars, lorries and large goods can be screened and searched, would greatly support the X-ray screening operators in their work. "I also think that at some point in the future, body scanners might be implemented. Although I don't know the exact situation in Sweden, they seem to become more and more of a standard at high security facilities such as airports, government buildings or nuclear power plants worldwide", the security supervisor adds. In any case, security at nuclear facilities remains a topic of high importance. Nuclear power plants are inherently secure constructions, built to withstand storms, floods, or earthquakes, and modern technologies are used in the different layers of security. However, the human operator will remain a central element. In the case of X-ray screening, threats cannot yet be detected without the awareness, skills and knowledge of well-trained screening personnel.

[1] See Newsletter Issue No. 2, Nov 2012, for details regarding computer-based training of X-ray image interpretation competencies.

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