



## SLOVENSKI STANDARD

**SIST EN 16603-32:2014**

**01-november-2014**

**Nadomešča:**

**SIST EN 14607-2:2005**

---

**Vesoljska tehnika - Konstrukcija, splošne zahteve**

Space engineering - Structural general requirements

Raumfahrttechnik - Strukturen, allgemeine Anforderungen

**iTeh STANDARD PREVIEW**

Ingénierie spatiale - Structure, exigences générales

**(standards.iteh.ai)**

**Ta slovenski standard je istoveten s:EN 16603-32:2014**

[https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4bf8-875fd94b24e39e9c/sist\\_en\\_16603\\_32\\_2014](https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4bf8-875fd94b24e39e9c/sist_en_16603_32_2014)

---

**ICS:**

49.140

Vesoljski sistemi in operacije Space systems and operations

**SIST EN 16603-32:2014**

**en,fr,de**

**iTeh STANDARD PREVIEW  
(standards.iteh.ai)**

SIST EN 16603-32:2014

<https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-d94b24c39c9e/sist-en-16603-32-2014>

EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**EN 16603-32**

August 2014

ICS 49.140

Supersedes EN 14607-2:2004

English version

## Space engineering - Structural general requirements

Ingénierie spatiale - Structure, exigences générales

Raumfahrttechnik - Strukturen, allgemeine Anforderungen

This European Standard was approved by CEN on 1 March 2014.

CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN and CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN and CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN and CENELEC members are the national standards bodies and national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

(Standard at [standards.iteh.ai](https://standards.iteh.ai))

[SIST EN 16603-32:2014](https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-d94b24c39c9e/sist-en-16603-32-2014)

<https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-d94b24c39c9e/sist-en-16603-32-2014>



CEN-CENELEC Management Centre:  
Avenue Marnix 17, B-1000 Brussels

## Table of contents

---

<b>Foreword .....</b>	<b>9</b>
<b>1 Scope.....</b>	<b>10</b>
<b>2 Normative references.....</b>	<b>11</b>
<b>3 Terms, definitions and abbreviated terms.....</b>	<b>12</b>
3.1 Terms from other standards.....	12
3.2 Terms specific to the present standard .....	12
3.3 Abbreviated terms.....	18
<b>4 Requirements.....</b>	<b>20</b>
4.1 Overview .....	20
4.2 Mission .....	20
4.2.1 Lifetime .....	20
4.2.2 Natural and induced environment.....	21
<a href="https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-d94024c39c9/sist-en-16603-32-2014">https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-d94024c39c9/sist-en-16603-32-2014</a>	
4.2.3 Mechanical environment.....	21
4.2.4 Microgravity, audible noise and human induced vibration.....	22
4.2.5 Load events .....	22
4.2.6 Combined loads .....	23
4.2.7 Limit loads.....	24
4.2.8 Design limit loads .....	24
4.3 Functionality .....	24
4.3.1 Overview.....	24
4.3.2 Strength .....	24
4.3.3 Local yielding .....	25
4.3.4 Buckling .....	25
4.3.5 Stiffness .....	25
4.3.6 Dynamic behaviour .....	25
4.3.7 Thermal.....	25
4.3.8 Damage tolerance.....	26
4.3.9 Tolerances and alignments .....	26
4.3.10 Electrical conductivity.....	26

4.3.11	Lightning protection.....	26
4.3.12	Electromagnetic compatibility.....	26
4.3.13	Dimensional stability .....	27
4.4	Interface .....	27
4.5	Design .....	28
4.5.1	Inspectability .....	28
4.5.2	Interchangeability.....	28
4.5.3	Maintainability .....	28
4.5.4	Dismountability.....	29
4.5.5	Mass and inertia properties.....	29
4.5.6	Material selection .....	30
4.5.7	Mechanical parts selection .....	30
4.5.8	Material design allowables .....	30
4.5.9	Metals .....	31
4.5.10	Non-metallic materials.....	32
4.5.11	Composite materials .....	32
4.5.12	Adhesive materials in bonded joints.....	33
4.5.13	Ablation and pyrolysis .....	33
4.5.14	Micrometeoroid and debris collision .....	33
4.5.15	Venting.....	33
4.5.16	<a href="https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-d94624c39c9/sist-en-16603-32-2014">Margin of safety (MOS).....</a>	34
4.5.17	Factors of safety (FOS).....	34
4.5.18	Scatter factors.....	35
4.6	Verification.....	35
4.6.1	Overview.....	35
4.6.2	Verification by analysis.....	36
4.6.3	Verification by test.....	41
4.6.4	Verification of composite structures.....	46
4.7	Production and manufacturing .....	47
4.7.1	General.....	47
4.7.2	Manufacturing process.....	47
4.7.3	Manufacturing drawings .....	47
4.7.4	Tooling .....	47
4.7.5	Assembly .....	48
4.7.6	Storage .....	48
4.7.7	Cleanliness .....	49
4.7.8	Health and safety .....	49

**EN 16603-32:2014 (E)**

4.8	In-service .....	49
4.8.1	Ground inspection .....	49
4.8.2	In-orbit inspection .....	49
4.8.3	Evaluation of damage .....	50
4.8.4	Maintenance .....	50
4.8.5	Repair .....	51
4.9	Data exchange .....	52
4.9.1	General .....	52
4.9.2	System configuration data .....	53
4.9.3	Data exchange between design and structural analysis .....	53
4.9.4	Data exchange between structural design and manufacturing .....	53
4.9.5	Data exchange with other subsystems .....	53
4.9.6	Tests and structural analysis .....	54
4.9.7	Structural mathematical models .....	54
4.9.8	Data traceability .....	54
4.10	Deliverables .....	54
<b>Annex A (normative) Computer aided design model description and delivery (CADMDD) - DRD .....</b>		<b>56</b>
A.1	DRD identification .....	56
A.1.1	Requirement identification and source document .....	56
A.1.2	Purpose and objective .....	56
A.2	Expected response .....	56
A.2.1	Scope and content .....	56
A.2.2	Special remarks .....	61
<b>Annex B (normative) Design loads (DL) - DRD .....</b>		<b>62</b>
B.1	DRD identification .....	62
B.1.1	Requirement identification and source document .....	62
B.1.2	Purpose and objective .....	62
B.2	Expected response .....	62
B.2.1	Scope and content .....	62
B.2.2	Special remarks .....	65
<b>Annex C (normative) Dimensional stability analysis (DSA) - DRD .....</b>		<b>66</b>
C.1	DRD identification .....	66
C.1.1	Requirement identification and source document .....	66
C.1.2	Purpose and objective .....	66
C.2	Expected response .....	66

C.2.1 Scope and content .....	66
C.2.2 Special remarks .....	69
<b>Annex D (normative) Fatigue analysis (FA) - DRD .....</b>	<b>70</b>
D.1 DRD identification .....	70
D.1.1 Requirement identification and source document.....	70
D.1.2 Purpose and objective.....	70
D.2 Expected response .....	70
D.2.1 Scope and content .....	70
D.2.2 Special remarks .....	72
<b>Annex E (normative) Fracture control analysis (FCA) - DRD .....</b>	<b>73</b>
E.1 DRD identification .....	73
E.1.1 Requirement identification and source document.....	73
E.1.2 Purpose and objective.....	73
E.2 Expected response .....	73
E.2.1 Scope and content .....	73
E.2.2 Special remarks .....	76
<b>iTeh STANDARD PREVIEW</b>	
<b>Annex F (normative) Fracture control plan - DRD .....</b>	<b>77</b>
F.1 DRD identification .....	77
F.1.1 Requirement identification and source document..... <a href="https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-0402459e9/sist-en-16603-32-2014">https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-0402459e9/sist-en-16603-32-2014</a>	77
F.1.2 Purpose and objective..... <a href="https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-0402459e9/sist-en-16603-32-2014">https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-0402459e9/sist-en-16603-32-2014</a>	77
F.2 Expected response .....	77
F.2.1 Scope and content .....	77
F.2.2 Special remarks .....	79
<b>Annex G (normative) Fracture control items lists (PFCIL, FCIL and FLLIL) - DRD .....</b>	<b>80</b>
G.1 DRD identification .....	80
G.1.1 Requirement identification and source document.....	80
G.1.2 Purpose and objective.....	80
G.2 Expected response .....	80
G.2.1 Scope and content .....	80
G.2.2 Special remarks .....	81
<b>Annex H (normative) Material and mechanical part allowables (MMPA) - DRD .....</b>	<b>82</b>
H.1 DRD identification .....	82
H.1.1 Requirement identification and source document.....	82
H.1.2 Purpose and objective.....	82

**EN 16603-32:2014 (E)**

H.2	Expected response .....	82
H.2.1	Scope and content .....	82
H.2.2	Special remarks .....	84
<b>Annex I (normative) Mathematical model description and delivery (MMDD) - DRD .....</b>		<b>85</b>
I.1	DRD identification .....	85
I.1.1	Requirement identification and source document .....	85
I.1.2	Purpose and objective .....	85
I.2	Expected response .....	85
I.2.1	Scope and content .....	85
I.2.2	Special remarks .....	92
<b>Annex J (normative) Modal and dynamic response analysis (MDRA) - DRD .....</b>		<b>93</b>
J.1	DRD identification .....	93
J.1.1	Requirement identification and source document .....	93
J.1.2	Purpose and objective .....	93
J.2	Expected response .....	94
J.2.1	Scope and content .....	94
J.2.2	Special remarks .....	96
<b>Annex K (normative) Stress and strength analysis (SSA) - DRD .....</b>		<b>97</b>
K.1	DRD identification .....	97
K.1.1	Requirement identification and source document .....	97
K.1.2	Purpose and objective .....	97
K.2	Expected response .....	97
K.2.1	Scope and content .....	97
K.2.2	Special remarks .....	103
<b>Annex L (normative) Structure alignment budget (SAB) - DRD .....</b>		<b>105</b>
L.1	DRD identification .....	105
L.1.1	Requirement identification and source document .....	105
L.1.2	Purpose and objective .....	105
L.2	Expected response .....	105
L.2.1	Scope and content .....	105
L.2.2	Special remarks .....	108
<b>Annex M (normative) Structure buckling (SB) - DRD .....</b>		<b>109</b>
M.1	DRD identification .....	109
M.1.1	Requirement identification and source document .....	109
M.1.2	Purpose and objective .....	109

M.2	Expected response .....	109
M.2.1	Scope and content .....	109
M.2.2	Special remarks .....	111
<b>Annex N (normative) Structure mass summary (SMS) - DRD .....</b>	<b>112</b>	
N.1	DRD identification .....	112
N.1.1	Requirement identification and source document.....	112
N.1.2	Purpose and objective.....	112
N.2	Expected response .....	112
N.2.1	Scope and content .....	112
N.2.2	Special remarks .....	114
<b>Annex O (normative) Test-analysis correlation (TAC) - DRD .....</b>	<b>115</b>	
O.1	DRD identification .....	115
O.1.1	Requirement identification and source document.....	115
O.1.2	Purpose and objective.....	115
O.2	Expected response .....	115
O.2.1	Scope and content .....	115
O.2.2	Special remarks .....	117
<b>Annex P (normative) Test evaluation (TE) - DRD .....</b>	<b>118</b>	
P.1	DRD identification .....	118
P.1.1	Requirement identification and source document.....	118
P.1.2	Purpose and objective.....	118
P.2	Expected response .....	118
P.2.1	Scope and content .....	118
P.2.2	Special remarks .....	121
<b>Annex Q (normative) Test prediction (TP) - DRD .....</b>	<b>122</b>	
Q.1	DRD identification .....	122
Q.1.1	Requirement identification and source document.....	122
Q.1.2	Purpose and objective.....	122
Q.2	Expected response .....	122
Q.2.1	Scope and content .....	122
Q.2.2	Special remarks .....	125
<b>Annex R (informative) Document description list .....</b>	<b>126</b>	
R.1	Computer aided design model description and delivery .....	126
R.2	Configuration item data list (document controlled by ECSS-M-ST-40) .....	126
R.3	Design definition file (document controlled by ECSS-E-ST-10).....	126

**EN 16603-32:2014 (E)**

R.4 Design development plan (included in the System engineering plan controlled by ECSS-E-ST-10) .....	126
R.5 Design justification file (document controlled by ECSS-E-ST-10).....	126
R.6 Drawings (document controlled by ISO 128).....	127
R.7 Design loads.....	127
R.8 Dimensional stability analysis .....	127
R.9 Fatigue analysis.....	127
R.10 Fracture control analysis.....	127
R.11 Fracture control plan.....	127
R.12 Fracture control items lists .....	127
R.13 Material and mechanical part allowables .....	128
R.14 Mathematical model description and delivery.....	128
R.15 Modal and dynamic response analysis .....	128
R.16 Stress and strength analysis.....	128
R.17 Structure alignment budget.....	128
R.18 Structure buckling .....	128
R.19 Structure mass summary.....	128
<b>iTeh STANDARD PREVIEW (standards.iteh.ai)</b>	
R.20 Test-analysis correlation.....	128
R.21 Test evaluation .....	129
R.22 Test prediction .....	129
R.23 Test procedure/ <del>s (document controlled by ECSS-E-ST-10-03) 875f</del> <del>d94b24c39c9e/sist-en-16603-32-2014</del> .....	129
R.24 Test report (document controlled by ECSS-E-ST-10-03) .....	129
R.25 Test specification (document controlled by ECSS-E-ST-10-03) .....	129
R.26 Verification plan (document controlled by ECSS-E-ST-10-02) .....	129
<b>Annex S (informative) Effective mass definition .....</b>	<b>130</b>
<b>Annex T (informative) E-32 discipline documents delivery per review .....</b>	<b>133</b>
<b>Bibliography.....</b>	<b>135</b>

## Foreword

---

This document (EN 16603-32:2014) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN.

This standard (EN 16603-32:2014) originates from ECSS-E-ST-32C Rev. 1.

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 February 2015, and conflicting national standards shall be withdrawn at the latest by February 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 supersedes EN 14607-2:2004.

**iTeh STANDARD PREVIEW**

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).

According to the SIST EN 16603-32:2014 Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

**1****Scope**

ECSS-E-ST-32C (Space engineering – Structural) defines the mechanical engineering requirements for structural engineering.

This Standard specifies the requirements to be considered in all engineering aspects of structures: requirement definition and specification, design, development, verification, production, in-service and eventual disposal.

The Standard applies to all general structural subsystem aspects of space products including: launch vehicles, transfer vehicles, re-entry vehicles, spacecraft, landing probes and rovers, sounding rockets, payloads and instruments, and structural parts of all subsystems.

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

**(standards.iteh.ai)**

SIST EN 16603-32:2014

<https://standards.iteh.ai/catalog/standards/sist/2dff8009-d189-4f3f-875f-d94b24c39c9e/sist-en-16603-32-2014>

## 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 16603-32-01	ECSS-E-ST-32-01	Space engineering – Fracture control
EN 16603-32-02	ECSS-E-ST-32-02	Space engineering – Structural design and verification of pressurized hardware
EN 16603-32-10	ECSS-E-ST-32-10	Space engineering – Reliability-based mechanical factors of safety 2014
EN 16602-70-36	ECSS-Q-ST-70-36	Space product assurance – Material selection for controlling stress-corrosion cracking
EN 16602-70-37	ECSS-Q-ST-70-37	Space product assurance – Determination of the susceptibility of metals to stress-corrosion cracking

## 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.

### 3.2 Terms specific to the present standard

#### 3.2.1 A-basis design allowable (A-value)

mechanical property value above which at least 99 % of the population of values is expected to fall, with a confidence level of 95 %

#### 3.2.2 B-basis design allowable (B-value)

mechanical property value above which at least 90 % of the population of values is expected to fall, with a confidence level of 95 %

#### 3.2.3 buckling

not stable equilibrium of a structure under loads applied statically or dynamically

NOTE Buckling include snapping of slender beams, buckling of flat plates, buckling of cylindrical panels, three dimensionally curved shells, rib crippling, and skin buckling of a sandwich.

#### 3.2.4 composite material

combination of materials different in composition or form on a macro scale

NOTE 1 Composite materials provide improved characteristics not obtainable by any of the original components acting alone

NOTE 2 The constituents retain their identities in the composite.

NOTE 3 Normally the constituents can be physically identified, and there is an interface between them.

NOTE 4 Composites include

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

- laminar (layers of materials), and
- hybrid (combinations of any of the above).

NOTE 5 Composites material can be metallic, non-metallic or a combination thereof.

### **3.2.5 composite structure**

structure fully or partially made of composite materials

### **3.2.6 contributing loads**

loads which decrease the margin of safety.

### **3.2.7 damage tolerance**

capability of a structure to resist failure due to the presence of flaws, cracks, or other damage for a specified period of usage without inspection or repair.

### **3.2.8 design allowable**

statistically based strength capability with respect to a failure mode

NOTE For example in terms of load resistance, stress resistance, or strain limit with respect to rupture, collapse, detrimental deformation.

### **iTeh STANDARD PREVIEW**

#### **3.2.9 design factor**

factor used in the determination of DLL to account for uncertainties

NOTE Design factor accounts for uncertainties related to  
*SIST EN 16603-32:2014*  
<https://standards.iteh.ai/catalog/standards/sist/201609-d189-451-8-SF-d94b24c39d63a7f3ecf3241014>  
 loads, models and project programmatic aspects  
 (i.e. protoflight approach, uncertainty in launcher  
 environment, maturity of design, growth potential  
 and other design considerations).

### **3.2.10 design limit load (DLL)**

limit load multiplied by a design factor

NOTE Design factors are defined in ECSS-E-ST-32-10.

### **3.2.11 design load (DL)**

design limit load or design yield load or design ultimate load

### **3.2.12 design parameters**

physical features which influence the design performances

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

- structural sizing for the dimensioning of beams, shells;
- shape optimization;
- material selection;
- structural topology.