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Space systems — Human-life activity support systems and equipment integration in space flight

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operation*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

0 Introduction

0.1 General

This is a first level standard in a set of documents regarding human-life activity support systems and equipment integration in space flight.

This document, along with second and third level standards, form a complex three-level international standard entitled: *Space systems — Human-life activity support systems and equipment integration in space flight"*.

The second level covers standards on separate issues and is entitled: *Techno-medical requirements for spacecraft crew habitation environment — Requirements for life activity support of a human in spacesuit and other requirements*.

The third level covers standards on separate tasks, with specific requirements included into the second level documents.

NOTE Detailed data regarding this first level standard are presented in Annex A.

0.2 Basis for standard development

The experience from RSC Energia, Russian allied organizations, and the authors themselves was summarized in order to develop this proposed document regarding the development and operation of Salyut LSS, Mir, and ISS space stations. In addition, the experience of joint operations with NASA in the Mir-Shuttle and Mir-NASA international programmes, as well as the experience of operation with international partners during the Mir and ISS space stations operation was taken into account.

Russian standards, USA standards and joint international normative documents were used to develop this first level standard, in human life activity support during space flight.

0.3 Purpose

The purpose of this document is to develop a common approach and unified requirements for habitability, environmental aspects, safety, comfort and evaluation and management of techno-medical conditions for manned space flight. Maintenance of these conditions is required for human life activity support systems and equipment in space flight. Such standards increase crew efficiency and support their health

0.4 Tasks

The tasks of a first level standard include the definition of requirements for development of ecological habitability in limited pressurized volumes and the definition of content of second and third level standards, the requirements of which will support human life activity in space vehicle conditions.

Space systems — Human-life activity support systems and equipment integration in space flight

1 Scope

This document (first level standard) is the main document among the others regarding human-life activity support systems and equipment integration in space flight.

This document, along with second and third level standards, forms a complex three-level international standard entitled: *Space systems — Human-life activity support systems and equipment integration in space flight*.

It is applicable to all human space flight programmes in all manned space objects, including space systems, space stations, lunar and planetary bases, as well as extravehicular activity. It covers all phases of development of a manned space object, such as design, production, tests, operation, and maintenance.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
human habitation environment in spacecraft
complex issue that involves material, energy and information flow, as well as elements formed in SC habitable compartments

Note 1 to entry: Such elements are derived from life activity processes, human social-labour processes, space factors, space mobility, human comfort and safety, and hardware functioning processes, including the ones that are designed to arrange human beings' interaction with the habitation environment in order to provide specified conditions for human life activity in space flights.

3.2
human living conditions in spacecraft
complex of human habitation environment parameters in SC, providing health maintenance, human safety and keeping his ability to work at the level needed to execute the planned work programme

3.3
techno-medical requirements for human habitation environment
complex of biomedical, hygiene/sanitary, ergonomic and design and construction requirements

Note 1 to entry: Those requirements take into account physiological and social-psychological human needs in the process of hardware development and operation in order to guarantee specified living conditions aboard space systems.

4 Abbreviated terms

SS Space Systems

SC Spacecraft

EVA Extra Vehicle Activity

5 Application of this document in space programmes

5.1 General

Upon implementation of space programmes, integration with human life activity shall be considered at all levels — from individual components to full integration.

5.2 Applicability

All requirements stated in this document, unless otherwise specified, shall be applied to all phases of the flight programme.

5.3 Specific programme requirements

Each human space flight program shall establish its specific requirements for the development of this document. These requirements shall be verifiable.

5.4 Monitoring of flight programme conformance according to this document

Each human space flight programme shall be the subject of permanent monitoring to verify conformance with this document, including design, development, tests, and operation.

5.5 Verification of programme requirements

The requirements of each human space flight programme shall be verified in accordance with this document.

6 Matter terrestrial cycle

6.1 General

During terrestrial life activity, a human consumes oxygen, food, water and some other products from the biosphere, which regulate life activity. Oxidation reaction products are released in the environment as carbon dioxide and liquid and solid waste products. In terrestrial conditions, these products are processed by bacteria, plants and animals, which restore them to oxygen, water, foodstuff and other parent substances, completing a closed cycle of matter.

Completion of such a biological cycle aboard modern spacecraft is not feasible due to low energy efficiency for natural processes, their unreliability in small volumes, inadequate level of readiness for flight, and equipment heavy launch mass.

6.2 Human life activity support in space flight

Human life activity support in space flight is provided through the employment of pressurized modules in which an artificial habitation environment is assured throughout flight.

Under space flight conditions, all circulation functions are performed based on special physico-chemical methods for substance regeneration, which are performed by life activity support systems and equipment.

6.3 Human habitation environment during long-term space missions

For this document, the concept of space object habitability is based on human physiological, comfort, safety and hygiene requirements. The task/purpose of life activity support systems/equipment is to provide required physico-chemical environmental parameters, to guarantee amount and quality of consumed products (oxygen, water, food), and to dispose of waste products for the specified time period.

When applying requirements of biologically adequate habitation environment to human life activity support systems and equipment, formation of an appropriate environment is required, which shall be suitable to support current organism life activity, in addition to normal evolution of future generations. Biological adequacy of the habitation environment can be achieved through biological mechanisms similar to natural ecosystems. Only systems with biological links, ensuring a biological circulation of substances, can achieve this. At this moment, only time-limited human habitability is assured, since biogenic components of the habitation environment are not taken into account (native habitation environment components include a great amount of organic substances released by plant and soil organisms (e.g. humans breathe air rather than oxygen). In addition, natural water is a complex multicomponent product.

The task of biologically adequate human habitation environments will be solved at the next stages of space exploration. For this purpose, this document will be updated and amended.

7 Basic provisions

7.1 Concept of three-level structure of standards

Annex A establishes the concept of a three-level structure of standards regarding human-life activity support systems and equipment integration in space flight. This document, in accordance with A.1 and Figure A.1, is a first level standard and applies to:

a) manned space vehicles, spacecraft, habitable compartments of orbital transportation vehicles, on-orbit complexes, space stations with long-term human presence, up to 3 years;

b) unmanned space vehicles designed for operation jointly with space systems in order to control of hygiene and sanitary conditions, as well as toxicological safety; and

c) research and experimental equipment installed in crew compartments, as well as materials, hardware and systems. A permit is necessary to employ these items in crew compartments of space systems, considering sanitation, microbiological and toxicological parameters.

7.2 Validity of general techno-medical requirements

General techno-medical requirements are defined regarding habitation environments for crew compartments within independently functioning space systems, in long-term missions (up to 3 years), considering intermittent human presence.

7.3 Assurance of habitation environment

The space system habitation environment is provided for people whose health status and physical fitness meet relevant medical requirements addressed in documents stating medical examination procedures and fitness validation for human candidates to complete the programme.