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Secured Transmission of Data from Environments with High Potential Risk

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Abstract **– Materials exposed to a high-radiation environment suffer a gradual degradation process, with notable environmental influences, which require careful analysis. For this purpose, it is necessary to take a sample and test it in specialized laboratories. However, given the particular importance of data from potentially high-risk environments, eliminating or reducing the human exposure risk during the collection and processing of specimen data has been and is a continuing concern of the competent institutions.**

The paper presents the results of the research activities regarding the design and implementation of a remote control data system for in-situ γ-radiation measurements that has to ensure minimal measurements impact and a feasible solution for data transmission control.

Keywords-radiation; gamma radiation; high risk; secured transmission.

I. INTRODUCTION

From 1896, when Antoine Henri Becquerel discovered radioactivity, until nowadays, scientific research activity led to remarkable progress in the fields of energy production, medicine, biology, agriculture, and industry. At the same time, it generated a worldwide concern regarding the disastrous consequences of military applications, such as 1945 Hiroshima and Nagasaki nuclear bombing, or accidents that occurred in nuclear stations operation. Nevertheless, even today, one does not truly know the radioactive level we all are exposed to, the diverse radioactive sources or the impact of these radiations on health [1].

Radioactive materials, that are also mentioned in the related literature as radionuclides or radioisotopes, are unstable atoms, having the permanent tendency to change themselves into a stable form; doing this, they are continuously emitting radiation [2].

When performing alpha, beta and gamma measurements, the best method to ensure screening cosmic radiation is considered to be building measurement laboratories in underground having big enough depths [3]. In underground laboratories are succesfully performed studies of penetrating cosmic rays, or contaminated materials can be identified and radiation detectors can be calibrated with an increased accuracy [4].

II. VULNERABILITIES AND SECURITY RISKS

In Romania, National Strategy for National Security and Safety, aproved by HG no. 600 from 2014, promotes an integrated approach of the nuclear security and safety concepts [2].

The term “nuclear safety” is defined as the combination of measures of physical protection and control of nuclear guarantees, and “nuclear security“ is defined as the combination of technical and organizational measures intended to ensure proper operation of nuclear plants, to prevent and limit their deterioration and to ensure the protection of the exposed personnel, of the population, environment and material goods against radiations or radioactive contamination [2].

The integrated approach of nuclear security and safety has as aim the control and the maintainance at the lowest possible reasonable level of the specific risks associated to plants, materials and activities belonging to the nuclear fied. Among these risks, some of the most important are:

- the risk of accidental exposure to radiations of personnel, of pacients diagnosed or receiving treatments with radiations or of population;
- the risk of accidental contamination of the environment over the limit allowed by the legislation;
- the risk of damaging nuclear plants as a result of internal or external events, accidental or with intention, with potential radiologic consequences;
- the risk of using in illegal purposes nuclear or radioactive materials, including the risk of proliferation of nuclear weapons [3].

III. DETECTION AND ENVIRONMENTAL RADIATION MONITORING EQUIPMENTS

The related scientific literature [1-11] discloses the existence of a wide range of equipments for environment radiation detection and monitoring, used for preventing radioactive contamination and for protecting precincts and human personnel, as well as public.

Air Monitor Thermo Scientific™ ALPHA-7A (figure 1) uses modern technologies and powerful algorithms for identifying alpha radiation emissions, generating alert procedures for the operation personnel exposed to these radiations [12].

Fig. 1. Air Monitor Thermo Scientific™ ALPHA-7A [12]

A similar equipment is Thermo Scientific™ FHT 59 N1 Nuclide-Specific Aerosol Monitor, that is a monitoring equipment for the gamma radiation concentration in air or in an effluent carrier gas [12][14].

Gamma Sensor is a supervising device for the gamma radiation level that ensures detection, localization, and a rapid characterization of the radiation sources and of the radioactive pollution level (figure 2). Important characteristics refer to creating and managing a data base containing information related to dosage rates, specific data, measurements timing, as well as to generating alarm signals when allowed values are exceeded [13].

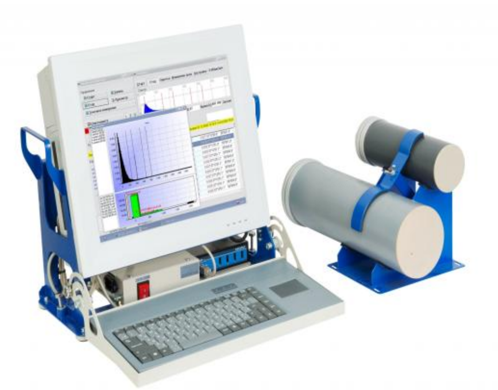

Fig. 2. Gamma Sensor monitoring device [13]

This device is equipped with a "Sensor" software support, that is installed in an automated system context for environment radiation monitoring with real time data transmission [13][15].

Figures 3, 4 and 5 present an example of an intervention procedure for in-situ spectrometric measurement of the gamma radiation level performed by the specialists of Horia Hulubei National Institute for R&D in Physics and Nuclear Energy, Bucharest, Romania.

Fig. 3. Intervention for in-situ gamma radiation level measurement, Râfov, Romania, 2014

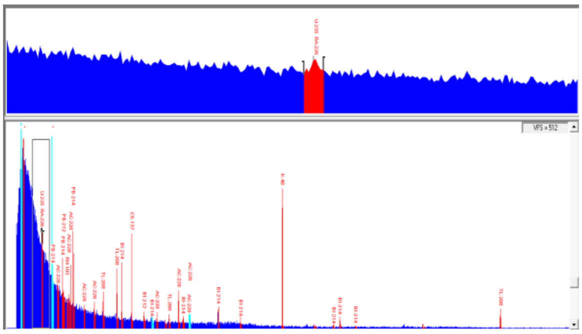

Fig. 4. Spectrometric "in-situ" measurement of high resolution gamma radiation, Tc=1200 s, Râfov, Romania, 2014

A laboratory equipment (figure 6), used in high-resolution gamma-ray spectroscopy, includes detectors that are sensitive to energy radiation, electronic processing devices for these detected signals, such as high voltage source, a digital signal processor and a multichannel analyzer (MCA), as well as data readout devices that generate, display, and store the gamma-ray energy spectrum [12].

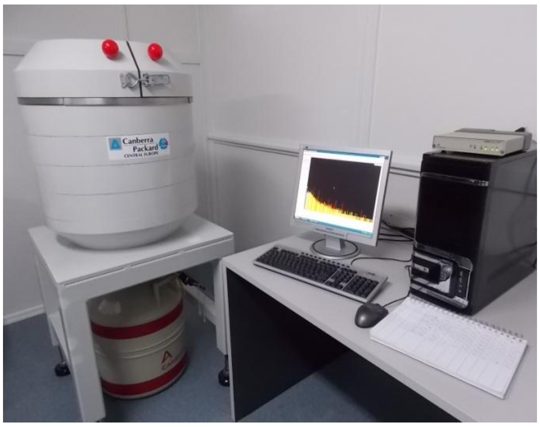

Fig. 5. Laboratory equipment for gamma-radiation spectrum measurement

In the present experiment, the InSpector ™ 2000 portable spectroscopy workstation was used for digital signal processing (DSP) (figure 6) [10].

Fig. 6. InSpector™ 2000 Portable Spectroscopy Workstation[10]

In order to ensure efficient calibration for large objects at minimal cost, the Situ Object Counting InSpector ™ 2000 software (ISOCS ™) uses mathematical modeling instead of sources. It has the ability to establish a correspondence between the channel number and the corresponding gamma energy in the spectrum (figure 7).

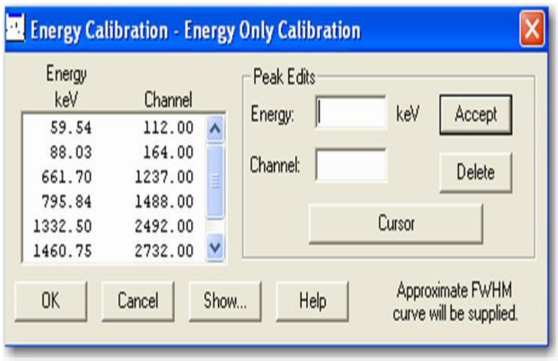

Fig. 7. InSpector™ 2000 energy only calibration

IV. EXPERIMENTAL STUDY OF A REMOTE CONTROL DATA SYSTEM FOR IN-SITU GAMMA-RADIATION MEASUREMENTS

The experimental study performed by the author proposed an automated system composed of the radioactivity measurement equipment and of a portable radio communication station, laptop and a smartphone.

Initially, the equipment has been placed in this tough investigating environment, and then the same experiment has been repeated for an on-ground site, under very low temperature conditions (below -10^0 C). The TeamViewer remote control application has been installed on the two laptops and on the smartphone and the required connection settings have been performed [16].

Another important objective of the research was the development of computer software products represented by the software implementation of information security algorithms based on various types of encryption. Thus, the author envisaged the implementation of the quantum encryption protocol software BBM92, with the presentation of a graphical interface for simulating a data transmission application and the development of a quantum encryption application running on a real-time system [8].

An important issue regarding this experimental study is related to advancing modern solutions for ensuring the transport of the measurement system by means of remote controlled systems, such as drones or robots.

The study has emphasized the fact that remote control is feasible; consequently, the human operator is safe, besides any risk. Moreover, considering the in-site measurements performed using portable equipments, one can take actions in perfect safety, even from very long distances [19].

The measurement system can be controlled using a large variety of electronic devices (laptop, tablet, smart phone) and can be used in tough investigation circumstances [19].

In that direction, among the most important advantages of using a robotic system during a measurement operation in high risk environments one can underline the following:

- enhanced safety, by eliminating the direct exposure of the personnel to possible dangerous radiations;
- reduced operation time;
- precision and accuracy in providing information;
- reduced costs, as it can minimize the social and economic impact of possible accidents.

Fig. 8. FFR-1 Robot

In order to minimize the risk of human exposure in hazardous environments, the author proposes to carry out an experiment consisting of transporting the detection equipment with a remote controlled robot. Thus, the robot will carry the equipment that was the subject of the first experiment on rough terrain, in order to perform specific measurements to determine the radioactivity of the environment. The data will be transmitted remotely via a secure connection by a laptop connected to the multichannel analyzer (MCA), and taken over by the specialized staff in order to process it and take the decisions that are being challenged.

Considering this, the author took into account of using the FFR-1 robot, developed at the Faculty of

Informatics of Titu Maiorescu University from Bucharest, Romania (figure 8) for in-situ measurement experimental study, having as arguments the degree of autonomy, namely the decisional capacity of the robot in the presence of preliminary information (insufficient or erroneous) to achieve the current task [17].

Other important features that recommend using this equipment were the constructive solutions, such as motorization and sustainability, type of energy source and drives, embedded sensor system, degree of structuring of the operating scene [17].

For mobile robots, the mobility function in the general case is the ability to move externally between two positions, or more precisely:

- the ability to evolve in a hostile environment (for example dangerous, like labyrinth) and on various types of soil, including unprepared a priori (sand or gravel);
- existing opportunities to avoid or overcome obstacles (natural obstacles, ladders, ditches, inclined planes);
- performance achieved: speeds, accelerations, range, capacity, duration of energy independence. [17][18].

CONCLUSION

The main concluding remarks are:

- Remote control of the radiation measurement system is required to ensure the work safety conditions for the team of specialists working in potentially hazardous environments;
- The experiment presented in this paper emphasized that the proposed system may be feasible; consequently, the human operator is safe in an environment with high risk potential. In addition, in-situ measurements made with portable equipment can be carried out safely, even at great distances;
- The importance of the data resulting from these measurements determines the need to ensure a secure connection so that no unauthorized or malicious person can substitute the human operator or modify the results of the measurements.

As future research directions, the authors intend to develop an expert system can succeed in problems without a deterministic algorithmic solution and can explore a wealth of information to draw conclusions about difficult activities to examine.

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