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Space engineering - Human factors engineering

Raumfahrttechnik - Technik der Humanfaktoren

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Foreword

This document (EN 16603-10-11:2014) has been prepared by Technical Committee CEN/CLC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-10-11:2014) originates from ECSS-E-ST-10-11C.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2015, and conflicting national standards shall be withdrawn at the latest by January 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document has been developed to cover specifically space systems and has therefore precedence over any EN covering the same scope but with a wider domain of applicability (e.g. : aerospace).

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Introduction

This Standard defines requirements for the integration of the human in the loop for space system products. Thus it provides all requirements to be applied when the presence of the human is planned on-board, or for the nominal or non-nominal interaction of the human with the system, subsystem or equipment to be designed (e.g. a ground based human-computer interface). This Standard identifies requirements for the equipment for implementing a proper manned system that takes into consideration efficiency, effectiveness and wellbeing of the on-board crew, and ground based operators of human-in-the-loop systems. This Standard also identifies the verification methods and related methodologies to be used to confirm compliance to the above mentioned requirements.

This Standard is applicable to both the flight and the ground segment of the space system and refers to the maximum extent possible to already existing HFE non-space domain standards, deviating only when the specific application environment dictates it.

The application of human factors (that in the space domain includes ergonomics) to systems design enhances effectiveness and efficiency, improves human working conditions, and diminishes possible adverse effects of use on human health, safety and performance. Applying ergonomics to the design of systems involves taking account of human capabilities, skills, limitations and needs.

A space system design will consider human factors and especially the two following main aspects from the very beginning of the conceptual phase. Firstly the human being will be correctly taken into account in the design of the hardware, software and operations products and secondly the corresponding organisation and training will be addressed in parallel to the design of the hardware and software.

This standard provides:

- a set of requirements for a human centred design process applied to a space system compatible with the ISO Standard 13407:1999 - Human-centred design processes for interactive systems.

A planned accompanying Handbook will provide:

- a tailoring guide of the existing standard - ISO STD 17399:2003 previously known as NASA STD 3000 “Space systems - Man-systems integration”.

A key issue of the human centred design approach is the involvement of the stakeholders from the beginning and continuously throughout the project. Benefits of a human centred design include increased productivity, enhanced

quality of work, reductions in support and training costs, and improved user satisfaction. This approach aims to help those responsible for managing hardware and software design processes as well as planning for operations to identify and plan effective and timely human-centred design activities. It complements existing design approaches and methods.

NOTE The customer's total cost of ownership will be dramatically reduced if HFE practices are well integrated into all project phases, from the very beginning.

1
Scope

This Standard forms part of the System engineering branch of the Engineering area of the ECSS system. As such it is intended to assist in the consistent application of human factors engineering to space products by specifying normative provisions for methods, data and models to the problem of ensuring crew safety, well being, best performance, and problem avoidance in space system and payload operations.

This Standard ECSS-E-ST-10-11 belongs to the human factors discipline, as identified in ECSS-E-ST-10, and defines the human factors engineering and ergonomics requirements applicable to elements and processes.

This Standard is applicable to all flight and ground segments for the integration of the human in the loop for space system (this includes hardware and software or a combination of the two) products.

When viewed in a specific project context, the requirements defined in this Standard should be tailored to match the genuine requirements of a particular profile and circumstances of a project.

This standard may be tailored for the specific characteristics and constraints of a space project in conformance with ECSS-S-ST-00.

2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system – Glossary of terms
EN 16603-10-06	ECSS-E-ST-10-06	Space engineering – Technical specification
EN 16603-34	ECSS-E-ST-34	Space engineering – Environmental control and life support (ECLS)
EN 16603-70	ECSS-E-ST-70	Space engineering – Ground systems and operations

3 Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply, in particular for the following terms:

operation

procedure

stakeholder

3.2 Terms specific to the present standard

3.2.1 context of use

users, tasks, equipment (hardware, software, operations products), and physical, social and organisational environment in which a product is used

3.2.2 crew

an organised group of users on-board a spacecraft or on a planetary surface mission

3.2.3 crew station

an area or volume where the crew operates

3.2.4 crew systems

hardware, software and operations products used to enable space systems to be safely, efficiently and effectively used by the crew

3.2.5 effectiveness

extent to which planned activities are realized and planned results achieved also considering accuracy and completeness with which users achieve specified goals

3.2.6 efficiency

relationship between the result achieved and the resources used where the human resource is the primary one to be considered

3.2.7 human-machine system

system composed by hardware, software and operations products which include human in the loop

NOTE For example:

- this includes the simple tool up to the complete -International Space Station (ISS), passing through a human-robot system;
- the system can also be multi machine or an organization that interface with a group of people.

3.2.8 human centred design

approach to human-machine system design and development that focuses, beyond the other technical aims, on making systems usable

3.2.9 operation

activities and measures to enable, maintain, or both, the intended use of the system, payload, or both

NOTE For example:

- a group of tasks,
- flight or scientific payloads operations.

3.2.10 operations nomenclature

consistent mission terminology and symbology across all items that the users interact with

3.2.11 procedure

set of instructions available to the users for system and payload execution that describe the specific sequence of operations to be performed by the users to logically, safely, and efficiently accomplish nominal and off nominal tasks during the mission

3.2.12 stakeholder

any entity (individual or organisation) with a legitimate interest in the system

NOTE For example: managers, users, hardware and software developers, HFE practitioners, operations engineers, curriculum developers and training instructors.

3.2.13 synoptic display

display for providing monitoring and command capabilities to users

3.2.14 task

set of activities that are assigned for a particular actor (human or machine) to perform a specific operation

3.2.15 user

human who has a role in the operation of the system

NOTE For example: crew and flight controllers.

3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
CSR	crew station review
DHM	digital human model
HCD	human centred design
HFE	human factors engineering
HMI	human machine interface NOTE: In the context of HFE, MMI (man-machine interface) and HCI (human-computer interaction/interaction) are synonyms to HMI
NBF	neutral buoyancy facility
PF	parabolic flight
TA	task analysis
VE	virtual environment

4 Requirements

4.1 Overview

Requirements defined in this standard are specific to human factors engineering applied to the design and development of human machine systems for space applications. Furthermore this standard defines the high level requirements for these hardware, software and operation products that are specifically required by the presence of the crew on board. They include requirements aimed at reaching the best efficiency and effectiveness of system that foresee the interaction with the human being.

This document is organised in three different parts namely:

- Process requirements: 4.2 to 4.4 clauses are dedicated to process requirements applicable to all space related products – where there are users
- Requirement applicable to flight parts (applicable because are related to the crew and or to other "space related operators"):
  - — 4.5 is dedicated to human characteristics
  - — 4.6 is dedicated to general HFE domain requirements
  - — 4.7 to 4.9 are dedicated to the identified crew related systems (crew system, HMI and operations products).
- Assessment and verification requirements: 4.10 and 4.11 clauses are dedicated to assessments and verifications for related HFE requirements, especially the process requirements mentioned in 4.2 to 4.4.

4.2 Key HFE parameters for human-machine systems

4.2.1 General

4.2.1.1 Characterization

a. The HFE parameters listed in 4.2.1.2 to 4.2.1.6 shall be characterised during design, development and assessment of space projects that includes presence of humans in the loop.