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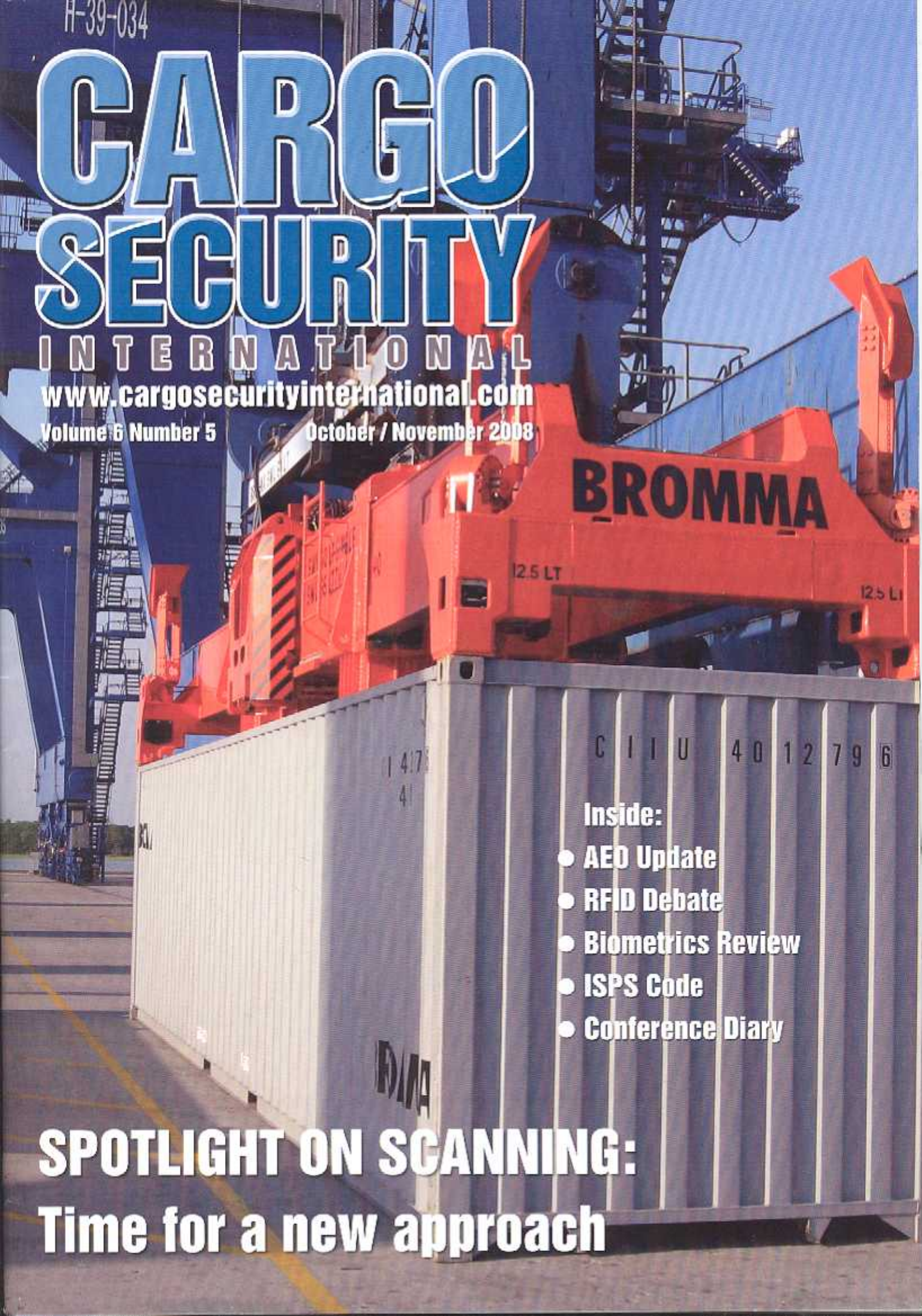

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SPOTLIGHT ON SCANNING:
Time for a new approach

Passport to the futu

Gustavo Bottan of Passport Systems maps out a future scenario for cargo container inspection which calls on new technologies to complement x-ray scanners

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Arms, drugs, and other illegal goods concealed in cargo containers or their transports have crossed inspection points around the world for millennia. When x-ray scanners started to be used, some interdiction became possible primarily because of the careful watch of experienced inspectors, items poorly concealed or significantly shielded, or the detection of large articles easily seen in the x-ray images. In many cases, it has been possible to repay the cost of such x-ray systems by better tax collection.

Unfortunately, this kind of inspection is far from optimal in today's environment and cannot fill inspectors with much confidence that the container just scanned is free from threatening or illegal materials. An operator, even if aided by computer programs, requires several minutes per container to reach a conclusion about its contents and even then cannot ascertain the presence or lack thereof of a particular material or threat. Furthermore, if the level of inspection requires high confidence i.e. ascertaining that no cleared container is carrying nuclear weapons, explosives, or other materials which can cause catastrophic consequences, then one must keep in mind that current generation x-ray systems have limitations.

Deploying a security solution therefore requires significant analysis of the technology options and careful planning, as the costs due to queuing for inspection, diversion of cargo to secondary screening, as well as manpower requirements to resolve alarms, overshadow the cost of the inspection equipment.

Such solutions must:

- have a return on investment and/or provide competitive advantages to the users e.g. create new business opportunities and revenue; provide higher productivity; reduce costs due to loss or theft, lower insurance premiums, validate the cargo manifest for product quality and consumer protection, etc.
- be meaningful in ascertaining that the inspected cargo is safe, i.e. if by inspecting we cannot tell if a container is safe, why inspect for safety at all?

These two necessary conditions are clearly not met with current scanner systems. To see why, consider the case of a container full of cartons of spring water in plastic bottles.

The container arrives at the inspection area and is completely scanned with x-rays. The inspectors check all data available, including the manifest, properly listing the cargo as bottled water. The images are of high penetration, extraordinary resolution and contrast.

The inspector confirms the cargo is bottles of water and thus a safe container is cleared to leave the port. A success story as it relates to inspection. But is it? The reality could have very well been that those bottles contained vodka or other spirits, or been filled with liquid explosives. Not even the most accurate x-ray imagers would have given the inspector a chance to see a difference. Actually, not even if an unopened bottle was in front of his/her eyes.

The time required to analyse an x-ray image is in the order of two to 10 minutes. To inspect all cargo, throughput and productivity would go down – a poor return on investment for sure.

Possible alternatives

Various concepts of operation are being considered or proposed to scan cargo containers.

- Passive radiation monitoring on all containers:

Containers and vehicles pass under a portal that contains passive radiation detectors. The advantages are: they require little space to deploy and vehicles drive through without significant slow-down. The disadvantages are: only lightly-shielded radioactive materials can be detected, no information can be

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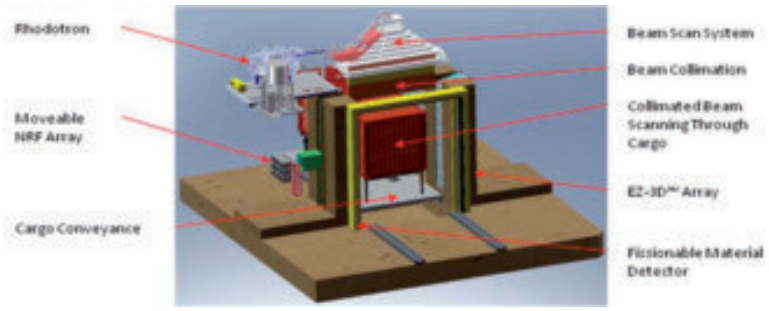
obtained about other materials in the cargo, and despite improvements in avoiding innocent alarms, these still occur.

- High volume primary scanning:

One such system collects the container's ID, passive radiation data, and a low energy x-ray image. The advantages include no slowing down of traffic because drivers do not have to stop or get out of the vehicle carrying the container. Some argue that having this type of system is useful because it captures information and this can only increase the intelligence information available to a risk-based security supply chain. The disadvantages are that to avoid delays or throughput reduction, secondary inspections or alarm resolution are not performed. The system just records, stores, and transmits data but does not actually alarm. Furthermore, there is actually no investigation done at the scanning point, instead, the interpretation of the x-ray images is left for a future time after the containers have left the scanner or are en-route to their destination.

'Better security in the supply chain can be achieved if change is driven by the quest for productivity improvements, growth and profits'

Although the throughput can be kept up, there is no value added to the supply chain because no cargo manifest validation is possible and thus nothing new is known about the cargo. There is no meaningful inspection to determine the containers are safe.



Imagine a container vessel carrying several thousand units which have passed through the data collection station at the port of embarkation. Intelligence information points to a possible weapon of mass destruction being smuggled. Safety officers start analysing the images of each container as the vessel is still at sea. Assume that most of the cargo is low density and therefore the scanned images had mostly full penetration and that of the thousands of containers only 100 have enough shadows to make it difficult to interpret the images; or the cargo was shielded enough to have rendered the passive radiation monitors ineffective; of these containers, 20 have shadow areas big enough to hide a nuclear weapon. These are completely pitch-black to the inspector. Is this ship safe for entry to the port and to unload?

Higher energy x-ray scanners will provide more penetration but cannot be used on the driver, although some equipment vendors promote a system in which the x-ray beam is only applied once the driver cabin has passed the beam location. This should provide higher clearing confidence for a nuclear weapon.

Future technologies, however, would have to be used if other questions need to be answered i.e. is the cargo free of products known to be unsafe such as lead tainted toys or dog food containing melamine? Is the consolidated cargo in the container prone to accidents simply because of the proximity to each other? Such future technologies would similarly enhance the inspectors' ability to interdict contraband or cargo improperly declared for duty payment e.g. is the stainless steel low or high grade; is the material marble or granite?

- specific-threat scanning:

Highly threat-specific inspections may be tried to solve the most pressing security problems first and do so with the least impact to commerce throughput. One approach being considered by x-ray system providers would, sooner rather than later, deploy equipment to at least avoid having a nuclear weapon in a container actually making it to a ship bound for the United States. These systems would use high energy x-rays with enough penetration to clear most containers and reduce the number of secondary inspections needed at the port of embarkation. Time will tell how successful this approach may be but is certainly worth considering. The advantages would include the use of proven commercial equipment with potentially acceptable footprint and cost. The disadvantages remain the lack of future value-added applications for the supply chain.

Transformational technology

Better security in the supply chain can be achieved if change is driven by the quest for productivity improvements, growth and profits. The incorporation of new technologies and the reconfiguration of operations and cargo flows because it makes good business sense, should be a realistic

path to the ubiquitous deployment of inspection systems around the world.

The immediate need for ensuring that sea cargo containers bound for any destination do not contain a weapon of mass destruction could be a trigger for the long-term transformation of present-day supply chain operations. However, no two ports are alike and therefore a careful process study is necessary to determine the best solution that maximises port efficiency for today and tomorrow.

Passport Systems Inc. has taken a path to develop transformational technologies with the goal of addressing the limitations of current systems and to provide the global supply chain industry with meaningful inspection. Screened cargo can thus be considered safer, while at the same time add value to the port's operations and supply chain's bottom line.

Scanning in 20 seconds

When containers need to be screened for nuclear threats e.g. for shipping to the United States, a process called *Prompt Neutron Photo-fission* (*PNPF*) may be used. By measuring certain type of neutrons (prompt) which are only emitted by fissionable materials when interrogated by a suitable photon beam energy, it is possible to identify the presence or not of a nuclear weapon, even if shielded. With the use of high duty-cycle electron accelerators, a PNPF scan may be accomplished in less than 10 seconds per twenty-foot equivalent unit (TEU) container. During such scan, an operator can also be provided with a three-dimensional (3D) map of the contents of the container via another technology known as *Effective Atomic Number in 3 Dimensions* (*EZ-3D*). This map would show the location of all the materials in the container differentiated by atomic number (Z). This is of immense importance, as high-Z materials are consistent with either nuclear or shielding elements. The combination of these two technologies would detect any suspicious cargo without slowing down the cargo flow at a port.

A third transformational technology known as *Nuclear Resonance Fluorescence* (*NRF*) is well suited for deployment. Each element in nature, with the exception of Hydrogen and Helium, has a unique (NRF) fingerprint, which unambiguously identifies them from their surroundings. This is accomplished by the same photon interrogation beam of PNPF and EZ-3D which when interacting with the nuclei of materials will produce photons identifying the exact isotopic composition. Thus, NRF applied in a primary scanner would determine if what is being measured is consistent with the declaration in the manifest. Any inconsistencies can be flagged and those regions in the container be further inspected either in the same station or in a secondary scanning location at the port.

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Verification in less than two minutes

When a suspicious cargo is detected or an alarm has been produced by any primary inspection system at a port, such containers can be sent to a separate location. The highest possible scrutiny today would require taking the contents out of the container to inspect them properly, either by opening packages or using portable detection tools. This reduces the productivity of inspectors, a costly proposition because of the long time required. It also requires more space to accommodate the waiting vehicles.

NRF can be best used for alarm resolution by focusing on the specific region in the container identified during the EZ-3D primary scan. Depending on the cargo type, the presence or absence of an element or isotope in this region can be made. Most alarms in normal commerce would be resolved within two minutes, which means the container can quickly return to the flow of commerce undisturbed.

NRF doesn't just separate materials for security needs by identifying explosives, dangerous chemicals, toxins and nuclear materials, e.g. depleted uranium can be identified separately from highly enriched uranium – the latter being a nuclear weapon material. NRF can also provide information as to the origin of the goods or in some cases about product safety (food and product forensics). It is potentially an ultimate Customs' tool to enforce tariffs and legal trade; and for importers and exporters it would provide better piece of mind.

Passport schematic

Passport's technology offers a fast and comprehensive way to facilitate the processing of cargo, adding value by confirming cargo composition for product quality, consumer product safety, correct duty payment, as well as interdiction of weapons of mass destruction, explosives, chemicals and toxins. These breakthrough technologies would provide the incentive to be deployed to build the port of the future: highly competitive, more robust to external disruptions with sustained growth and profitability.