International Standard

ISO 10786

Space systems — Structural components and assemblies

Systèmes spatiaux — Composants et assemblages de structure

Second edition
2025-09

Reference number
ISO 10786:2025(en)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 10786:2011), which has been technically revised.

The main changes are as follows:

— clarification of the Scope;

— updates of the normative references and their citations in the text;

— updates of the terms and definitions to harmonize with the other ISO structural related standards.

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.

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Introduction

Structures are the backbones of all spaceflight systems. A structural failure can cause the loss of human lives for crewed space systems or can jeopardize the intended mission for uncrewed space systems.

The purpose of this document is to establish general requirements for structures in all space flight systems. It provides the uniform requirements necessary to minimize the duplication of effort and the differences between approaches taken by the participating nations and their commercial space communities in developing structures. In addition, the use of agreed-upon standards can facilitate cooperation and communication among space programmes.

This document, when implemented for a particular space system, ensures high confidence in achieving safe and reliable operation in all phases of its planned mission.

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Space systems — Structural components and assemblies

1 Scope

This document establishes requirements for the design, material selection and characterization, fabrication, testing and inspection of all structural items in space systems, including expendable and reusable launch vehicles, satellites and their payloads.

This document applies to all structural items, including fracture-critical hardware used in space systems during all phases of the mission, with the following exceptions: adaptive structures, propulsion systems, nuclear systems, and thermal protection systems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14623, *Space systems - Pressure vessels and pressurized structures — Design and operation*

ISO 15864, *Space systems — General test methods for spacecraft, subsystems and units*

ISO 16126, *Space systems — Survivability of unmanned spacecraft against space debris and meteoroid impacts for the purpose of space debris mitigation*

ISO 16454, *Space systems — Structural design — Stress analysis requirements*

ISO 21347, *Space systems — Fracture and damage control*

ISO 21648, *Space systems — Flywheel module design and testing*

ISO 24113, *Space systems — Space debris mitigation requirements*

ISO 24638, *Space systems — Pressure components and pressure system integration*

ISO 24917, *Space systems — General test requirements for launch vehicles*

3 Terms and definitions

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

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

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

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

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3.1
A-basis allowable
A-basis design allowable
A-value
mechanical strength value above which at least 99 % of the population of values is expected to fall, with a *confidence level* (3.13) of 95 %

[SOURCE: ISO 14623:2003, 2.1, modified — The admitted terms "A-basis design allowable" and "A-value" have been added.]

3.2
acceptance test
required formal *test* (3.77) conducted on flight hardware to ascertain that the *materials* (3.39), *manufacturing processes* (3.36), and workmanship meet specifications and that the hardware is acceptable for intended usage

[SOURCE: ISO 14623:2003, 2.2, modified — The term and definition have been changed from plural to singular forms.]

3.3
adaptive structure
autonomous structural system which incorporates sensors, processors, and actuators to enable adaptation to changing environmental conditions, thereby enhancing safety, stability, vibration damping, acoustic noise suppression, aerodynamic performance and optimization, pointing accuracy, load redistribution, damage response, structural integrity, etc.

3.4
allowable load
maximum load that can be accommodated by a *material* (3.39)/*structure* (3.75) or a component of a structural *assembly* (3.5) without potential rupture, *collapse* (3.9), or *detrimental deformation* (3.19) in a given environment

Note 1 to entry: Commonly, “allowable load” is the load which correspond to the statistically based *ultimate strength* (3.80), *buckling* (3.7) strength, and *yield strength* (3.86), or strength defined by maximum strain (for ductile materials).

Note 2 to entry: "Allowable stress", or "allowable strain" are similar definition of "allowable load”, which are defined for potential rupture, collapse, or detrimental deformation, by using other physical properties such as "stress" or "strain" respectively, instead of "load".

3.5
assembly
combination of parts, components and units that form a functional entity

[SOURCE: ISO 10795:2019, 3.23]

3.6
B-basis allowable
B-basis design allowable
B-value
mechanical strength value above which at least 90 % of the population of values is expected to fall, with a *confidence level* (3.13) of 95 %

Note 1 to entry: See also *A-basis allowable* (3.1).

[SOURCE: ISO 21648:2008, 2.1.4, modified — The admitted terms "B-basis design allowable" and "B-value" have been added.]

3.7
buckling
failure mode (3.22) in which an infinitesimal increase in the load can lead to sudden *collapse* (3.9) or *detrimental deformation* (3.19) of a *structure* (3.75)

EXAMPLE Snapping of slender beams, columns, struts and thin-wall shells.

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3.8
catastrophic failure
failure which results in the loss of human life, mission or a major ground facility, or long-term detrimental environmental effects

3.9
collapse
failure mode (3.22) induced by *quasi-static loads* (3.58) (compression, shear or combined stress) accompanied by irreversible loss of load-carrying capability

3.10
composite material
combination of *materials* (3.39) different in composition or form on a macro scale

Note 1 to entry: The constituents retain their identities in the composite.

Note 2 to entry: The constituents can normally be physically identified; and there is an interface between them.

Note 3 to entry: Composites include:

— fibrous (composed of fibres, usually in a matrix),

— laminar (layers of materials), and

— hybrid (combination of fibrous and laminar).

[SOURCE: ISO 16454:2024, 3.6, modified— Note 3 to entry has been added.]

3.11
composite overwrapped pressure vessel
COPV
pressure vessel (3.46) with a fibre-based composite system fully or partially encapsulating a liner

Note 1 to entry: The liner serves as a liquid or gas permeation barrier and may or may not carry substantial pressure loads. The composite overwraps generally carry pressure and environmental loads.

3.12
composite structure
structural components (3.71) that are made of *composite materials* (3.10)

3.13
confidence level
value $(1 - \alpha)$ of the probability associated with a confidence interval or a statistical coverage interval

Note 1 to entry: The confidence level, i.e. $(1 - \alpha)$, is often expressed as a percentage.

Note 2 to entry: In some cases, the confidence level is dictated by the needs of the situation. In all other instances, use of $(1 - \alpha) = 0{,}95$ is recommended.

3.14
damage tolerance
ability of a *structure* (3.75) or a component of a structural *assembly* (3.5) to resist failure due to the presence of *flaws* (3.25) for a specified period of unrepaired usage

[SOURCE: ISO 24638:2021, 3.5, modified — The wording “a material/structure” has been replaced by “a structure or a component of a structural assembly”.]

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3.15
damage tolerance life
safe life
<methodologies> design criterion under which failure due to the presence of *flaws* (3.25) does not occur in the expected environment during the *service life* (3.65)

Note 1 to entry: In this design criterion, a flaw is assumed consistent with the *inspection* (3.31) process specified and it is shown that the largest undetected flaw that can exist in the *structure* (3.75) will not grow to failure in durations multiplying *life factors* (3.32) to service lifetimes when subjected to the cyclic and sustained loads in the environments encountered.

3.16
damage tolerance life
safe life
<time span> required period during which a *structural item* (3.73), even containing the largest undetected *flaw* (3.25), is shown by analysis or testing not to fail catastrophically under the expected service load and environment

3.17
design parameter
physical feature which influences the design performance of the design of *structural items* (3.73)

Note 1 to entry: According to the nature of the design variables, different design problems can be identified such as:

— structural sizing for the dimensioning of beams, shells, etc.;

— shape optimization;

— *material* (3.39) selection;

— structural topology.

3.18
design safety factor
safety factor
design factor of safety
factor of safety
multiplying factor to be applied to *limit loads* (3.33) and/or *maximum expected operating pressure (MEOP)* (3.41)

Note 1 to entry: The factor is defined in order to account for the statistical variations of loads and structural strength, and inaccuracies in the knowledge of their statistical distributions.

Note 2 to entry: In this definition, the term, maximum expected operating pressure (MEOP), may be replaced by *maximum design pressure (MDP)* (3.40).

[SOURCE: ISO 24638:2021, 3.8, modified — The wording “or maximum design pressure (MDP)“ has been deleted from the definition; notes 1 and 2 to entry have been added.]

3.19
detrimental deformation
structural deformation, deflection or displacement that prevents any portion of the *structure* (3.75) or some other system from performing its intended function or that jeopardizes mission success

[SOURCE: ISO 24638:2021, 3.9]

3.20
development test
test (3.77) to provide information that can be used to check the validity of analytic techniques and assumed *design parameters* (3.17), to uncover unexpected system response characteristics, to evaluate design changes, to determine interface compatibility, to prove *qualification* (3.56) and acceptance procedures and techniques, to check manufacturing technology, or to establish accept/reject criteria

[SOURCE: ISO 14623: 2003, 2.20, modified — "may" has been replaced by "can".]

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3.21
dynamic load
time-dependent load with deterministic or stochastic variation

3.22
failure mode
manner in which failure occurs

Note 1 to entry: A failure mode may be defined by the function lost or other state transition that occurred.

Note 2 to entry: Structural failure modes include: rupture, *collapse* (3.9), *detrimental deformation* (3.19), excessive wear or any other phenomenon resulting in an inability to sustain loads, pressures and corresponding environments, or that jeopardizes mission success.

[SOURCE: IEC 60050-192:2015, 192-03-17, modified — Note 2 to entry has been added.]

3.23
fail-safe structure
structural item (3.73) for which it can be shown by analysis or *test* (3.77) that, as a result of structural redundancy, the *structure* (3.75) remaining after the failure of any element of the structural item can sustain the redistributed *limit loads* (3.33) with an ultimate *design safety factor* (3.18) of 1,0

Note 1 to entry: For this entry, it is possible to verify that the structural item can withstand the fatigue induced by cyclic loads for all the mission life for multi-mission applications, without *damage tolerance life* (3.16) *verification* (3.82).

[SOURCE: ISO 21347:2005, 3.10, modified – The term "safety factor" has been replaced by "design safety factor"; note 1 to entry has been restated.]

3.24
fatigue life
number of cycles of stress or strain of a specified character that a given *structure* (3.75) or component of a structural *assembly* (3.5) can sustain [without the presence of *flaw* (3.25)] before failure of a specified nature can occur

3.25
flaw
local discontinuity in a structural *material* (3.39)

EXAMPLE Crack, cut, scratch, void, delamination disbond, impact damage and other kinds of mechanical damage.

3.26
fracture control
application of design philosophy, analysis methods, manufacturing technology, *verification* (3.82) methodology, quality assurance, including non-destructive evaluation (NDE) and operating procedures to prevent premature structural failure caused by the presence and/or propagation of *flaws* (3.25) during fabrication, testing, transportation, handling and service events such as launch, in-orbit operation and return

3.27
fracture-critical item
fracture-critical part
structural part whose failure due to the presence of a *flaw* (3.25) would result in a catastrophic hazard

3.28
full-scale article
full-size *test* (3.77) article which represents the whole flight *structure* (3.75) or a part of the flight structure with representative loading and boundary conditions

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3.29
hydrogen embrittlement
reduction in the ductility or mechanical properties such as strength, toughness of a metal resulting from the absorption of hydrogen into a metal

Note 1 to entry: Mechanical environmental failure due to the hydrogen embrittlement usually occurs in combination with residual or applied tensile stresses.

3.30
human vibration
vibration transmitted to and/or induced by the crew members

3.31
inspection
determination of conformity to specified requirements

Note 1 to entry: If the result of an inspection shows conformity, it can be used for purposes of *verification* (3.82).

Note 2 to entry: The result of an inspection can show conformity or nonconformity or a degree of conformity.

[SOURCE: ISO 9000:2015, 3.11.7]

3.32
life factor
factor by which the *service life* (3.65) is multiplied to obtain total *fatigue life* (3.24) or *damage tolerance life* (3.16)

Note 1 to entry: Life factor is often referred to as a *scatter factor* (3.63) that is normally used to account for the scatter of a *material's* (3.39) fatigue or crack growth rate data.

Note 2 to entry: It can also account for the dispersion of loading spectra parameters and other uncertainties, when appropriate.

[SOURCE: ISO 21648:2008, 2.1.24, modified —Note 1 to entry has been separated to note 1 to entry and note 2 to entry.]

3.33
limit load
design limit load
maximum load, or combination of loads, which a *structure* (3.75) or a component in a structural *assembly* (3.5) is expected to experience during its *service life* (3.65) in association with the applicable operating environments

Note 1 to entry: Load is a generic term for thermal load, pressure, external mechanical load (force, moment, or enforced displacement) or internal mechanical load [*residual stress* (3.61), pretension, or inertial load].

Note 2 to entry: The corresponding stress or strain is called limit stress or limit strain.

[SOURCE: ISO 24638:2021, 3.13, modified— "maximum expected load" has been replaced by "maximum load".]

3.34
loading case
combined loading case
particular condition of single (or combined) mechanical load, pressure and temperature that can occur for some *structural components* (3.71) or a structural *assembly* (3.5) (at the same time) during their *service life* (3.65)

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3.35
loading spectrum
load spectrum
loads spectrum
representation of the cumulative loading levels and associated cycles anticipated for the *structure* (3.75) or component of a structural *assembly* (3.5) according to its *service life* (3.65) under all expected operating environments

Note 1 to entry: Significant transportation, *test* (3.77), and handling loads are included in this definition.

Note 2 to entry: Also referred as "service life spectrum" or "load history".

[SOURCE: ISO 24638:2021, 3.15, modified— The admitted terms "load spectrum" and "loads spectrum" have been added; note 2 to entry has been added.]

3.36
manufacturing process
set of interrelated or interacting activities or operations performed upon *material* (3.39) to convert it from the raw material or a semi-finished state to a state of further completion

[SOURCE: ISO 15531-1:2004, 3.6.25, modified — The wording "structured set of activities or operations" has been replaced by "set of interrelated or interacting activities or operations"; note 1 to entry has been deleted.]

3.37
margin of safety
MS
parameter to express the margin of structural load carrying capability for the loads derived from multiplying the *design safety factor* (3.18) to *loading cases* (3.34) defined as *limit loads* (3.33)

Note 1 to entry: For a single loading condition, MS is expressed for both yield and ultimate criteria as follows:

$$M_{s,i} = \frac{L_{\text{allow},i}}{S_{F,i} \times L_{\text{limit}}} - 1$$

where

$M_{s,i}$ is the margin of safety for the criteria i (yield or ultimate);

$L_{\text{allow},i}$ is the *allowable load* (3.4) for the criteria i (yield or ultimate);

$S_{F,i}$ is the design safety factor for the criteria i (yield or ultimate);

L_{limit} is the limit load.

Note 2 to entry: Load can mean force, stress or strain, if the load-stress relationship is linear.

Note 3 to entry: The relation also can be expressed for a combined loading case, when the load-stress relationship remains linear for all the contributors of the loading case. Also see alternative methods in Annex D.

3.38
mass and inertia properties
set of parameters that express the properties concerning mass and inertia

Note 1 to entry: Mass and inertia properties of a *structure* (3.75) comprise its mass, the location of its centre of gravity, its moments and products of inertia and, where applicable, its balancing masses.

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3.39
material
raw, semi-finished or finished purchased item (gaseous, liquid, solid) of given characteristics from which processing into a functional element of the product is undertaken

[SOURCE: ISO 10795:2019, 3.148]

3.40
maximum design pressure
MDP
highest pressure, as defined by maximum relief pressure, maximum regulator pressure and/or maximum temperature, including transient pressures, at which a *pressurized hardware* (3.48) item retains two-fault tolerance without failure

[SOURCE: ISO 24638:2021, 3.16]

3.41
maximum expected operating pressure
MEOP
maximum allowed working pressure
MAWP
maximum operating pressure
MOP
highest differential pressure which a *pressurized hardware* (3.48) item is expected to experience during its *service life* (3.65) and retain its functionality, in association with its applicable operating environments

Note 1 to entry: MEOP includes the effects of temperature, transient peaks, relief pressures, regulator pressure, vehicle acceleration, phase changes, transient pressure excursions, and relief valve tolerance.

Note 2 to entry: Some projects may replace MEOP by *maximum design pressure (MDP)* (3.40), which takes into account more conservative conditions.

Note 3 to entry: The terms MAWP and MOP are used when required to replace the term MEOP in a specific application.

[SOURCE: ISO 24638:2021, 3.17]

3.42
metallic structural item
structural item (3.73) made of metals

Note 1 to entry: In this document, load bearing metallic liners of COPVs are also referred to as metallic structural items.

3.43
moving mechanical assembly
MMA
device that controls the movement of a deployable or other movable system of a spacecraft or launch vehicle

Note 1 to entry: Moving mechanical assemblies include, but are not limited to, deployment mechanisms, sensor mechanisms, pointing mechanisms, drive mechanisms, de-spin mechanisms, separation mechanisms, momentum and reaction wheels, control-moment gyros, gimbals, switches, valves, and other mechanisms required to perform specific functions.

3.44
POGO
instability due to the coupling between the launch vehicle axial motion and the dynamic response characteristic of the propulsion system

Note 1 to entry: The coupling between the dynamic behaviour of the launch vehicle *structure* (3.75) and a fluctuating thrust, results in a fluctuation of the mass flow rate at the engine inlet.

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3.45
pressure component
component in a pressure system, other than a *pressure vessel* (3.46), or *pressurized structure* (3.49) that is designed largely by the internal pressure

EXAMPLE Lines, fittings, pressure gauges, valves, bellows and hoses.

[SOURCE: ISO 24638:2021, 3.18]

3.46
pressure vessel
container designed primarily for the storage of pressurized fluids, which either contains gas/liquid with high energy level, or contains gas/liquid that will create a mishap (accident) if released, or contains gas/liquid with high pressure level

Note 1 to entry: This definition excludes *pressurized structures* (3.49) and *pressure components* (3.45).

Note 2 to entry: Energy and pressure levels are defined by each project and approved by the procuring authority (customer). If appropriate values are not defined by the project, the following levels are used:

— stored energy is at least 19 310 J, based on adiabatic expansion of perfect gas;

— *MEOP* (3.41) is at least 0,69 MPa.

[SOURCE: ISO 24638:2021, 3.19]

3.47
pressurized equipment
special pressurized equipment
piece of equipment that meets the *pressure vessel* (3.46) definition, but for which it is not feasible or cost effective to comply with the requirements applicable to pressure vessels

EXAMPLE Batteries, heat pipes, cryostats and sealed containers.

3.48
pressurized hardware
hardware items that contain primarily internal pressure

Note 1 to entry: Pressurized hardware includes *pressure vessels* (3.46), *pressurized structures* (3.49), *pressure components* (3.45) and *pressurized equipment* (3.47).

[SOURCE: ISO 14623:2003, 2.47, modified— Note 1 to entry has been updated.]

3.49
pressurized structure
structure (3.75) designed to carry both internal pressure and vehicle structural loads

EXAMPLE Main propellant tanks and solid rocket motor cases of launch vehicles, and crew cabins of space modules.

3.50
primary structure
part of a *structure* (3.75) that carries the main flight loads and defines the overall *stiffness* (3.68) of the structure influencing its natural frequencies and mode shapes

3.51
proof factor
multiplying factor applied to the *limit load* (3.33) or *maximum expected operating pressure (MEOP)* (3.41) or *maximum design pressure (MDP)* (3.40) to obtain proof load or proof pressure for use in the *acceptance test* (3.2)

[SOURCE: ISO 24638:2021, 3.22, modified — The full forms of MEOP and MDP have been added; the wording “acceptance testing” has been replaced by “acceptance test”.]

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3.52
protoflight hardware
protoflight model
hardware that is qualified using a protoflight *verification* (3.82) approach

3.53
protoflight test
test (3.77) performed on flight or flight-like hardware [i.e. is built with same drawings, *materials* (3.39) and processes as the flight unit] to demonstrate that the design meets structural integrity requirements

Note 1 to entry: Protoflight tests combine elements of *prototype test* (3.55) programmes and *acceptance test* (3.2) programmes.

Note 2 to entry: The test is performed at loads or pressure in excess of *limit load* (3.33) or *maximum design pressure* (3.40) but below the *yield strength* (3.86) of the *structure* (3.75). When performed on flight structure, the test also verifies the workmanship and material quality of the flight build.

3.54
prototype hardware
prototype model
proto model
hardware of a new design that is produced from the same drawings and using the same *materials* (3.39), tooling, *manufacturing processes* (3.36), *inspection* (3.31) methods, and personnel competency levels as will be used for the flight hardware

Note 1 to entry: Prototype hardware is dedicated *test* (3.77) hardware that is not intended to be used as a flight unit.

3.55
prototype test
test (3.77) conducted using *prototype hardware* (3.54) to demonstrate that all structural integrity requirements have been met

Note 1 to entry: The prototype test is performed at load levels sufficient to demonstrate that the test article will not fail at ultimate design loads.

3.56
qualification
act or conduct by the supplier to provide evidences to prove that design and manufacturing [including *manufacturing process* (3.36)] of hardware/software is adequate to fulfil all requirements under required environment conditions

Note 1 to entry: This may be implemented by analysis, *test* (3.77), *inspection* (3.31), or demonstration.

[SOURCE: ISO 10795:2019, 3.183]

3.57
qualification test
required formal contractual *test* (3.77) conducted to demonstrate that the design, manufacturing, and *assembly* (3.5) have resulted in hardware conforming to specification requirements

Note 1 to entry: Qualification tests are conducted on a flight-quality article at load levels and durations sufficient to demonstrate that all design requirements have been met under the specified environmental conditions. Both *protoflight test* (3.53) and *prototype test* (3.55) are considered qualification tests.

Note 2 to entry: The qualification test may also validate the planned acceptance programme including test techniques, procedures, equipment, instrumentation, and software.

[SOURCE: ISO 14623:2003, 2.52, modified — The term has been changed from “qualification tests” to “qualification test”; the wording “used” has been replaced by “conducted”; note 1 to entry and note 2 to entry have been added.]

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3.58
quasi-static load
load with magnitude and direction that are independent of time; includes that varies slowly and in which dynamic response of the *structure* (3.75) is insignificant

Note 1 to entry: This load can be induced by steady wind, aerodynamic forces and thrust (constant or wind slow variations), manoeuvres and spin stabilization.

Note 2 to entry: Quasi-static loads comprise both *static loads* (3.67) and *dynamic loads* (3.21) and are applied at a frequency sufficiently below the natural frequency of the considered part, thus being equivalent to static loads in their effects on the structure.

[SOURCE: ISO 15864:2021, 3.1.9, modified — Note 2 to entry has been added.]

3.59
random load
vibrating load or fluctuating load whose instantaneous magnitudes are specified only by probability distribution functions giving the probable fraction of the total time that the instantaneous magnitude lies within a specified range

Note 1 to entry: A random load contains non-periodic or quasi-periodic constituents.

3.60
residual strength
maximum value of load and/or pressure (stress) that a flawed or damaged *structural item* (3.73) is capable of sustaining without further damage or *collapse* (3.9), considering appropriate environmental conditions

3.61
residual stress
stress that remains in a *structure* (3.75) after processing, fabrication, *assembly* (3.5), testing or operation

EXAMPLE Welding-induced residual stress.

[SOURCE: ISO 14623:2003, 2.54]

3.62
S-basis allowable
mechanical strength value specified as a minimum by the governing industrial specification, or a particular contractor's specification

EXAMPLE Properties given in MMPDS (Metallic Materials Properties Development and Standardization)[17].

3.63
scatter factor
multiplying factor to be applied to the number of load/pressure cycles defined as *service life* (3.65) when performing fatigue and/or crack growth analysis, for the purpose of covering the scatters that potentially exist in the *material's* (3.39) fatigue or crack growth data

Note 1 to entry: Scatter factor is sometimes referred to as *life factor* (3.32), which is usually used for just the difference in material data used in the analysis; for example, S-N data used in *fatigue life* (3.24) analysis, or da/dN data used in crack grow analysis.

[SOURCE: ISO 24638:2021, 3.24, modified — The wording "multiplying factor to be applied to the number of load/pressure cycles, for the purpose of covering the scatters that potentially exist in the material's fatigue or crack growth data" has been restated as shown ; note 1 to entry has been added.]

3.64
secondary structure
structure (3.75) attached to the *primary structure* (3.50) with negligible participation in the main load transfer and overall *stiffness* (3.68)

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3.65
service life
period of time (or number of cycles) that starts with item *inspection* (3.31) after manufacturing and continues through all testing, handling storage, transportation, launch operations, orbital operations, refurbishment, retesting, re-entry or recovery from orbit, and reuse that can be required or specified for the item

[SOURCE: ISO 24638:2021, 3.25, modified — The wording "(or cycles)" has been replaced by "(or number of cycles)".]

3.66
shock load
special type of *transient load* (3.78), where the load shows significant peaks and the duration of the load is well below the typical response time of the *structure* (3.75)

Note 1 to entry: This load can be induced by:

— shockwave phenomena;

— pyrotechnic systems;

— physical impacts by deployed appendages;

— explosions.

3.67
static load
load having unchanging magnitude, direction, and point or points of application

3.68
stiffness
ratio between an applied force and the resulting displacement

3.69
stress-corrosion cracking
mechanically and environmentally induced failure process in which sustained tensile stress and chemical attack combine to initiate and propagate a crack or a crack-like *flaw* (3.25) in a metal part

[SOURCE: ISO 21347:2005, 3.36]

3.70
stress-rupture life
minimum time during which a non-metallic *structural item* (3.73) maintains structural integrity, considering the combined effects of stress level(s), time at stress level(s) and associated environments

3.71
structural component
mechanical part(s) in a functional hardware item designed to sustain load and/or pressure or maintain alignment

EXAMPLE Antenna support *structure* (3.75), instrument housing, and *pressure vessel* (3.46).

3.72
structural design
process used to determine geometries or dimensions and to select *materials* (3.39) of a *structure* (3.75)

3.73
structural item
hardware item which is designed to sustain load and/or pressure or maintain alignment

EXAMPLE Spacecraft trusses, launch vehicle fairings, *pressure vessels* (3.46) and *pressurized structures* (3.49); also fasteners, instrument housing and support brackets.

Note 1 to entry: Structural items include: *structure* (3.75), structural subsystem [*assembly* (3.5)], and *structural component* (3.71).

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[SOURCE: ISO 21347:2005, 3.37, modified — Note 1 to entry has been added.]

3.74
structural mathematical model
analytical or numerical representation of a *structure* (3.75)

Note 1 to entry: The model provides an adequate description of the structure's response under loads, pressures or temperatures, in accordance with the purpose of the structural analysis and requirements to the structural math model fidelity.

3.75
structure
structural assembly
set of mechanical components or *assemblies* (3.5) designed to sustain (carry) internal and/or external loads or pressures; provide (maintain) *stiffness* (3.68), alignment, and/or stability; and provide support or containment for other systems or subsystems

Note 1 to entry: The space vehicle structure is usually categorized into *primary* (3.50) and *secondary structures* (3.64).

3.76
system threat analysis energy level
maximum expected energy level due to an impact resulting from a credible threat event determined in a system threat analysis

3.77
test
<space system> formal process of evaluating the performance of a system or item by manual or automatic means to identify differences among specified, expected, and actual results

[SOURCE: ISO 10795:2019, 3.239]

3.78
transient load
load whose magnitude or direction varies with time and for which the dynamic response of the *structure* (3.75) is significant

Note 1 to entry: These loads can be induced by transportation, gusts, engine ignition or shutdown, separation, orbital docking, physical impact, or deployment of appendages.

3.79
ultimate load
UL
maximum design load that the *structure* (3.75) is expected to withstand without rupture or *collapse* (3.9), which is expressed as a *limit load* (3.33) multiplied by an ultimate *design safety factor* (3.18)

Note 1 to entry: The corresponding stress and/or strain is called ultimate stress and/or strain.

3.80
ultimate strength
maximum load or stress that a *structure* (3.75) or *material* (3.39) can withstand without incurring rupture or *collapse* (3.9)

3.81
validation
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

Note 1 to entry: The objective evidence needed for a validation is the result of a *test* (3.77) or other form of determination such as performing alternative calculations or reviewing documents.

Note 2 to entry: The word “validated” is used to designate the corresponding status.

Note 3 to entry: The use conditions for validation can be real or simulated.

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[SOURCE: ISO 9000:2015, 3.8.13]

3.82
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

Note 1 to entry: The objective evidence needed for a verification can be the result of an *inspection* (3.31) or of other forms of determination such as performing alternative calculations or reviewing documents.

Note 2 to entry: The activities carried out for verification are sometimes called a *qualification* (3.56) process.

Note 3 to entry: The word "verified" is used to designate the corresponding status.

[SOURCE: ISO 9000:2015, 3.8.12]

3.83
vibroacoustic
environment induced by high-intensity acoustic noise associated with various segments of the flight profile

Note 1 to entry: It manifests itself throughout the *structure* (3.75) in the form of transmitted acoustic excitation and as structure-borne random vibration.

3.84
visual damage threshold
VDT
impact energy level shown by *test(s)* (3.77) to create an indication that is barely detectable by a trained inspector using an unaided visual *inspection* (3.31) technique

3.85
yield load
YL
maximum design load that the *structure* (3.75) is expected to withstand without *detrimental deformation* (3.19), which is expressed as a *limit load* (3.33) multiplied by a yield *design safety factor* (3.18)

Note 1 to entry: The corresponding stress and/or strain is called yield stress and/or strain.

3.86
yield strength
maximum load or stress that a *structure* (3.75) or *material* (3.39) can withstand without incurring a specified permanent deformation or yield

Note 1 to entry: The yield is usually determined by measuring the departure of the actual stress-strain diagram from an extension of the initial straight proportion. The specified value is often taken as an offset unit strain of 0,002.

4 Symbols and abbreviated terms

ε - N	fatigue strain-life data
$\sum n/N$	Miner's rule
AOCS	attitude and orbit control system
BIT	built-in testing
CAD	computer aided design
CAE	computer aided engineering
CAM	computer aided manufacturing
da/dN	fatigue crack growth rate

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