

The ECSS-E-30 Mechanical Engineering Standard

M. Klein

Mechanical Engineering Department, ESA Directorate for Technical and Operational Support, ESTEC, Noordwijk, The Netherlands

Introduction

The disciplines and major topics addressed by the various volumes of ECSS-E-30, produced and issued by the European Cooperation for Space Standardization (ECSS), are:

- thermal control
- structures
- mechanisms
- environmental control and life support
- propulsion
- pyrotechnics
- mechanical parts
- materials.

The ECSS-E-30 standard defines the high-level rules, the overall principles and the requirements to be applied to all mechanical-engineering activities performed for the establishment of requirements and for the definition, development, production, operation, and eventual disposal of mechanical space products. The standard takes into account both the engineering processes and the technical aspects of products in accordance with system-engineering approaches and practices as described in ECSS-E-00 and ECSS-E-10, respectively. It applies to all space-product types defined in ECSS-E-00 (e.g. spacecraft or launchers) and their associated equipment.

The standards define the activities and requirements that are relevant for all areas of mechanical engineering. They also identify the critical points that need to be assessed during the design, development and verification phases, plus their associated requirements. The mechanical-parts standard and the materials standard also define requirements for hardware rather than purely mechanical-engineering activities. This is addressed in terms of requirements for the process of selecting parts (in the case of the mechanical-parts standard) and the requirements for selecting and verifying the use of materials employed in products for space applications (in the case of the materials standard).

Within each of the respective disciplines, the standards define the

scope of the discipline and the terminology for all activities within it. Also defined are the respective topics and activities that need to be considered to ensure proper engineering. The interfaces of the discipline and related activities within them are defined. The other disciplines and interfaces with the domains of management and product assurance are as defined in ECSS-E-00.

Tailoring

Since it cannot be divorced from the customer-supplier and product-type aspects, the ECSS-E-30 standard does not include general rules. Instead, guidelines with respect to technical aspects of tailoring have been identified for the respective engineering disciplines, where deemed possible, and these are included within the discipline standards.

Structure

ECSS-E-30 consists of a coherent set of eight engineering level-2 standards. This reduces the number of standards that need to be considered by industry within Invitations to Tender (ITTs) or projects. The standard was developed from scratch between 1996 and 1998 by a working group of more than 70 people (70% from industry, 30% from agencies) split into eight discipline teams and led by one convenor. This division of responsibilities ensured that the capture and usage of requirements was in a form that was clearly understandable by all parties. It also ensured flexibility with respect to projects and products via tailoring, and guaranteed ECSS compatibility.

The maximum direct benefit of the ECSS-E-30 standard is expected to come from the improved interface between small- and medium-sized enterprises, sub-contractors and their primes, where excessive time to track requirements or differences in understanding of requirements have the greatest detrimental effect.



Table 1. Summary guide to ECSS-E-30

Standard	Title	Information
ECSS-E-30 Part 1	Thermal Control	<ul style="list-style-type: none"> • Set of engineering processes and products that enable temperature variations to be constrained in a specific range. • Thermal-control discipline definitions. • Requirements for thermal activities related to: mission, performance, interface, design, verification, production, integration, in-service activities. • Uncertainty and margin approach. • Analysis approach. • TCS development philosophy.
ECSS-E-30 Part 2	Structural	<ul style="list-style-type: none"> • Set of engineering processes and products that ensure that structures are able to withstand specified loads and meet mission requirements (e.g. stability). • Basic requirements for structures used on space missions, including definition, analysis, development, production, test verification, in-orbit operation and disposal. • Mechanical analysis, design and verification of structures. • Static, dynamic, thermal, acoustic and shock loads. • Fracture control. • Design concepts. • Assembly techniques and alignment.
ECSS-E-30 Part 3	Mechanisms	<ul style="list-style-type: none"> • Basic requirements for mechanisms used on space missions, including definition, analysis, development, production, test verification, in-orbit operation and disposal. • General, thermal and mechanical design. • Lubrication engineering. • Electrical power and control. • Alignment, bias and stability. • Functional performance tests.
ECSS-E-30 Part 4	Environmental Control and Life Support	<ul style="list-style-type: none"> • Set of engineering processes and products to ensure a safe and comfortable environment for manned space missions. • Analysis, design and verification for the provision of safe and comfortable environment for crew and equipment in manned spaceflight. Includes: <ul style="list-style-type: none"> - atmosphere management - water management - food management - waste management.
ECSS-E-30 Part 5	Propulsion	<ul style="list-style-type: none"> • Set of engineering processes and products required to ensure the motion of a spacecraft through thermodynamic means. • Special rules and guidelines applicable for the design and development of propulsion systems, covering interaction between various disciplines (materials, thermal, structure) and practices proven by experience in the field of development and design process. • Launcher and spacecraft aspects are addressed. • Solid-, liquid- and electric-propulsion technologies addressed.
ECSS-E-30 Part 6	Pyrotechnics	<ul style="list-style-type: none"> • Set of engineering processes and products developed for the use of energy released by explosive substances and its conversion into useful mechanical work. • Subsystem definition. • Component definition. • Technical and product-assurance requirements for design, procurement, integration and verification at component and subsystem levels.
ECSS-E-30 Part 7	Mechanical Parts	<ul style="list-style-type: none"> • Characterisation, selection, procurement, verification and control of mechanical parts considering the environments experienced during their application life in space products. • Basic requirements for the selection of mechanical parts to be used for space missions. • This applies to any type of mechanical part, such as: <ul style="list-style-type: none"> - assembly parts: bolts, washers, inserts, rivets and spacers - thermal parts: heaters and thermocouples - bearing parts - separation parts: springs, cutters.
ECSS-E-30 Part 8	Materials	<ul style="list-style-type: none"> • Characterisation, selection, procurement, verification and control of materials considering the environments experienced during their application life in space products. • Basic requirements for the establishment of mechanical and physical properties of materials to be used for space missions. • Includes: <ul style="list-style-type: none"> - mechanical and physical requirements - environmental constraints - manned environment - interface requirements (coatings/layers, joining) - material design allowables (metals/composites) - composite sandwich constructions - ceramic matrix composites - polymers (thermosets/thermoplastics) - mechanical and physical test methods - non-destructive inspection - procurement, production, verification - maintenance, inspection, repair.