Abstract
In the report the characteristics of ALARM radiation monitoring systems and feature of their use at the Technical Storage Complex of F.V. Lukin State Research Institute of Physical Problems are presented.

TECHNICAL STORAGE COMPLEX
The Technical Storage Complex (TSC) of F.V. Lukin State Research Institute of Physical Problems (see Fig. 1) consist of 3 electron accelerators:
- Linear accelerator (Injector) of 100 MeV;
- Small booster-storage of 400 MeV;
- Main storage of 2.5 GeV.

The main use of TSC is the synchrotron rays source for quantity production of integrated circuits by a rentgenolithography method and research of processing behavior of used materials.

According to Ref. [1, 2] the radiation fields by 1-st and 2-nd stages of TSC running are formed the following basic components:
- Electromagnetic cascade radiation (EMS);
- High energy electron bremsstrahlung (EB);
- GDR neutrons (GDRN).
Some contribution can be created by high energy (En > 80 MeV) neutrons, muons and induced radioactivity.

Inside the accelerator locating rooms at \( \theta > 15^\circ \) to beam direction the radiation fields are formed by EMS electrons, positrons and photons with \( E < 10 - 20 \) MeV. At normal frontal interaction of this radiation on a human body the maximum dose equivalent (MED) is located on \( 0 \ldots 6 \) cm depth (depth of localization of a maximum of dose equivalent is augmented with \( \theta \) decreasing). The maximum of MED to a surface dose ratio at \( \theta \approx 15^\circ \) does not exceed a factor 2. At smaller angles the EMS effects are increasing.

Figure 1: The Technical Storage Complex of F. V. Lukin State Research Institute of Physical Problems
The similar nature has a EMS radiation field arising at damping on the accelerator equipment a thin beam of hard bremsstrahlung radiation. Outside the rooms the dose equivalent values (at all \( \theta \)) are depended from low-energy \((E<10-20 \text{ MeV})\) EMS particles and photons and MED is located on a surface of a body versed to radiation shielding. In view of these data and analysis on spectra of neutrons and photons it is necessary to consider that the effective dose \( E \) will be close to the sum \( E_i \) from all regions of a spectrum for all types of radiation. According to [2] the conservative estimation of an effective dose is ambient dose equivalent \( H^*(10) \).

There are a several modes of normal TSC (1-st and 2-nd stages) running:

a) electronic beam injection from linear accelerator (LU) to small booster-storage (MN) at \( E_e=100 \text{ MeV} \);

b) beam acceleration in MN to \( E_e=450 \text{ MeV} \) to main booster-storage (BN).

In a)-mode it possible the partial or full losses of injected beam with generation of pulsed radiation fields. The pulse value is determined by an electronic bunch time \((30 \text{ ns})\). In b)-mode it possible a slow (second) or fast \((10^{-9}-10^{-5} \text{ s})\) losses (partial or full) of accelerated beam with generation of the radiation fields. At debugging mode a full intensity of accelerated beam is utilized on the beam absorber. It results a time-dependent radiation fields.

At December 2002 the first stage of TSC (linear injector) was to put into operation (see Fig. 2).

\[ H^*(10)/T, \text{mcZv}/10s \]
\[ 0.0 \]
\[ 0.1 \]
\[ 0.2 \]
\[ 0.3 \]
\[ 0.4 \]
\[ 0.1 \]
\[ 0.2 \]
\[ 0.3 \]
\[ 0.4 \]
\[ 0.1 \]
\[ 0.2 \]
Figure 2: The dynamics of ambient dose equivalent values inside the linear injector room.

ALARM RADIATION MONITORING SYSTEM

The ALARM radiation monitoring system for TSC was developed with using of the new Radiation Safety Rules (NRB-96/98). The radiation monitoring system of TSC consists of three control systems:

- The non-stop ALARM monitoring is based on the Automated system of radiation levels monitoring (ASNKRO).
- Integral radiation monitoring is based on the phantom systems (NTK “Atom”, Riga production) with termoluminescent detectors (TLD).
- Personal dosimetry is based on the personal dosimeters with TLD.

ACNKRO System

The ACNKRO system contained a following types of unified detector units:

- BDMG–19. Gas-discharge detector is intended for measurements of photonic ambient dose equivalent in a countable mode outside the TSC shielding.
- BDMG-A-1T. Argon-charged (at pressure 11 atm.) ionization chamber is intended for measurements of photonic ambient dose equivalent in a current mode inside the TSC shielding.
- BDBN-16C. CNM-type of thermal neutrons detector combined with a polyethylene moderator \((D=254 \text{ mm})\) is intended for measurements of ambient dose equivalent of neutrons in a countable mode in protected rooms.
- BDBN-17C. CNM-type of thermal neutrons detector combined with a polyethylene moderator \((D=254 \text{ mm})\) is intended for measurements of ambient dose equivalent of neutrons in a current mode outside protected rooms.

The rack of control includes a processor module, unit of adapters and uninterruptible power supply. The processor module of a system is intended for data acquisition from detectors, transformation of information from a DB into ambient dose value, storage and information display, support of network tools, data transfer to other users. The processor module was manufactured on base of industrially issued modules of the corporation ADLINK Technology Ink.

The system is certificate by GOSSTANDART of Russia.

Phantom System

The phantom system consist of tissue-equivalent elliptical phantom assemblies, LiF \((^{6}\text{LiF}, ^{7}\text{LiF} \text{and} ^{7}\text{LiF})\) termoluminescent detectors. The TLD measurements are executed on the readers (TLD – analyzers) of DTU-01, AKIDK-301 types.

Phantom assembly is elliptical phantom \((200\times400\times7600 \text{ mm})\) manufactured from the tissue-equivalent P2D-MBT (MIFI) plastic. The termoluminescent detectors (TLD) are located inside the phantom. The TLD placed in a central section of FS (on a surface - uniformly on a angle approximately 45 deg., at the 0, 10, 20, 30, 50 mms depths from the phantom...
surface on two perpendicular axes and in the phantom center).

For measurements of neutronic ambient dose equivalent at the 50 mm depth, the $^6$LiF and $^7$LiF TLD pairs are located in a center and on a phantom surface. In remaining cells the LiF TLD with the natural contents of Li isotopes will be used.

**Software Development**

For the visualization, logic analysis of the operative data and automatic forming of the report documentation the Windows application “Operative TSC Radiation Monitoring” was developed.

**REFERENCES**