

# Detection of Radioactive Materials at Astrakhan

*A. Dougan, B. Pohl, J. Richardson, P. Hemberger, H. Williams, R. York, L. Cantuti, D. Martin, N. Kravchenko, A. Gramov, M. Brailovskiy, E. Zaitsev*

This article was submitted to  
40<sup>th</sup> Annual Meeting of the Institute of Nuclear Materials  
Management, Phoenix, AZ, July 25-29, 1999

## July 1999

*U.S. Department of Energy*

Lawrence  
Livermore  
National  
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A. Dougan, B. Pohl and J. Richardson, Lawrence Livermore National Laboratory  
7000 East Avenue L-175, Livermore CA 94551 USA 925/423-5187 FAX: 925/422-6434

P. Hemberger, H. Williams and R. York, Los Alamos National Laboratory  
NIS-7, Los Alamos NM 87545 USA 505 665-5735

L. Cantuti and D. Martin, Department of Energy  
1000 Independence Ave S.W., Washington, D.C. 20585 USA 202 586 7227

N. Kravchenko and A. Gromov  
Regional Information and Technical Customs Department  
State Customs Committee of the Russian Federation  
11/5 Novozavodskayskaya str. Moscow, 121087 Russia 095 449-8789

M. Brailovskiy, Customs, Astrakhan International Seaport and Cargo Port  
Astrakhan, Russia FAX 82-12 32 15 29

A. Ivanov, Aspect  
P. O. Box 62, 141980 Dubna, Moscow reg., Russia 096 21 65 292

### **Abstract:**

Astrakhan is the major Russian port on the Caspian Sea. Consequently, it is the node for significant river traffic up the Volga, as well as shipments to and from other seaports on the Caspian Sea. The majority of this latter trade across the Caspian Sea is with Iran. The Second Line of Defense and RF SCC identified Astrakhan as one of the top priorities for upgrading with modern radiation detection equipment. The purpose of the cooperative effort between RF SCC and DOE at Astrakhan is to provide the capability through equipment and training to monitor and detect illegal shipments of nuclear materials through Astrakhan. The first facility was equipped with vehicle and rail portal monitoring systems. The second facility was equipped with pedestrian, vehicle and rail portal monitoring systems. A second phase of this project will complete the equipping of Astrakhan by providing additional rail and handheld systems, along with completion of video systems. Associated with both phases is the necessary equipment and procedural training to ensure successful operation of the equipment in order to detect and deter illegal trafficking in nuclear materials. The presentation will describe this project and its overall relationship to the Second Line of Defense Program.

### **INTRODUCTION**

**BACKGROUND** Astrakhan is a city of about 500,000 and is the major Russian port on the Caspian Sea. Consequently, it is the node for significant river traffic up the Volga as far as Moscow, as well as shipments to and from other seaports on the Caspian Sea. The majority of this latter trade across the Caspian Sea is with Iran, and all sea trade between

Russia and Iran goes through Astrakhan. The volume varies, but during the summer season approximately one ship per day leaves for Iran; the annual average is about 3 ships per week, with each ship carrying about 1000 tons of various goods (e.g., building materials, machine products, raw materials, ore concentrates, fertilizers, hazardous materials, agricultural products).

The Russian Federation State Customs Committee (RF SCC) operates two separate facilities at Astrakhan which are physically separated by several kilometers, with a staff of about 600 which covers both the seaport and the customs region. The first facility is at the Astrakhan Seaport, which primarily ships exports to Caspian Sea nations (e.g., Iran); the Seaport also is the primary fishing port. The second facility is at the Astrakhan Port of Cargo Handling, which is the primary port for importation of goods from Caspian Sea nations. This second port is the larger of the two, although each marine port at Astrakhan has several cranes and the capacity to service several ships simultaneously. Cargo is loaded and off-loaded using a combination of rail and truck access. Initially neither SCC facility had operating radiation detection equipment. It is not surprising that RF SCC identified Astrakhan as one of its top priorities for upgrading with modern radiation detection equipment, and as one of the first two border control points to be equipped in the Second Line of Defense (SLD) Program.

The purpose of the cooperative effort between RF SCC and DOE via the SLD Program at Astrakhan is to provide the capability through equipment and training for RF SCC to monitor and detect illegal shipments of nuclear materials through Astrakhan. The first facility (Astrakhan Seaport) was equipped with one vehicle and one rail portal monitoring systems. The second facility (Port of Cargo Handling) was initially equipped with one pedestrian, one vehicle and one rail portal monitoring systems. A second phase of this project, just in the final stages of completion, will conclude the equipping of Astrakhan by providing an additional rail portal monitoring system which is needed at the Port of Cargo Handling as well as 2 hand-held radiation detection and identification units. Associated with both phases is the necessary equipment and procedural training to ensure successful operation of the equipment in order to detect and deter illegal trafficking in nuclear materials. The overall response of the RF SCC in Astrakhan to potential illicit trafficking in nuclear materials also includes links to the Frontier Service (which guards foreign ships docked at Astrakhan), the local police response force, and institutes which are approved to provide technical assistance.

**RADIATION DETECTION EQUIPMENT** One intention of the SLD program is to accelerate the on-going acquisition of indigenous Russian manufactured radiation detection equipment. The SCC, through a previously conducted test and evaluation process, had selected Yantar equipment produced by Aspect. Consequently, to maintain continuity and uniformity, and supported by U.S. laboratory and field testing, Aspect equipment was purchased for installation at Astrakhan. Dual post pedestrian (Yantar 2P), dual post vehicle (Yantar 1A) and dual post rail (Yantar 1Zh) portal monitors were purchased from Aspect (Dubna, Russia). The pedestrian monitor posts had a recommended separation of approximately 1.5 m, and the vehicle and rail monitor posts had separations of approximately 6.0 and 7.5 m, respectively, with maximums suggested

as less than 8 m. All of the Yantars used organic plastic scintillators for detection of gamma rays, with each scintillator having a volume of about 4000 cm<sup>3</sup> and being shielded by lead on all but the front side. The neutron detectors are proportional He-3 counters, each about 800 cm<sup>3</sup> in volume (for Yantar 2P, 400 cm<sup>3</sup>) operated at about 500 V. Each post in the Yantar 2P has two gamma detectors and four neutron detectors, with two / four gamma detectors and six / six neutron detectors in each post of the Yantar 1A / 1Zh, respectively. While obviously suitable for detection of a wide variety of radioactive materials, the interest of the SLD Program is the detection of special nuclear materials. Manufacturer specified minimum detectabilities for the Yantars vary from 1 and 10 g of Pu<sup>239</sup> and U<sup>235</sup>, respectively for the pedestrian portal at a distance of 1.5 m to 10 and 1000 g of Pu<sup>239</sup> and U<sup>235</sup>, respectively for the vehicle monitor through a six-meter wide portal at a speed of 15 km/hr (in all cases with a background of 20 µR/h). The rail monitors have lower specified minimum detectabilities (20 and 2500 g of Pu<sup>239</sup> and U<sup>235</sup>, respectively), albeit at a speed of 25 km/h. The Yantar 1A specifically has been tested at the Los Alamos National Laboratory in 1996 and certified to meet the performance standards for vehicle monitor detection of special nuclear materials as described in ASTM standards C1236-93, C1112-93, and C993-92. In subsequent domestic and international testing, the Yantar portal monitors have also been evaluated and demonstrated to have performance comparable to the best commercially available performance. The manufacturer's specified temperature range is - 50 to +50 °C, sufficient to endure anticipated Russian climate variations.

**PROCUREMENT AND INSTALLATION** Monitors were procured in two phases and installed during three separate time periods. All installation was done as part of the equipment procurement contract with Aspect. Additionally, the contract provided for additional auxiliary equipment to be procured (e.g., computer peripherals for data acquisition and processing, hand-held monitors (Aspect MKC-A021), video monitoring system for surveillance and interface to computer control system). The contract also provided for each deliverable to be first submitted to RITTY (Regional Information and Technical Customs Department) of the Russian SCC for coordination and concurrence before submission to LLNL.

The initial deliverable was a design document delineating from a Russian perspective the justification for considering Astrakhan as a high priority candidate and the requirements for installation. This report attributed Astrakhan Customs to the high priority list of SCC border crossings due to its geographical location, volume of traffic, and current state of radiation detection equipment. For example, in 1997 the volume of foreign trade was more than two million tons by weight and about 280 million US dollars. Ships and rail were responsible for most of this cargo. In 1998, the two Astrakhan ports had a total traffic flow of 14-24 ships per week, of which 5-7 were headed for Iran, with the balance being to other NIS of the Caspian Sea. Typical cargoes were mineral products, metals and timber. Major imports from Iran included stone and tile. Major cargoes in transit from Europe through Russia to Iran included ores, fertilizers, metals, and chemical industry products. Major cargoes in transit from CIS through Russia to Europe included crushed rock and building material.

Figure 1 illustrates the general location of the portal monitors at the Astrakhan Seaport, and is representative of the general installation procedure. All portal monitors and auxiliary equipment were placed within the SCC controlled facility. Installation sites were chosen with respect to choke points for traffic flow and facility physical security. For example, train monitors were placed before divergence of the incoming rail line. Care was taken to position vehicle monitors to adequately cover entering and exiting vehicles, without unnecessary risk to the equipment. Installation of the pedestrian monitor was chosen to physically preclude bypass of the fixed, dual post portal monitors. Actual separations were within Aspect recommendations; for example, the pedestrian posts had 1.55 m separation, and the two vehicle monitors had separations of 7 and 7.9 m. Speed limits hold the train and truck velocities to less than 5 and 15 km/hr, respectively.

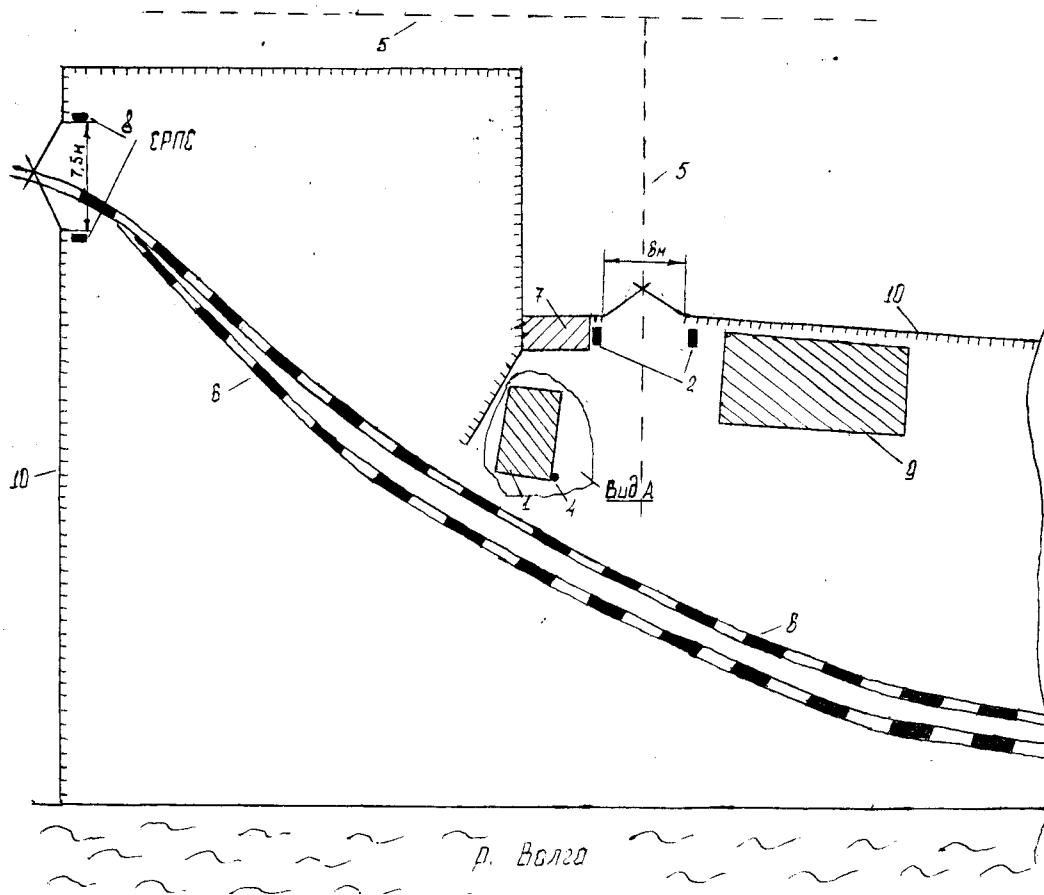


Figure 1. Schematic of installation of monitors at Astrakhan Seaport.

A typical finished installation is shown in Figure 2, depicting the location of one of the rail portal monitors in the Astrakhan Port of Cargo Handling.

**ACCEPTANCE TESTING** Acceptance testing and verification of performance and installation occurred during three separate phases. The initial contract was signed in

August 1998, with manufacture, delivery and installation of the two vehicle portal monitors (Yantar 1A) and the one pedestrian portal monitor (Yantar 2P) being completed in October 1998. Two rail monitors were manufactured, delivered and installed, with testing and acceptance being completed in February 1999. The final rail monitor has just been delivered and installed (July 1999), with acceptance testing being scheduled for late summer 1999.



Figure 2. Installed rail monitor (Yantar 1Z) at Astrakhan Port of Cargo Handling.

Acceptance testing consisted of evaluating both the gamma and neutron detectors with respect to uniformity of response across the detector surface and, in the case of the pedestrian monitors, with respect to gamma sensitivity as a function of horizontal position within the monitored area.  $\text{Co}^{60}$ ,  $\text{Ba}^{133}$  and  $\text{Cs}^{137}$  were used as gamma sources during various test periods, and  $\text{Cf}^{252}$  was used as the neutron source. Typical gamma ray backgrounds were 1500 counts/sec, with the test sources providing from 2X - 4X background. Typical neutron backgrounds were 2-4 counts/sec, with test sources providing 10X - 20X background. Final testing included detection of the sources in simulated field exercises (e.g., sample hidden in a car).

**CONCLUSIONS** Working with Russian SCC and the Russian commercial company Scientific & Industrial Company Aspect, the Second Line of Defense Program has completed installation of modern radiation detection equipment at the Caspian Sea port of Astrakhan. The SLD Program will continue working with SCC and Aspect to similarly upgrade radiation detection facilities at other important border crossing points in Russia. For example, similar upgrades have been done at Sheremetyevo-1 Airport in Moscow, and additional locations along the Russian borders are being jointly evaluated for upgrades.

It is expected that these upgrades will be sustainable, due to the warranty, maintenance record, and support network that Aspect has established to service their products in the

field. The latter is a particularly important attribute, as Russia has over 20,000 km of border and it is difficult to provide field servicing. Aspect, both directly and through a network of subcontractors, has arranged to provide routine and as-needed servicing for its monitors installed at SCC sites. Finally, training is provided within SCC to ensure proper operation and response to radiation alarms from Custom inspectors in the field. Training is another area of cooperation between SCC and DOE which is being developed under the SLD Program.

As reported in the Astrakhan press (i.e., Volga), the new monitors at Astrakhan almost immediately detected the importation of contaminated mineral wool, although a later investigation ascertained that the contamination was within acceptable standards. It is SCC's expectation that the installed systems will be used to prevent the penetration into Russia of food products, goods and building materials whose radiation background exceeds permissible standards. SLD's expectation is that it will assist in the prevention of illicit trafficking of fissile materials. The objectives of both parties are met at Astrakhan with the installation of the Yantar systems.

**ACKNOWLEDGEMENTS** We would like to thank David Herr for his exceptional work in facilitating the contracting process, and all the additional staff at Aspect and Russian SCC whose enthusiasm and dedication made the success of this project possible. This work was performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.