The results of sterilization of mail in typical packages using $^{60}$Co $\gamma$ rays with average energy 1.33 MeV and in an electron accelerator with electron energy 9 MeV are presented.

It has now become necessary to develop radiation sterilization of mail. It is believed that radiation sterilization of mail entering from the quarantine zone can be accomplished if only the exposure dose of ionizing radiation is known. The first experiments showed that this is inadequate to determine the commercial regulations for the process. In addition, the possibility that pathogenic microorganisms could be used as biological weapons [1–3] has predetermined experimental testing of any technology for commercial sterilization of mail by radiation methods.

The present paper presents the results of the sterilization of mail in typical packages using a plasma-beam discharge in an electron accelerator and in the field of 1.33 MeV $^{60}$Co $\gamma$-rays.

To sterilize mail, it is necessary to provide aseptic conditions under which the technological zones are divided into two zones – a “dirty” zone which mail enters for sterilization and a clean zone where sterilized mail is stored. These zones must be separated by a continuous barrier with an independent exit which is carefully monitored to prevent mixing of sterilized and dirty mail [4]. An object (books) enters in a standard package, a 600 $\times$ 300 $\times$ 300 mm cardboard or plastic box, sealed in polyethylene packaging. The thickness of the film is >150 $\mu$m. The objects to be sterilized are placed in the reaction zone using a specially developed scheme taking account of the positional height of the object to be sterilized and the distribution of the $\gamma$-ray intensity over the zone. To accumulate the required absorbed dose, the objects are irradiated for several days. For uniform irradiation, they must be successively rotated by 180°, as a result of which with repeated irradiation the absorbed dose is increased and evened out. The sterilized objects are moved into the clean room, where they are examined, additional monitoring is performed, and an established protocol is followed.

Microbiological testing systems have been developed to determine the required radiation sterilization regime. These systems consist of polyethylene packets containing samples of sublimation dried test cultures of *Bacillus thuringiensis*, which simulate the organisms *Bacillus anthracis* that cause malignant anthrax. The number of spores in each sample was 2·10$^8$. Models containing 16 books, each with 304 pages, which were tightly packaged in a cardboard box, were used as mail samples.

**Sterilization on a $\gamma$ Apparatus.** Packets each containing 1 gram of the test culture were placed in a model between books at different distances from the source. Film dosimeters were placed in the same order. The arrangement of the biological samples and dosimeters in the model is shown in Fig. 1. The objects were irradiated with $\gamma$-ray exposure dose rate
It is evident from the experimental data that complete suppression of growth of the spore culture *Bac thuringiensis* is already observed with an exposure dose of 2.1 Mrad for a period of 4 days of irradiation on the GUT 200 M apparatus. Since the setup has operated for 18 years, to decrease the sterilization time for mail periodic monitoring is required and the radioactive sources $^{60}$Co must be replaced.

**Sterilization Using the Fakel Electron Accelerator.** Mail is sterilized with a high-energy electron beam produced by a plasma-beam discharge in the atmosphere and a solid body [6]. Electrons with energy 9 MeV can penetrate to a depth up to 0.5 m in a solid body whose density is less than 1 g/cm$^3$, exciting along its path a plasma-beam discharge.

\[D_{\text{exp}, \text{M}^*} = \frac{D_{\text{abs}}}{D_{\text{exp}}} \]

\[D_{\text{exp}} \text{ – exposure dose of radiation, recorded by control dosimeters [5]; } D_{\text{abs}} \text{ – dose absorbed by biological materials and paper in the mail, determined using the coefficient } K_{\gamma} = \frac{D_{\text{abs}}}{D_{\text{exp}}} \text{ for real conditions.}\]