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Tamper-Indicating Devices in GIPP Project

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Abstract

Tamper-Indicating Devices (TIDs) serve the purpose of providing reliable and timely detection of any type of access to a containerized cargo or any other protected cargo. Functionally, they replace simple sealing devices, such as basic seals and tags that are widely used in various fields for storage and transportation applications. In most cases, the use of simple modern seals made of plastic or metal is justified due to the obvious advantages of ease of application and low cost. However, there is a current need to have highly reliable sealing technologies for containers that may carry hazardous or high-risk/consequence cargo such as nuclear, chemical, or biological materials or weapons/weapons components. Greatly increased assurance and operational flexibility results when those highly reliable sealing technologies can be monitored remotely. Additionally, these higher assurance devices could appropriately be used to monitor compliance with the international treaties on non-proliferation control, or other monitoring applications.

Over the last seven years, TID development has been the focus of an international technology collaboration between the Russian Federal Nuclear Centers and the U.S. National Laboratories. The All-Russian Scientific Research Institute of Experimental Physics (VNIIEF) as jointly developed a commercial application with Sandia National Laboratories (SNL) and Canberra – Albuquerque (formerly Aquila) as part of the DOE Global Initiatives for Proliferation Prevention (GIPP) program. A new sealing technology to provide highly reliable sealing and monitoring of hazardous or high-risk/consequence cargo containers is being developed as part of Project GIPP RUE2-011122-SV-05. The technology uses a new type of active seal, also known as a Radio-Frequency Seal/Tag (RFST) system. It consists of a miniature electronic and mechanical device with a digital RF-channel that represents the state-of-the-art in micromechanics and computer technologies. RFST seals are free from the limitations inherent in simple basic seals and provide both sealing and container monitoring functions. Their handling does not require specially trained personnel.

RFST System Components and Principle of Operation

The RFST system consists of two key components: a seal/tag equipped with an RF-channel and a reader. RFST is executed in the shape of a bolt and is mounted on the container lid at the appropriate place of attachment. Each RFST has a built-in digital RF-channel and forms a local radio network in a container warehouse. This RF network is used to circulate data on attempts to gain access to each container cargo and make a record of each and every procedure for handling objects stored in the containers with a real-time stamp. Access to the data circulated on the radio network is provided via the reader used for intermittent monitoring or the

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base station for continuous monitoring. Intermittent monitoring is performed by an inspector or users who have the reader connected to a PDA-type computer (see Fig.1). Intermittent monitoring can be easily performed by a user who has all of the above-mentioned equipment in the process of a visit to the container warehouse. While in the RFST radio coverage area, data on the current status of each container can be downloaded via the reader into the PDA computer database. This information may contain the following:

- Container ID;
- Container breach and tamper events over a certain specified period of time;
- Log of operations carried out with the container cargo with a time stamp for every action generated in the following format: year-month-hour-minute-second;
- Unauthorized access attempts;
- Information on the container contents/cargo, container packer, etc.

Continuous monitoring of containers stored in a warehouse is performed using a stationary base station installed in the same warehouse.

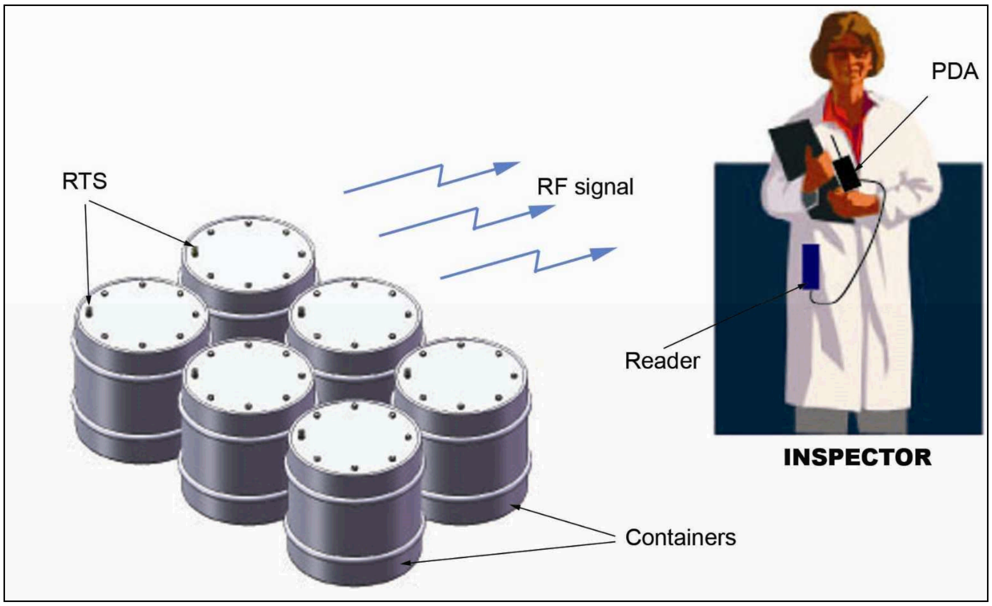

Figure 1: RFST Communication with Reader Connected to a PDA

The RFST can also be located within the RF radio network coverage range (see Fig.2) and linked to a personal monitoring computer. The principle of the base station operation and type of information collected are identical to the ones described above. The only point of difference is that the monitoring function is run continuously, and the operating personnel may respond immediately to any attempt to tamper with the container cargo.

Intermittent monitoring is a preferred option whenever there is a need to monitor containers placed into interim storage, or transported by rail or by sea, etc. Continuous monitoring is better suited for more permanent, fixed-site storage applications.

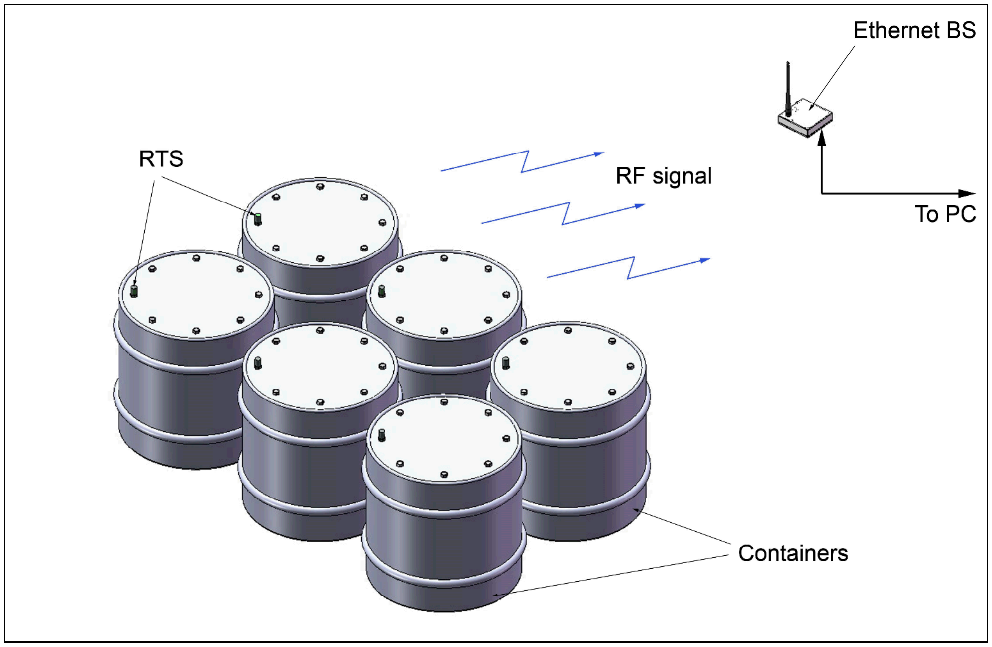

Figure 2. RFST Communication with RF Network Connected to PC

RFST Components and Their Design

A simplified diagram of the RFST design is provided in Fig. 3. A capacitive-type tension sensor is mounted at the base of a bolt ***2***. It sends out a signal to a microcontroller *7* to indicate whether RFST is "loosened or tightened". Data on the RFST status are sent into the network via a transceiver ***6*** equipped with an antenna ***4***. Power to the RFST electronic circuitry is provided by a standard lithium battery ***5***. A metal-plastic cap ***1*** is mounted on the base ***2*** to protect the internal RFST components from the environment.

The reader that transfers data from the RFST radio network into the user's PDA during intermittent container status checks is shown in Fig.4.

The plastic body ***1*** accommodates the following components:

— Electronic transceiver circuit to support data exchanges with the RFST radio network;

— Electronic microcontroller circuit to adapt the transceiver to the standard USB 2.0 interface;

— Lithium rechargeable battery;

— Reader status indicator ***2***;

— Power switch ***3***.

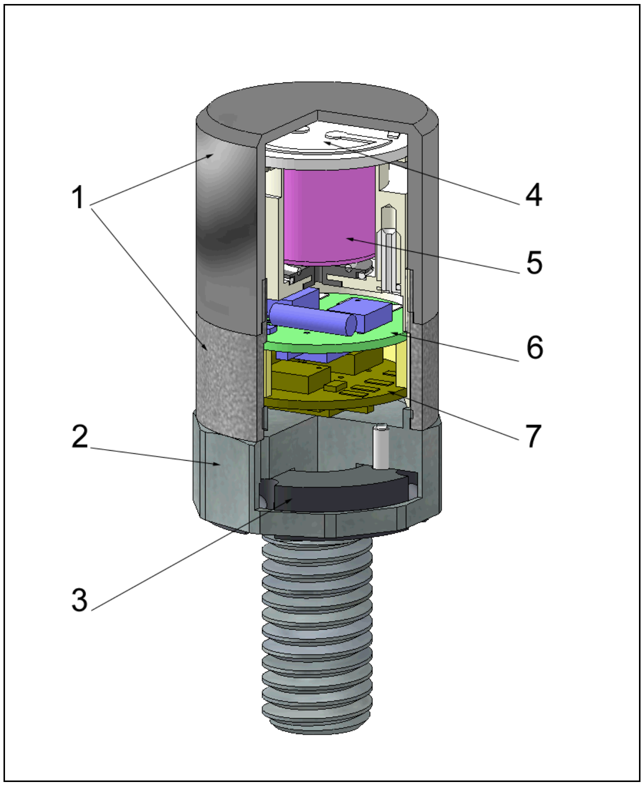

Figure 3: RFST Design

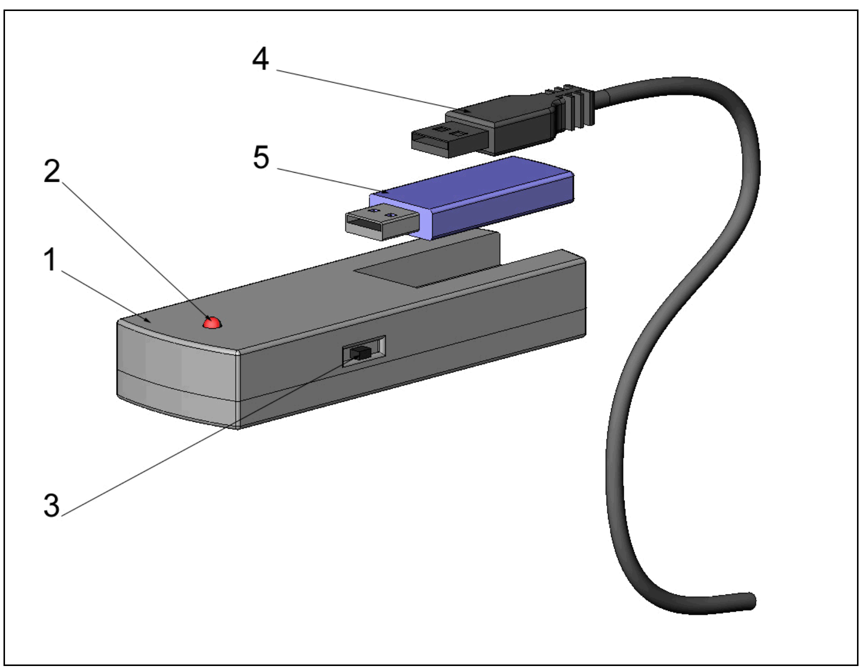

Figure 4: RFST Reader

The data interface between the reader and the user's PDA can be set up directly via a standard USB cable ***4*** or using a wireless connection based on the Bluetooth standard ***5***.

The base station that provides continuous monitoring of the containers in fixed-site storage conditions is shown in Fig.5.

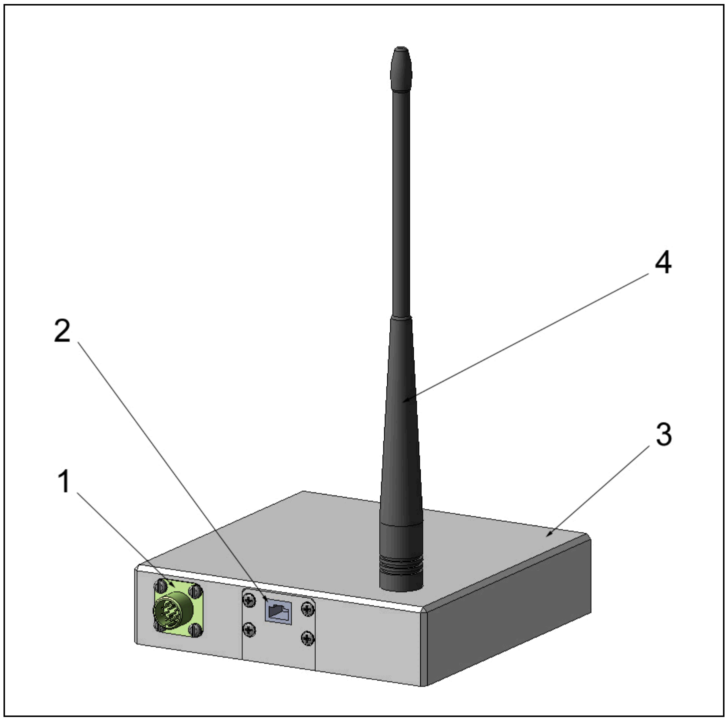

Figure 5: Base Station for Continuous Monitoring of Containers

In terms of their functions, the internal components of the base station are identical to those of the reader. The difference is that the base station does not have a rechargeable power supply source. Instead, the electric power is supplied from an external source through a connector ***1***, and the interface with the personal computer is based on the Ethernet 100 standard via the RJ45 connector ***2***. All of the electronic circuits are located in a metal body ***3***, and radio signals of the transceiver are broadcast through a spike antenna ***4***.

Conclusions

In the process of building the RFST system, specialists from VNIIEF and SNL will jointly develop, manufacture, and conduct field testing of several working prototypes of the system. Detailed design documentation generated at various phases of the project will be used to set up a pilot small-scale production line for the manufacture of the RFST system components in order to pre-test and market this new technology in both the U.S. and Russia.