INTEGRATED INSPECTION METHOD OF MOTOR TRANSPORTS BASED ON ACCELERATION TECHNOLOGY

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Abstract

Integrated inspection method of motor transports was suggested based on linear electron accelerator and neutron generator, which helps to detect substances forbidden for carrying, including explosives, narcotic drugs and fissionable materials. The linear high-frequency electron accelerator is a source of X-ray bremsstrahlung. The result of scanning is an introscopical image of a motor transport with color-selected suspicious substances. The neutron activation analysis of these substances with neutron generator as a neutron source lets detect elemental substance composition as well as identify explosives or narcotic drugs. This article contains accelerator specifications, which lets implement suggested method.

PURPOSE

The purpose of the inspection system (IS) is an examination of motor transports. IS lets detect and identify substances forbidden for carrying including explosives, narcotic drugs and fissionable materials. Integrated informational and technical system of the IS aims to let the operator make valid decision on the presence or absence of the transportation rules violation signs.

IS provides:

- Visualization of inspected object contents.
- Recognition of the different devices located therein, objects and substances.
- Determining load merchandise volume of the container and inspect the contents of the spatial location.
- Coordinate attachment of the detected items to their location.
- Ability to recognize items of different materials (metals, organic substances, including elemental analysis).
- Ability to view the structural cavities and spaces between walls, ceilings and container floors, car components.

Additional specialized process equipment of the IS allows inspection of the driver and the persons accompanying the vehicle.

All information contributes to the overall control of cargo, identifying caches and prohibited substances.

The complex information technology tools of the IS are placed in a one-story industrial building (customs examination hall) and in the control room unit. The walls of the inspection hall are made of reinforced concrete, weighing not less than 2350 kg / m^3. The IS contains all necessary systems to ensure efficient functioning and safety management system. The basis of the IS is the system of inspection of containers loaded and trucks using the accelerator, which is the source of the X-ray bremsstrahlung with 6 MeV energy in the normal mode and an additional method for the implementation of the dual energy – 9 MeV.

General view of the IS is shown in Fig. 1.

Figure 1: General view of the IS building.

INTEGRATED METHOD

To solve the problem of identification and detection of the prohibited items in the inspected vehicle there is provided an integrated method comprising applying the following techniques:

αβγ Channel

Detection system of radioactive and fissile materials monitors the vehicle for the presence of radioactive and fissile materials.

X-Ray Channel

Scans the vehicle and gets its picture at two radiation energies; displays images on the screen completely without loss of visual information with a quality that allows the detection of hidden places, objects and substances under control; identifies suspicious areas for the presence of hazardous (explosive) substances by dual-energy and transmits their coordinates to the neutron - sensing module for detailed substance identification.

n-Neutron Channel

Neutron - sensing system conducts the spectral analysis of the selected areas and performs identification of substances, including drugs and explosives.

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Block diagram of the IS is presented in Fig. 2.

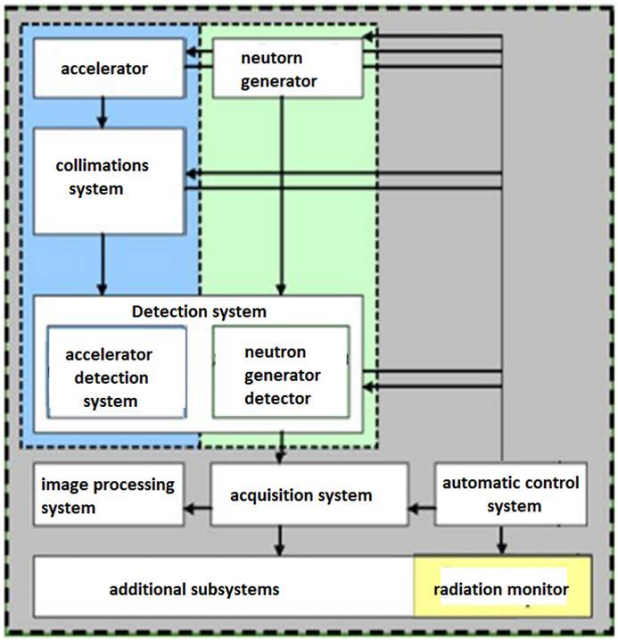

Figure 2: Block diagram of the IS.

INTEGRATED INSPECTION SYSTEM

According to structural features and control technology, IS is the second-type stationary inspection accelerator complex containing an electron accelerator with energies up to 10 MeV (according to SanPiN 2.6.1.2369-08). The second-type IS includes fixed and mobile IS with a stationary object and moving control source of ionizing radiation. IS produces a flat beam of bremsstrahlung, which scans a stationary inspected object when moving the portal parallel to the longitudinal axis of the object. IS general characteristics are shown in Table 1.

Radiating and receiving systems comprising the portal, the linear electron accelerator and the system receiving the detectors is shown in Fig. 3.

Figure 3: Radiating and receiving systems of the IS.

Table 1: IS General Characteristics

Characteristic	**Value**
Bremsstrahlung energy	6/9 MeV
Dose rate	2-5 Gy / min 1 m
Steel Penetration	400 mm
Detection of steel wire diameter without barriers	0.8 mm
Detection of steel wire diameter with 100 mm steel barrier	mm
Detection of steel wire diameter with 250 mm steel barrier	8 mm
Contrast sensitivity	0.5 %
Scanning height	4.5 m
ADC capacity	20 bit
Capacity	Up to 25 vehicles per hour
The maximum dimensions of the inspected vehicle	20 m (L)×3 m(W)×4,5 m (H)
Continuous duty	7/24
Radiation safety	SanPiN 2.6.1.2369-08
Operating ambient temperature	
• for apparatus inside the IS building	+5°C to +45°C
• for apparatus outside the IS building	-45°C to +50°C
Humidity	Up to 95% at +25°C
Presence of condensable atmospheric precipitation	frost, dew
Rain intensity	Up to 40 mm/h
Snowfall intensity	Up to 10 mm/h
Wind gusts at speeds	Up to 30 m/s
Snow cover thickness	Up to 2 m
Static and dynamic dust	+
Solar radiation	+
Power consumption	Less than 70 kVA

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Receiving detector system provides bremsstrahlung intensity conversion to an analog electrical signal, the analog signal into the digital form, and transfers the obtained values to the computer. The sensitivity and dynamic range of the detection system determines the quality of the images and, therefore, the operator's ability to control the vehicle and the cargo. The detector module is shown in Fig. 4.

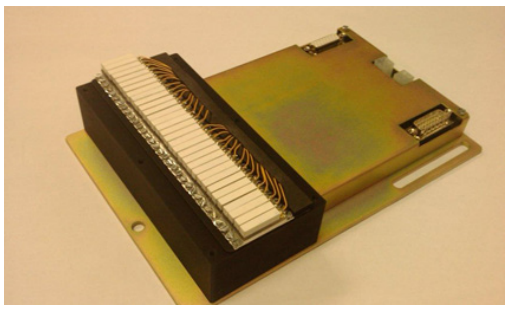

Figure 4: The detector module of the IS receiving systems.

Detection ability of the IS X-Ray channel is shown in Fig. 5.

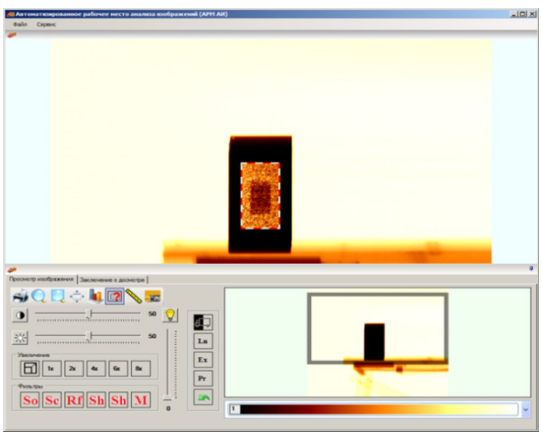

Figure 5: Measurement of the maximum penetrating power of the IS. Image of the lead brick behind the steel barrier at the image analysis operator workstation.

n-Neutron Channel

Main characteristics of the neutron channel are shown in Table 2.

Table 2: Main Characteristics of the IS Neutron Channel

Characteristic	**Value**
Neutron energy, MeV	14.1
Maximum neutrons flux, n/s	Up to 10^8
Technology used	Method of tagged neutrons
Transverse object dimensions (W×H) (mm, up to)	2900×4000
Probability of explosives detection (% ,at least)	90
Probability of false positives, (%, not more than)	15
Localization resolution of explosives in each orthogonal direction (cm, not more than)	15
The list of detected explosives trinitrobenzene, dazin, geksonitrostilben, PVV-5A, TC, TATB, RDX, okfol, okfol-3.5, TG-50, A-the IX-3T, HL-24, izopropilnitrat, okfel-20, OLA-8T, still-smon, LD-70, Pentol, POE-85, TGA-16, TM, tokaf, tetra, nitrate, ammonium-19 POE-7, TEN, TA-23	

Features of the neutron channel are:

- Determination of the three-dimensional distribution of substances in the volume of the inspection object.
- Automated algorithm for unattended identifying hazardous substances.

αβγ Channel

Detection of fissile and radioactive materials based on the use of transport radiation monitors by registration of penetrating gamma and / or neutron radiation accompanying radioactive conversion of nuclear materials and radioactive substances.

CONCLUSION

Integrated inspection method of motor transports was suggested, which helps the detection of substances forbidden for carrying, including explosives, narcotic drugs and fissionable materials. The combination of solutions is unique.

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