PROVISION OF RADIATION SAFETY OF PILOTED SPACE FLIGHTS

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Abstract. The article considers the problem of the growing need to create a new, effective counter to cosmic ionizing radiation. The importance of this problem for the planning of long-term manned missions and the impossibility of further development of the space industry was emphasized. The existing methods of preventing radiation exposure of astronauts, their features and problems of application are analyzed. The main directions of development of radiation safety of space flights are specified.

Keywords: radiation, space, interplanetary missions, space radiation, colonization.

Анотація. У статті розглянуто проблему наростаючої необхідності в створенні нової, ефективної протидії космічному іонізуючому випромінюванню. Підкреслено важливість цієї проблеми для планування довготривалих пілотованих місій та неможливість подальшого розвитку космічної галузі. Проаналізовано існуючі методи запобігання радіаційному впливу на організм космонавтів, їх особливості та проблеми застосування. Вказано основні напрямки розвитку радіаційної безпеки космічних польотів.

Ключові слова: радіація, космос, міжпланетні місії, космічне випромінювання, колонізація.

Introduction. The main obstacle to the comprehensive conquest of space is radiation coming from various sources: galactic and solar cosmic rays. Colonization of the planets closest to Earth is also impossible due to the lack of a dense atmosphere, which in turn creates an aggressive radiation background on the surface.

During the preparation of space missions, it is extremely important to quantify radiation hazards, taking into account the ionizing front of the future flight path, the degree of protection of the crew and equipment, to ensure their smooth operation.

The solution to this problem is a complex process that includes the analysis of a wide range of radiation. In addition, constant changes in radiation weather and design features of the spacecraft should be taken into account [1].

Analysis of the state of the issue. Much of the features of space flight can be analyzed using statistical modelling using modern computing tools and software. At the present stage of solving the problem, programs have already been developed that allow to take into account the design of the spacecraft, the radiation impact on the human body and the use of various equipment [2].

Purpose: to explore promising ways to protect against ionizing radiation in long-term extraterrestrial missions. Analyze existing methods to minimize the negative effects of cosmic radiation.

Methods, materials and research results. When preparing long-term interplanetary expeditions, it is important to take into account the periodic nature of the radiation situation in the solar system, which is associated with an 11-year solar cycle. For example, galactic cosmic rays are characterized by a relatively hard spectrum, which can reach several hundred GeV. Their high-energy component weakens slightly with increasing thickness of the spacecraft's protection (fig. 1) [3]:

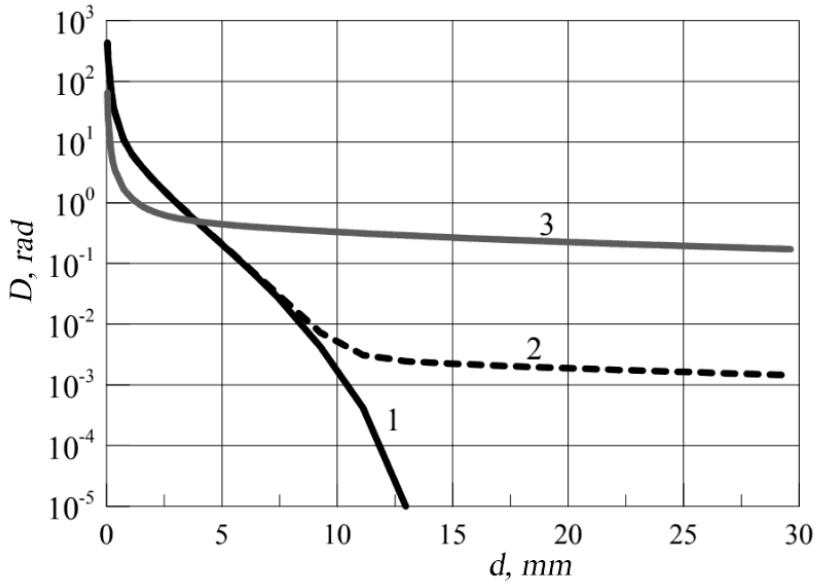

Fig. 1. Daily dose of radiation for aluminium protection
1 – from electrons; 2 – from electrons
and secondary radiation; 3 – from protons

Moreover, the doses for 365 days of flight during the period of minimum solar activity are quite high and 2-2.5 times higher than the dose during the period of maximum activity. Thus, long-term interplanetary flight (for example, to Mars) should be planned during the period of maximum solar activity [4].

To ensure radiation safety during space flight, a set of engineering and medical methods, tools and measures are used to ensure compliance with regulatory levels of radiation with known reliability. These include: physical protection, which reduces the exposure of the crew; the use of pharmacological drugs that increase the body's radioresistance; carrying out activities related to the forecasting and control of radiation levels during the flight and the creation of clear instructions for the crew in case of deterioration of the radiation situation.

Passive protection is based on the principle of weakening the flux of radiation due to its absorption during the passage through a certain thickness of any substance. The required thickness of protection primarily depends on the physical characteristics of the radiation, the trajectory and duration of the flight, the layout of the spacecraft (equipment also absorbs radiation) and the desired level of radiation safety .

The analysis of the radiation situation and the experience of space flights have shown that no special radiation protection is required for near-Earth orbital flights with an orbital height of ~ 400 km and an inclination of up to 50° with a shell thickness of

at least 3 g / cm^2.

Various medical methods and means are used in the system of radiation protection during space flights, in particular anti-radiation drugs – radioprotectors. Radioprotectors are individual means of pharmacochemical radiation protection, which realize their effect at the physicochemical and biochemical level of cells, significantly reducing the negative effects of radiation.

This effect has been found in a number of chemicals of various natures. For example, some substances cause a decrease in the concentration of oxygen in the tissues. Local decrease in the concentration of free oxygen in the tissues) reduces the possibility of the formation of free radicals at the time of irradiation. The protective mechanism of other substances is to reduce the indirect effects of radiation by intercepting and deactivating free radicals and other active products of water radiolysis.

Radioprotectors are taken immediately before the expected short-term exposure at high dose rates. Their reception reduces the body's radiosensitivity, reduces the severity of radiation sickness and prevents death from radiation in lethal doses.

In the process of space flight, constant dosimetric control is performed. The main tasks of such control are to assess the category of the radiation situation and determine the radiation dose received by each crew member during the flight. Dosimetric control consists of individual and onboard. As a result of individual dosimetric control, the absorbed or equivalent radiation dose on the astronauts' body surface is measured. This helps to respond in a timely manner to the deterioration of the radiation situation and avoid irreparable damage to the human body.

Conclusions. There are two most available and effective methods of protection against radiation in space:

– use of absorbent sheathing;

– use of radioprotectors;

Their use is due to a well-established technological process and economic feasibility.

However, even the combination of all existing techniques does not provide 100% protection against the negative effects of radiation. Long-distance flights require fundamentally new technologies that could fully secure astronauts without significantly increasing the cost and complexity of missions.

Full-fledged colonization of Mars is impossible primarily because of the effects of radiation on potential colonists.

It should be noted that during space flights the human body is negatively affected by a number of different factors. Cosmic radiation is just one of them.

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