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DOCUMENT

Tailored ECSS Engineering Standards for In-Orbit Demonstration CubeSat Projects

Prepared by	**TEB**
Reference	**TEC-SY/128/2013/SPD/RW**
Issue	**1**
Revision	**3**
Date of Issue	**24/11/2016**
Status	**Approved/Applicable**
Document Type	**SP**
Distribution	

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APPROVAL

Title Tailored ECSS Engineering Standards for In-Orbit Demonstration CubeSat Projects	
Issue 1	**Revision** 3
Author TEB	**Date** 24/11/2016
Approved by	**Date**
TEB TEB	26/03/2013 08/04/2016

CHANGE LOG

Reason for change	Issue	Revision	Date
Includes newly tailored ECSS-E standards on: -fracture control (ECSS-E-ST-32-01C) -structural design & verification of pressurised hardware (ECSS-E-ST-32-02C) -liquid and electric propulsion for spacecraft (ECSS-E-ST-35-01C) -radiofrequency and modulation (ECSS-E-ST-50-05C) -satellite AOCS requirements (ECSS-E-ST-60-30C)	1	2	08/04/2016
Updated tailoring to Testing & Thermal control standards to include thermal balance test on per project basis. Updated Mechanisms tailoring to make post-test inspection and life test factors applicable.	1	3	24/11/2016

CHANGE RECORD

Issue 1		Revision 3	
Reason for change	**Date**	**Pages**	**Paragraph(s)**

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1   INTRODUCTION

1.1   Purpose

This document specifies the applicability of the ECSS Space Engineering Standards to In-Orbit Demonstration CubeSat nano-satellite projects developed through the ESA General Support Technology Programme activity entitled "CubeSat Technology Pre-development" (G547-009SG).

In the first instance, the list of applicable standards is specified in terms of the applicability of each standard and whether that standard either applied in its entirety or specifically tailored. Then, for each of the applicable standards to be tailored, the document specifies the applicability of the requirements within the standard documents.

1.2   Project Classification

CubeSats are defined here as nano-satellites whose designs are compliant with the CubeSat Design Specification [AD1] and are multiples of a single CubeSat unit (10x10x10 cm, <1.33 kg) ranging from 2 units up to 6 units.

CubeSat projects for In-Orbit Demonstration (IOD) purposes in Low Earth Orbit are generally characterized by the following attributes:

- Complete stand-alone systems including platform, payload, ground segment & operations
- Higher risk acceptance profile
- Low level of complexity (relative to other ESA space projects)
- Low cost and short schedule (typically <1 MEuro and <2 years to flight readiness)
- Short operational lifetime (typically <1 year in low altitude LEO)
- Acceptance of single point failures
- Limited redundancy (where possible within the constraints)
- Limited fault tolerance (where possible within the constraints)
- Robust safe mode (thermal and power safe in any attitude)
- Extensive use of commercial off-the-shelf elements (modules that have previous flight heritage and are supplied by small industrial suppliers at a fixed price)
- Extensive testing focussed on system level (functionality and environmental qualification/acceptance)
- Simple project organisation with well integrated teams (single entity for system engineering, AIV and operations, very few suppliers or subcontractors)

Due to the very small satellite class, very low procurement cost, simple project organisation, short development schedule and short duration operations, IOD CubeSats in the ESA context are classified according to [AD2] as "other space-related procurement activities such as technology and pre-development" which are "non-complex procurement activities, with simple industrial structures, conducted as lower-cost and shorter-duration

contracts". As such, section 5 of [AD2] states "For such activities, the majority of the standards contained in the ESA approved list of standards may not be relevant and only a few may be selected as applicable."

Furthermore, "The verification process shall be adapted to reflect the reduced complexity of work and the absence of one or more disciplines."

From this, it is clear that the design, development and verification process cannot follow a classical ESA project approach to management, engineering, reviews and PA/QA with associated application of the ECSS standards. Furthermore, the majority of the standards documents are not relevant/suitable for this type of project. However, a heavy tailoring of the ECSS has been performed and where elements of the ECSS Space Engineering standards are relevant and applicable, they are specified in this document.

The tailoring process in this document is aimed at ensuring engineering best practice in the design, manufacturing and testing of IOD CubeSats across the space engineering technical disciplines, without requiring additional documentation to be produced beyond the documents specified in the project Deliverable Items List.

Due to the high level of integration of CubeSats, the verification programme is focussed only at system-level, i.e. lower level verification is not required to be demonstrated to ESA.

Furthermore, CubeSats partially or fully utilise Commercial Off The Shelf (COTS) modules for the different subsystems in a building block approach. These COTS modules, in many cases have already been qualified or possess flight heritage. In these cases, where qualification can be demonstrated, only the production/manufacturing and verification requirements of the tailored subsystem engineering standards are considered applicable (i.e. not the design and interface requirements sections).

1.3   Applicable Documents

[AD1]   CubeSat Design Specification, revision 12, California Polytechnic, 1 August 2009.
[AD2]   Application of ESA approved standards, ESA/ADMIN/IPOL(2007)11, 20 July 2007.

1.4   Acronyms

AD   Applicable Document
AIT   Assembly Integration and Test
AITP   Assembly Integration and Test Plan
AIV   Assembly Integration and Verification
AMSAT   Amateur Satellite
AOCS   Attitude and Orbit Control Subsystem
AOS   Advanced Orbiting Systems
ARQ   Automatic Repeat Request
CAD   Computer Aided Design

CAN	Controller Area Network
CCSDS	Consultative Committee for Space Data Systems
CLA	Coupled Loads Analysis
CLTU	Communications Link Transmission Unit
CoG	Centre of Gravity
COTE	Check-Out Terminal Equipment
COTS	Commercial Off The Shelf
ESD	Electro-Static Discharge
DC	Direct Current
DIL	Deliverable Items List
DML	Declared Materials List
DRB	Delivery Review Board
DRD	Document Requirements Description
ECLS	Environmentally-Controlled Life Support
ECSS	European Cooperation for Space Standardization
EMC	Electro-Magnetic Compatibility
FAR	Flight Acceptance Review
FSI	Fluid Structure Interaction
GMM	Geometric Mathematical Model
SRS	Shock Response Spectrum
HFE	Human Factors Engineering
ICD	Interface Control Document
I/F	Interface
IOD	In-Orbit Demonstration
ITU	International Telecommunications Union
LEO	Low Earth Orbit
LVDS	Low Voltage Differential Signalling
MOI	Moments of Inertia
NCR	Non-Conformance Report
NEA	Non-Explosive Actuator
PA	Product Assurance
PCB	Printed Circuit Board
PCDU	Power Conditioning and Distribution Unit
PDR	Preliminary Design Review
PFM	Proto-Flight Model
PMP	Parts, Materials and Processes
PIM	Passive Inter-Modulation
PSD	Power Spectral Density
PV	Photo-Voltaic
RF	Radio-Frequency
RFD	Request For Deviation
RoD	Review of Design
QA	Quality Assurance
SoW	Statement of Work
SRD	System Requirements Document
TCS	Thermal Control Subsystem

TMM	Thermal Mathematical Model
TRB	Test Review Board
UHF	Ultra High Frequency
VCB	Verification Control Board
XML	Extensible Markup Language

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2   GENERAL APPLICABILITY

The applicability assessment is based on the ECSS-E standards approved as of 24 January 2013.

The standards specified as "Guidelines" are not applicable to the CubeSat project, but shall be taken as a reference document by the Contractor as part of the engineering activities during the project execution.

ECSS number	Title	Issue	Applicability	Tailored
System Engineering				
ECSS-E-ST-10C	System engineering general requirements	6 March 2009	Guideline	N
ECSS-E-ST-10-02C	Verification	6 March 2009	Applicable	Y
ECSS-E-ST-10-03C	Testing	1 June 2012	Applicable	Y
ECSS-E-ST-10-04C	Space environment	15 November 2008	Applicable	Y
ECSS-E-ST-10-06C	Technical requirements specification	6 March 2009	Guideline	N
ECSS-E-ST-10-09C	Reference coordinate system	31 July 2008	Guideline	N
ECSS-E-ST-10-11C	Human factors engineering	31 July 2008	Not applicable	N
ECSS-E-ST-10-12C	Method for the calculation of radiation received and its effects, and a policy for design margins	15 November 2008	Guideline	N
Electrical Engineering				
ECSS-E-ST-20C	Electrical and electronic	31 July 2008	Applicable	Y
ECSS-E-20-01A	Multipaction design and test	5 May 2003	Guideline	N
ECSS-E-ST-20-06C	Spacecraft charging	31 July 2008	Guideline	N
ECSS-E-ST-20-07C Rev.1	Electromagnetic compatibility	7 February 2012	Guideline	N
ECSS-E-ST-20-08C rev.1	Photovoltaic assemblies and components	18 July 2012	Applicable	Y
Mechanical Engineering				
ECSS-E-ST-31C	Thermal control general requirements	15 November 2008	Applicable	Y
ECSS-E-ST-32C Rev.1	Structural general requirements	15 November 2008	Applicable	Y
ECSS-E-ST-32-01C Rev.1	Fracture control	6 March 2009	Applicable	Y
ECSS-E-ST-32-02C Rev.1	Structural design and verification of pressurized hardware	15 November 2008	Applicable	Y

ECSS-E-ST-32-03C	Structural finite element models	31 July 2008	Guideline	N
ECSS-E-ST-32-08C	Materials	31 July 2008	Applicable	Y
ECSS-E-ST-32-10C Rev.1	Structural factors of safety for spaceflight hardware	6 March 2009	Guideline	N
ECSS-E-ST-32-11C	Modal survey assessment	31 July 2008	Guideline	N
ECSS-E-ST-33-01C	Mechanisms	6 March 2009	Applicable	Y
ECSS-E-ST-33-11C	Explosive systems and devices	31 July 2008	Not applicable	N
ECSS-E-ST-34C	Environmental control and life support (ECLS)	31 July 2008	Not applicable	N
ECSS-E-ST-35C Rev.1	Propulsion general requirements	6 March 2009	Guideline	N
ECSS-E-ST-35-01C	Liquid and electric propulsion for spacecraft	15 November 2008	Applicable	Y
ECSS-E-ST-35-02C	Solid propulsion for spacecrafts and launchers	8 October 2010	Not applicable	N
ECSS-E-ST-35-03C	Liquid propulsion for launchers	10 May 2011	Not applicable	N
ECSS-E-ST-35-06C	Cleanliness requirements for spacecraft propulsion components, subsystems and systems	31 July 2008	Guideline	N
ECSS-E-ST-35-10C	Compatibility testing for liquid propulsion systems	6 March 2009	Not applicable	N
PSS-03-401	Atmosphere Quality Standards in Manned Space Vehicles	June 1992	Not applicable	N
PSS-03-402	Water Quality Standards in Manned Space Vehicles	October 1994	Not applicable	N

Software Engineering

ECSS-E-ST-40C	Software	6 March 2009	Guideline	N

Communications Engineering

ECSS-E-ST-50C	Communications	31 July 2008	Applicable	Y
ECSS-E-ST-50-01C	Space data links - Telemetry synchronization and channel coding	31 July 2008	Not applicable	N
ECSS-E-ST-50-02C	Ranging and Doppler tracking	31 July 2008	Not applicable	N
ECSS-E-ST-50-03C	Space data links - Telemetry transfer frame protocol	31 July 2008	Not applicable	N
ECSS-E-ST-50-04C	Space data links - Telecommand protocols, synchronization and channel coding	31 July 2008	Not applicable	N
ECSS-E-ST-50-05C Rev.2	Radio frequency and modulation	4 October 2011	Applicable	Y

ECSS-E-ST-50-12C	SpaceWire - Links, nodes, routers and networks	31 July 2008	Not applicable	N
ECSS-E-ST-50-13C	Interface and communication protocol for MIL-STD-1553B data bus onboard spacecraft	15 November 2008	Not applicable	N
MIL1553-B-Notice 2	Digital Time Division Command/ Response Multiplex Data Bus	8 September 1986	Not applicable	N
ECSS-E-ST-50-14C	Spacecraft discrete interfaces	31 July 2008	Not applicable	N
ECSS-E-ST-50-51C	SpaceWire protocol identification	5 February 2010	Not applicable	N
ECSS-E-ST-50-52C	SpaceWire - Remote memory access protocol	5 February 2010	Not applicable	N
ECSS-E-ST-50-53C	SpaceWire - CCSDS packet transfer protocol	5 February 2010	Not applicable	N
CCSDS 121.0-B-1	Lossless Data Compression	May 1997	Not applicable	N
CCSDS 122.0-B-1	Image Data Compression	November 2005	Not applicable	N
CCSDS 133.0-B-1	Space Packet Protocol	September 2003	Not applicable	N
CCSDS 133.1-B-2	Encapsulation Service	October 2009	Not applicable	N
CCSDS 135.0-B-4	Space Link Identifiers	October 2009	Not applicable	N
CCSDS 211.0-B-4	Proximity-1 Space Link Protocol - Data Link Layer	July 2006	Not applicable	N
CCSDS 211.1-B-3	Proximity-1 Space Link Protocol - Physical Layer	March 2006	Not applicable	N
CCSDS 211.2-B-1	Proximity-1 Space Link Protocol - Coding and Synchronization Sublayer	April 2003	Not applicable	N
CCSDS 301.0-B-4	Time Code Formats	November 2010	Not applicable	N
CCSDS 320.0-B-5	CCSDS Global Spacecraft Identification Field Code Assignment Control Procedures	September 2007	Not applicable	N
Recommendation 2.5.6B of CCSDS 401.0-B-20	Radio Frequency & Modulation Systems Recommendation on Differential One-Way Ranging For Space-To Earth Links In Angular Spacecraft Position Determination, Category B	April 2009	Not applicable	N
CCSDS 414.1-B-1	Pseudo-Noise (PN) Ranging Systems	March 2009	Not applicable	N
CCSDS 727.0-B-4	File Delivery Protocol (CFDP)	January 2007	Not applicable	N

CCSDS 732.0-B-2.	AOS Space Data Link Protocol	July 2006	Not applicable	N
ISO 11898-1	CAN Data Link Layer and Physical Signalling	2003/Cor 1:2006	Not applicable	N
ISO 11898-2	CAN High-Speed Medium Access Unit	2003	Not applicable	N
IPv4	J. Postel. Internet Protocol STD 5 [RFC 791, RFC 950, RFC 919, RFC 922, RFC 792, RFC 1112]	September 1981	Not applicable	N
ESSB-ST-E-006 Issue 1	ESA Procedural Requirements for Frequency Assignment	20 July 2011	Not applicable	N
Control Engineering				
ECSS-E-60A	Control engineering	14 September 2004	Guideline	N
ECSS-E-ST-60-10C	Control performance	15 November 2008	Guideline	N
ECSS-E-ST-60-20C Rev. 1	Star sensor terminology and performance specification	15 November 2008	Guideline	N
ECSS-E-ST-60-30C	Satellite attitude and orbit control system (AOCS) requirements	30 August 2013	Applicable	Y
Ground System and Operation Engineering				
CCSDS 502.0-B-2	Orbit Data Messages	November 2009	Not applicable	N
CCSDS 503.0-B-1	Tracking data message	November 2007	Not applicable	N
CCSDS 504.0-B-1	Attitude data message	May 2008	Not applicable	N
CCSDS 505.0-B-1	XML Specification for Navigation Data Messages	December 2010	Not applicable	N
CCSDS 910.11-B-1	Space Communication Cross Support - Service Management - Service Specification	August 2009	Not applicable	N
CCSDS 911.1-B-3	Space Link Extension - Return all frames service specification	January 2010	Not applicable	N
CCSDS 911.2-B-2	Space Link Extension - Return Channel Frames Service Specification	January 2010	Not applicable	N
CCSDS 911.5-B-2	Space Link Extension - Return Operational Control Fields Service Specification	January 2010	Not applicable	N

CCSDS 912.1-B-3	Space Link Extension - Forward CLTU service specification	July 2010	Not applicable	N
CCSDS 912.3-B-2	Space Link Extension - Forward Space Packet Service Specification	July 2010	Not applicable	N
ECSS-E-ST-70C	Ground systems and operations	31 July 2008	Guideline	N
ECSS-E-ST-70-01C	On-board control procedures	16 April 2010	Not applicable	N
ECSS-E-ST-70-11C	Space segment operability	31 July 2008	Not applicable	N
ECSS-E-ST-70-31C	Ground systems and operations - Monitoring and control data definition	31 July 2008	Not applicable	N
ECSS-E-ST-70-32C	Test and operations procedure language	31 July 2008	Not applicable	N
ECSS-E-70-41A	Telemetry and telecommand packet utilization	30 January 2003	Not applicable	N

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3 SPECIFIC TAILORING

3.1 ECSS-E-ST-10-02C Verification

This document is APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.1.3	Verification documentation	Partially applicable	Verification Plan and AIT Plan are covered by one single System AIV Plan in the project Deliverable Item List and its associated DRD
5.2.1	Verification approach	Partially applicable	a. Not applicable since the Contractor has the responsibility to define the requirements for IOD CubeSat projects.
5.2.2.1	General	Partially applicable	d. and e. not applicable.
5.2.2.2	Test	Partially applicable	g. The AIV Plan shall be used.
5.2.2.3	Analysis	Partially applicable	e. The AIV Plan shall be used.
5.2.2.4	Review-of-Design (ROD)	Partially applicable	b. The AIV Plan shall be used.
5.2.2.5	Inspection	Partially applicable	b. The AIV Plan shall be used.
5.2.4.2 and 5.2.4.3	Qualification and Acceptance	Partially applicable	At system-level, qualification and acceptance shall be performed simultaneously on the protoflight model
5.2.4.6	Post-landing	Not applicable	
5.2.6	Verification tools	Partially applicable	5.2.6.1 to 5.2.6.4 not applicable
5.2.7	Verification process phasing	Not applicable	
5.2.8	Verification planning documents	Partially applicable	Verification plan and AIT plan are covered by one single System AIV Plan in the project Deliverable Item List and its associated DRD
5.3.1	General	Partially applicable	c. The NCR format shall be defined by the project. The NCR shall be addressed at the FAR. A separate VCB or DRB is not required.

5.3.2.6	Other verification execution and reporting documents	Partially applicable	b. Test specifications shall be included in the Test procedures c. Test procedures shall be in conformance with the DRD specified in the project SoW
5.4.1	General	Partially applicable	a. Not applicable
5.4.2	Verification Control Board (VCB)	Not applicable	
Annex A	Verification Plan	Not applicable	Covered by the AIV Plan in the project Deliverable Item List and its associated DRD
Annex B	Verification Control Document DRD	Guideline	Replaced by a System Verification Control Matrix according to project DRD.
Annex C-F	Report DRD	Guideline	
Annex G	Verification documents per review	Not applicable	The project DIL shall be used

3.2   ECSS-E-ST-10-03C Testing

This document is APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.3.2.1	Test programme	Partially applicable	b. The test review board shall be part of the post-test review
4.3.2.4	Test review board	Partially applicable	The TRB shall be combined with the post-test review
4.3.3.2	Assembly, integration and test plan	Partially applicable	a. The AITP is encompassed by the system-level AIV Plan whose DRD is included in the project DRD specification.
4.3.3.3	Test specification	Partially applicable	a. The Test specification shall be included in the test procedure and shall follow the project DRD specification.

4.3.3.4	Test procedure	Partially applicable	a. Test procedures shall be in conformance with the DRD specified in the project SoW
4.3.4	Anomaly or failure during testing	Partially applicable	b. Non-conformances shall be managed according to project procedures established with the Agency c. Non-conformances shall be addressed to the Agency at the post-test review, and any re-test activity shall be decided at this point.
4.4.1	Test conditions	Partially applicable	d. Cleanliness and control shall conform to the tailored version of this standard.
4.4.3	Test accuracies	Partially applicable	MOI: not applicable, due to the small mass/dimensions, it is sufficient to verify MOI at system-level by analysis of the detailed CAD model to an accuracy of +/- 5%. Audible noise: not applicable
4.5.2	Qualification testing	Not applicable	A system-level protoflight approach is used for testing of new/heavily modified equipment
4.5.3	Acceptance testing	Partially applicable	Applies to off-the-shelf equipment or slightly modified equipment, whose status is confirmed at PDR to be qualified for the project.
4.5.4	Protoflight testing	Not applicable	A system-level protoflight approach is used for testing of new/heavily modified equipment
4.6	Re-testing	Not applicable	

5.1	General requirements (equipment)	Partially applicable	h. Not applicable since CubeSats are required to be powered OFF during launcher ascent. Fig. 5-1: not applicable, guideline only
5.2	Qualification tests requirements (equipment)	Not applicable	A protoflight approach is used for new/heavily modified equipment, and therefore section 5.4 applies
5.3	Acceptance test requirements (equipment)	Partially applicable	Table 5-3 and Table 5-4: The following tests are NOT applicable: humidity, life, burn-in, physical properties, static load, spin, transient, acoustic, shock, micro-vibration, pressure cycling, design burst pressure, burst, thermal ambient, ESD, PIM, multipaction, corona and arc discharge, audible noise. The following tests are tailored: • EMC (equipment type "a" only, test approach to be defined in project AIV plan); • magnetic (equipment type "a" only, if justified by mission needs).
5.4	Protoflight test requirements (equipment)	Not applicable	A system-level protoflight approach is used for testing of new/heavily modified equipment.
5.5.1.1	Functional and performance tests	Partially applicable	a. Solar array deployment test shall be performed at ambient pressure and temperature
5.5.1.2	Humidity test	Not applicable	Launch facility/launch pad relative humidity to be confirmed by Launch services provider. If humidity is >65%, then this test becomes applicable.

5.5.1.3	Life test	Not applicable	IOD CubeSats have a short mission duration (typically 6 months or less) therefore a life test is not relevant.
5.5.1.4	Burn-in test	Not applicable	
5.5.2.1	Physical properties measurements	Partially applicable	Only the mass, dimensions and interfaces of the equipment shall be measured. CoG and MOI shall be calculated from the equipment CAD model.
5.5.2.2	Acceleration test	Not applicable	Nominally, this is covered by the sinusoidal test with respect to launch loads. However, if the flight acceleration loads are calculated to be higher than the launch loads, then a specific static load test shall be performed on structural elements.
5.5.2.4	Acoustic test	Not applicable	Due to their small size and enclosure within a deployment system during launch, CubeSats are not susceptible to acoustic launch loads.
5.5.2.6	Shock test	Partially applicable	Only applicable to protoflight models of items assessed during the project as shock-critical (ie. their shock susceptibility is lower than the expected shock environment). The shock environment shall take into account attenuation at higher frequencies due to the fact that the CubeSat is not mechanically coupled to the deployment system. Shock test data from the deployment system supplier shall be used to define the applicable SRS.

5.5.2.7 and 5.5.2.8	Micro-vibration generated and susceptibility tests	Not applicable	Performances where micro-vibration becomes an issue are currently not feasible with CubeSats.
5.5.3.3 to 5.5.3.5	Pressure cycling, design burst pressure, and burst test	Not applicable	
5.5.4.3	Requirements applicable to Thermal ambient test	Not applicable	For CubeSats performing an atmospheric re-entry, the need for a thermal ambient test shall be evaluated.
5.5.5.1	EMC test	Partially applicable	EMC test approach for equipment shall be specified in the project AIV plan. The test concerns auto-compatibility since CubeSats are not operational during launch until typically 30 mins after separation.
5.5.5.2	Magnetic test	Partially applicable	Only to be performed if justified by the mission needs, e.g. magnetic sensors/actuators, or payload instruments with high magnetic cleanliness requirements.
5.5.5.3	ESD test	Partially applicable	Applicable only to items assessed during the project as an ESD risk
5.5.5.4 to 5.5.5.6	PIM, multipaction, corona and arc discharge tests	Not applicable	
5.5.6.1	Audible noise test	Not applicable	
6.2	Qualification test requirements (space segment element)	Not applicable	A system-level protoflight approach is foreseen for an IOD CubeSat.
6.3	Acceptance Test requirements (space segment element)	Not applicable	A system-level protoflight approach is foreseen for an IOD CubeSat.

6.4	Protoflight test requirements (space segment element)	Partially applicable	Table 6-5 and 6-6: The following tests are NOT applicable: modal survey, spin, transient, acoustic, shock, micro-vibration, proof pressure, pressure cycling, design burst pressure, leak, thermal ambient, PIM, magnetic, HFE, toxic offgassing, audible noise. The following tests are tailored: • launcher I/F (deployment system fit check); • physical properties (mass and dimensions only, COG/MOI by analysis); • EMC (equipment type "a" only, test approach to be defined in project AIV plan); • magnetic (equipment type "a" only, if justified by mission needs); • shock (applicable only to items assessed during the project as shock-critical); • ESD (applicable only to items assessed during the project as an ESD risk)
6.5.1.3	Performance test	Not applicable	The performance of IOD payloads on the CubeSat shall be measured and verified in-orbit as per the mission objectives. Platform performance is verified at subsystem or equipment level.

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6.5.1.4	Mission test	Not applicable	Functions such as mode transitions and safe mode recovery shall be covered by the functional tests specified in 6.5.1.2.1
6.5.1.5	Polarity test	Partially applicable	As a minimum, the test shall cover AOCS sensor/actuator polarity, as well as solar array – PCDU interface polarity and any drive mechanisms.
6.5.1.6	Launcher interface	Partially applicable	For CubeSats, this is limited to deployment system fit check and interface with any launch service provided COTE.
6.5.2.1	Physical properties measurements	Partially applicable	a. Limited to mass measurements. COG and MOI shall be based on analysis of the final CAD model for all mission configurations.
6.5.2.2	Modal survey test	Not applicable	
6.5.2.3	Static load test	Partially applicable	Limited only to cases where static flight loads exceed the launch loads covered by the sine vibration tests.
6.5.2.4	Spin test	Not applicable	
6.5.2.5	Transient test	Not applicable	
6.5.2.6	Acoustic test	Not applicable	
6.5.2.7	Random vibration test	Partially applicable	E, h and k are not applicable. CubeSats are not powered ON or operative during launch.
6.5.2.8	Sine vibration test	Partially applicable	E not applicable
6.5.2.9	Shock test	Not applicable	Covered at equipment-level for shock-critical items only. See previous notes.
6.5.2.10	Micro-vibration susceptibility test	Not applicable	CubeSat payloads and platform performances are not high enough such that micro-vibration becomes an issue.
6.5.3.2	Pressure cycling test	Not applicable	
6.5.3.3	Design burn pressure test	Not applicable	

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6.5.4.1	Requirements applicable to thermal vacuum and thermal ambient tests	Partially applicable	A, k and q not applicable
6.5.4.3	Requirements applicable to thermal ambient tests	Not applicable	
6.5.4.4	Thermal balance test	Partially applicable	Need for a thermal balance test shall be determined on a per project basis.
6.5.5	Electromagnetic tests	Not applicable	EMC test shall be conducted according to the project AIV plan in order to verify compliance with project EMC requirements. Magnetic test covered at equipment-level.
6.5.6.1	Aerothermodynamic test	Partially applicable	Applicable only to CubeSat re-entry demonstrators
6.5.7	Crewed mission tests	Not applicable	
7	Pre-launch tests	Partially applicable	H, I and j not applicable. Pyrotechnics are not used on CubeSats (NEA devices only are permitted).
Annex A	AIT Plan DRD	Partially applicable	Merged with the Verification Plan to form one single AIV Plan.
Annex B	Test Specification DRD	Partially applicable	Merged with Test Procedure into a single document
Annex C	Test Procedure DRD	Partially applicable	Merged with Test Specification into a single document

3.3   ECSS-E-ST-10-04C Space environment

This document is APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.2.2	Selection and application of gravity models	Partially applicable	Alternative models may be used, provided that they are justified and validated.
5.2	Requirements for model selection and application	Partially applicable	Simplified models may be used for magnetic field-based attitude control to the level of control accuracy required.

7.2.1	Earth atmosphere	Partially applicable	Alternative models may be used, provided that they are justified and validated.
7.2.2	Earth wind model	Partially applicable	Only applicable if relevant to the mission profile
7.2.3	Models of the atmospheres of the planets and their satellites	Not applicable	
8.2.2 and 8.2.3	Ionosphere and Auroral charging environment	Partially applicable	Only applicable if relevant to the mission
8.2.4 to 8.2.7	Other plasma environments	Not applicable	
9.2.1.2	Long Term Flux Models for specific orbits	Not applicable	
9.2.1.3	Worst case trapped electron fluxes for internal charging analyses	Not applicable	
9.2.1.4	Worst case trapped proton fluxes	Not applicable	
9.2.2.2	Solar particle fluence models	Partially applicable	The actual mission duration shall be used if the mission is <1 year
9.2.5	Neutrons		
9.2.6	Planetary radiation environments	Not applicable	
10	Space debris and meteoroids	Not applicable	Informative
Annex C	Space debris and meteoroids	Not applicable	Informative
11.2	Requirements for contamination assessment	Partially applicable	Assessment to be performed only if the spacecraft has equipment (e.g. optics) with a high contamination sensitivity. Additionally, since the spacecraft is enclosed in its deployment system during launch, only materials outgassing products shall be considered.

3.4 ECSS-E-ST-20C Electrical and electronic

This document is APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.1.2	Signal interfaces	Partially applicable	f. Applies with the following exception: no over-voltage protections shall be foreseen on RS422 and LVDS interfaces. The risk of over-voltage shall be prevented by correct operating procedures.
4.1.3	Commands	Partially applicable	C, f, g, j do not apply.
4.2.1	Failure containment and redundancy	Partially applicable	B to d, f to j, q, r, s, w, do not apply to an IOD CubeSat. In general due to volume/mass constraints, the only redundancy implemented is at PCB level, not functional on separate boards.
4.2.2.2	Data processing provisions	Partially applicable	A, d not applicable to IOD CubeSats.
4.2.4	Testing	Partially applicable	E and f not applicable provided operational procedures are in place to mitigate the risk of overvoltage on ground. G and n not applicable due to lack of functional redundancy on CubeSats.
4.2.5	Mechanical: wired electrical connections	Not applicable	Due to the short harness lengths involved in CubeSats
4.2.6	Dependability	Partially applicable	C and d not applicable, due to widespread use of COTS modules available on short timescales. Spares policy for newly developed items to be agreed with ESA on a case-by-case basis.

4.3	Verification	Partially applicable	4.3.1 verification shall be performed at PDR and FAR using appropriate methods agreed during the project. 4.3.2 not applicable –covered by the project DIL and DRD.
6	Electromagnetic Compatibility	Not applicable	Superceded by project specific EMC programme tailored to CubeSats (not powered on the launcher, use of low power circuits with low radiated emission). As a minimum, the Contractor shall identify at system level any EMC critical items (e.g. payload items sensitive to s/c charging or DC magnetic field, AOCS sensors etc), assess the risk and propose specific mitigation actions. Self-induced EMC shall be ensured through use of electrical engineering design best practices for bonding, grounding and wiring. Auto-compatibility is to be verified by system-level EMC test with s/c PFM. Space-to-ground RF compatibility verified by test with s/c PFM and ground station.
7.2.2.2.2 to 7.2.2.2.4	Reflector/lens antennas, Array antennas, Array-fed reflector antennas	Not applicable	CubeSats do not contain these antenna types.
7.2.2.3.1	Radiating elements	Partially applicable	B, c, d, f are not applicable
7.2.2.3.2 to 7.2.2.3.5	Reflector/lens antennas, Array antennas, Array-fed reflector antennas	Not applicable	CubeSats do not contain these antenna types.
7.2.2.3.6	Antenna support structures	Not applicable	Not expected to be an issue for CubeSats since their mono-/di-pole antennas are generally a similar length to the structure.

7.2.2.4	Technologies	Not applicable	No PIM products, or composite/plastic based components in the RF path.
7.2.3	Antenna interfaces	Not applicable	IOD CubeSats do not have high power RF interfaces, PIM or structural interactions.
7.2.4	Antennas verification	Guideline	In general, the antenna design shall be reviewed at PDR, and the performance shall be verified during the system-level EMC test.
7.3	RF Power	Not applicable	Multipaction, power handling requirements and corona not relevant for CubeSats.
7.4	Passive Intermodulation	Not applicable	Not relevant for CubeSats, since they only have one RF transmit source and power levels are low.
7.5	Verification	Not applicable	Refers to verification of 7.3 and 7.4, therefore not relevant.
Annex A	EMC Control Plan DRD	Informative	
Annex B	Electromagnetic effects verification plan DRD	Informative	
Annex C	Electromagnetic effects verification report DRD	Informative	
Annex D	Battery User Manual DRD	Informative	

3.5   ECSS-E-ST-20-08C rev.1 Photovoltaic assemblies and components

This document is NOT APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
5.3.3.1	Cell integration	Applicable	
5.3.3.2	Stringing	Partially applicable	CubeSat solar panels usually contain only one string each.
5.3.3.4	Cell interspacing	Applicable	
5.3.3.5	Reverse bias protection	Applicable	

5.3.3.6	Insulation	Applicable	
5.3.3.11	Adherence to substrate	Applicable	
5.4.3.2	Mass measurement	Applicable	
5.4.3.3	Wet insulation test	Applicable	
5.4.3.4	Adherence to substrate	Partially applicable	Dimensions of representative PV substrate to be defined according to CubeSat solar panel dimensions.
5.4.3.5	Visual inspection	Applicable	
5.4.3.6	Continuity check	Applicable	
5.5.1.2	Qualification tests - Process	Partially applicable	Only d. 1&2, e., g., and i. are applicable. No qualification tests are required if the PV assembly supplier demonstrates qualification for the mission requirements by providing qualification test data or operational data.
5.5.1.3	Qualification tests - Fatigue thermal cycling test	Partially applicable	Only 5.5.1.3.1, 5.5.1.3.2, 5.5.1.3.3 c. e. h. i. and k., 5.5.1.3.4 a. b. d. and g., and 5.5.1.3.5 are applicable. Number of fatigue thermal cycles to be agreed at project-level in agreement with supplier. No test is required if the PV assembly supplier demonstrates qualification for the mission requirements by providing qualification test data or operational data.
5.5.1.4	Qualification tests – Humidity test	Partially applicable	Only 5.5.1.4.3, 5.5.1.4.4 a. b. c. d. f. g., and 5.5.1.4.5 are applicable. No test is required if the PV assembly supplier demonstrates qualification for the mission requirements by providing qualification test data or operational data.
5.5.3.7	Thermal cycling acceptance test	Applicable	To be performed as part of the satellite PFM thermal vacuum thermal cycling test.

6.3.1	Solar cell assembly Acceptance tests - General	Applicable	
6.3.3	Solar cell assembly Acceptance tests – Electrical Performance Acceptance test	Applicable	

3.6   ECSS-E-ST-31C Thermal control general requirements

This document is APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.1.5	Interplanetary phases	Not applicable	
4.1.6	Planetary natural environment	Partially applicable	b. Not applicable
4.1.7	Docking, docked and separation phases	Not applicable	
4.1.8	Descent, entry and landing	Partially applicable	Applicable only to re-entry CubeSats
4.2.1	Performance - General	Partially applicable	g.4-6 only applicable to re-entry CubeSats
4.2.2	High temperature range	Partially applicable	Applicable only to re-entry CubeSats
4.2.3	Cryogenic temperature range	Not applicable	
4.3.1	Requirements towards other subsystems - General	Not applicable	Subsystem requirements spec not required, TCS requirements are defined at system-level only for CubeSat.
4.3.2	Mechanical	Partially applicable	c. Not applicable, since subsystem ICD not required for CubeSats.
4.3.4.1	Propulsion	Not applicable	CubeSats do not use chemical propulsion.
4.3.7	Launcher	Partially applicable	CubeSats are fully contained within a deployment system. The deployment system has the interface with the launcher. The interface requirements shall therefore be defined between the CubeSat and the deployment system provider.
4.3.9	ECLS	Not applicable	

4.4.1	Design - General	Partially applicable	c. the TCS design shall be documented in the system design report as per the project DRD.
4.4.3	Parts, materials and processes (PMP)	Partially applicable	a. Not applicable –CubeSats use COTS items b. Qualification/acceptance programme is performed at system-level during the satellite PFM protoflight testing. c. TCS input to system-level DML according to the project DRD.
4.4.4	EEE components	Partially applicable	a. Not applicable –CubeSats use COTS items b. Qualification/acceptance programme is performed at system-level during the satellite PFM protoflight testing.
4.4.9	Reliability	Not applicable	
4.4.10	Interchangeability	Not applicable	
4.4.11	Maintenance	Not applicable	
4.4.12	Safety	Not applicable	
4.5.1	Verification - Overview	Not applicable	
4.5.2.1	All temperature ranges	Partially applicable	d. not applicable e. TMM and GMM shall be documented in the thermal analysis report as per project DRD f. thermal analysis report shall use project DRD. g. Only thermal vacuum tests shall be performed on the satellite PFM h. and I, not applicable
4.5.2.2	CCS	Not applicable	
4.5.2.3	High temperature TPS	Partially applicable	Applicable only to re-entry CubeSats. a. Thermal tests on TPS shall be included in the system Development Plan.
4.5.3	Thermal balance test	Partially applicable	Need for a thermal balance test to be determined on a per project basis. In case of need, the references to the Annex DRDs are not applicable.

4.6	Production and manufacturing	Not applicable	
4.7	In-service requirements	Not applicable	
4.8	Product Assurance	Not applicable	
4.9.1	Deliverables - General	Not applicable	
4.9.2	Deliverables - Hardware	Partially applicable	TCS requirements are defined at system-level only
4.9.3	Deliverables - Documentation	Not applicable	
4.9.4	Deliverables – Mathematical models	Not applicable	
5	Document Requirements Definitions (DRD) List	Not applicable	The project DRD applies.
Annex A to F	Various TCS DRDs	Informative	
Annex G	Cryogenic Temperature range	Not applicable	

3.7   ECSS-E-ST-32C Rev.1 Structural general requirements

This document is APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.2.1	Lifetime	Partially applicable	e. not applicable –service life is very short for CubeSats
4.2.2	Natural and induced environment	Partially applicable	b. not applicable
4.2.4	Microgravity, audible noise and human induced vibration	Not applicable	
4.2.5	Load events	Partially applicable	c. 3 (b), (e), (g) to (j) not applicable c. 3 (f) applicable only to micro-vibration if there are sensitive items (e.g optical systems) identified c. 4 applicable only to re-entry CubeSats
4.3.1	Functionality - Overview	Not applicable	

4.3.11	Lightning protection	Not applicable	CubeSats are enclosed within a deployment system during launcher integration. The deployment system is contained within launcher fairing.
4.4	Interface	Partially applicable	B 3 and 5 C 1 is replaced by CubeSat Design Specification C 2, 3, 4 and 6 not applicable D 4 not applicable
4.5.1	Design - Inspectability	Partially applicable	a. visual inspection only b. and c. not applicable
4.5.2	Interchangeability	Not applicable	
4.5.3	Maintainability	Not applicable	
4.5.6.2	Corrosion effects	Not applicable	
4.5.7	Mechanical parts selection	Not applicable	
4.5.8	Material design allowables	Not applicable	
4.5.9	Metals	Partially applicable	B not applicable –no redundant structure
4.5.10.2	Non-metallics other than glass and ceramics	Partially applicable	B not applicable –no redundant structure
4.5.11	Composite materials	Partially applicable	B not applicable –no redundant structure
4.5.13	Ablation and pyrolysis	Partially applicable	Applicable only to re-entry CubeSats
4.5.14	Micrometeoroid and debris collision	Not applicable	Due to short mission duration and no available volume for protection systems on CubeSats.
4.6.1	Verification - Overview	Not applicable	
4.6.2.1	Verification by analysis - General	Partially applicable	c. not applicable. CubeSat is not directly interfaced to the launcher. CLA is performed by the deployment system provider.
4.6.2.4	Modal analysis	Partially applicable	b. and c. not applicable.
4.6.2.5	Dynamic response analysis	Partially applicable	B not applicable. CubeSats are enclosed in deployment systems, so have no structural assemblies during launch.

4.6.2.6	Acoustics analysis	Not applicable	CubeSats are enclosed in deployment systems during launch, hence protected from acoustic effects.
4.6.2.7	Fluid structure interaction (FSI)	Not applicable	
4.6.2.8	Fatigue analysis	Partially applicable	Applicable only to Fracture Critical Items.
4.6.2.9	Fracture control analysis	Not applicable	Covered by separate tailoring on Fracture Control standard.
4.6.2.10	Bucking analysis	Not applicable	
4.6.2.11	Thermo-elastic and Hygro-thermal analysis	Partially applicable	Applicable only to re-entry CubeSats and to items which are assess to be sensitive to misalignment.
4.6.2.12 to 4.6.2.16	Joints and Inserts	Not applicable	
4.6.2.17	Aeroelastic analysis	Partially applicable	Applicable only to re-entry CubeSats
4.6.2.20	Dimensional stability	Not applicable	
4.6.2.21	Micro-vibrations, microgravity, audible noise and human induced vibration analysis	Partially applicable	Applicable only to micro-vibration sensitive items (e.g. optical systems) where there are identified sources of micro-vibration (e.g. reaction wheels). Alternatively, verification may be performed by test.
4.6.3.1	Verification by test - Overview	Not applicable	
4.6.3.4	Development tests	Not applicable	
4.6.3.5 and 4.6.3.6	Qualification and Acceptance Tests	Partially applicable	Qualification and acceptance tests are combined since a protoflight model philosophy is used for CubeSats.
4.6.3.7	Static test	Not applicable	Verification by analysis.
4.6.3.9	Dynamic tests: sine, random, shock	Partially applicable	Shock tests shall only be performed if required by the launch authority. Any shock test shall take into account the attenuation of the spectrum provided by the deployment system.
4.6.3.10	Acoustic test	Not applicable	

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4.6.3.11	Fatigue and fracture test	Not applicable	
4.6.3.12	Micro-vibrations....tests	Not applicable	
4.6.3.13	Non-destructive inspection and test	Partially applicable	The satellite PFM structure shall undergo visual inspection only before and after mechanical testing.
4.6.3.14	Thermo-elastic test	Not applicable	Verification by analysis
4.6.3.15	Thermal cycling test	Partially applicable	a. and b. performed as part of satellite PFM thermal cycling test c. replaced by number of cycles required by the ECSS Testing standard tailoring.
4.6.3.16	Ageing test	Not applicable	
4.6.3.17	Contamination test	Not applicable	
4.6.3.18	Mass and inertia properties measurement	Partially applicable	Mass measurement only. Inertia properties determined by analysis.
4.6.3.19	Alignment checks	Partially applicable	Only for items identified as requiring precise alignment
4.6.3.20	Dimensional stability tests	Not applicable	
4.6.3.21	Geometrical control	Not applicable	
4.6.3.23 & 24	Aerothermodynamic test & Aeroelastic test	Partially applicable	Only applicable to re-entry CubeSats
4.6.3.25	Lightning protection	Not applicable	
4.6.4	Verification of composite structures	Not applicable	
4.7.1	General	Not applicable	
4.7.4	Tooling	Not applicable	
4.7.6	Assembly - Storage	Partially applicable	B, c and d not applicable
4.8	In-service	Not applicable	
4.9	Data exchange	Not applicable	
4.10	Deliverables	Not applicable	
Annex A to Q	Various DRDs	Not applicable	Informative only

3.8   ECSS-E-ST-32-01C Rev.1 Fracture control

This document is NOT APPLICABLE unless requested by the launch and/or ground safety authority (where the structural failure of system or its component lead to the catastrophic consequences). However, in this case, and in the case where programmatic reasons ask for it, the so called reduced fracture control program according para.11 becomes applicable.

Section	Title	Applicability	Note
6.3.2	Safe life items	Partially applicable	Fracture mechanics verification of metallic pressure vessels shall be performed in conformance with this section.
7	Fracture mechanics analysis	Partially applicable	Fracture mechanics verification of metallic pressure vessels shall be performed in conformance with this section.
8.2.2.2 a-c	Requirements (pressure vessels)	Applicable	For safe-life demonstration

3.9 ECSS-E-ST-32-02C Rev.1 Structural design and verification of pressurised hardware

This document is NOT APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.2.1 a-c	Leak tightness	Applicable	
4.3.1 b	Factors of safety	Applicable	
4.3.2.1	Development approach (metallic pressure vessels)	Applicable	Emphasis should be placed on non-LBB and safe-life demonstration by analysis and/or test
4.3.2.2	Qualification tests (metallic pressure vessels)	Applicable	2 qualification models
4.3.2.3	Acceptance tests (metallic pressure vessels)	Applicable	
5.2	Structural engineering	Applicable	

3.10 ECSS-E-ST-32-08C Materials

This document is NOT APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.2.1	Strength	Applicable	
4.2.2	Elastic modulus	Applicable	
4.2.3	Fatigue	Applicable	
4.4.1	Joining - General	Applicable	

4.5.1	Metallic design allowables	Applicable	

3.11   ECSS-E-ST-33-01C Mechanisms

This document is NOT APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.2.4.1	Product characteristics – Marking and Labelling	Applicable	
4.2.4.2	Parts and components	Partially applicable	Only b. and c. are applicable
4.2.4.4	Maintainability	Partially applicable	Only a. is applicable
4.2.5.1	Reliability	Partially applicable	Only c. and e. are applicable
4.2.5.2	Redundancy	Partially applicable	Only a., c. and e. are applicable. e. is modified as follows: compliance with ECSS-Q-ST-30 is not necessary, however the supplier shall demonstrate steps to ensure a high reliability of the mechanism.
4.3	Mission and environments	Applicable	
4.4	Functional requirements	Applicable	
4.5.2.8	Radiation	Partially applicable	Only a. is applicable
4.5.2.9	Atomic Oxygen	Partially applicable	Only a. is applicable
4.5.3	Operational constraints	Partially applicable	Only a., b., d. and e. are applicable.
4.6.2	Thermo-mechanical interfaces	Applicable	
4.7.2	Design Requirements – General Design	Applicable	
4.7.3.1	Tribology - General	Partially applicable	All applicable except f. and g.
4.7.3.4.2	Bearing pre-loading	Partially applicable	Only a., e., g. and h. are applicable.
4.7.4.2	Mechanisms thermal design and sizing	Applicable	
4.7.5.1	Mechanical design and sizing - General	Applicable	
4.7.5.2	Structural dimensioning	Applicable	

4.7.5.3	Functional dimensioning (motorization)	Applicable	
4.7.5.4	Other mechanical design and sizing requirements	Partially applicable	4.7.5.4.5 applicable. 4.7.5.4.6 applicable. 4.7.5.4.8 applicable. 4.7.5.4.10 applicable. 4.7.5.4.12 applicable.
4.7.7.1	Electrical design	Partially applicable	4.7.7.1.1 a. to e. applicable.
4.7.7.2	Insulation	Partially applicable	Only a. applicable.
4.7.7.2	Dielectric	Partially applicable	Only a. applicable.
4.7.7.4	Grounding	Applicable	
4.7.7.5	Electrical connectors	Applicable	
4.7.7.6	Over current protection	Applicable	
4.7.7.7	Strain on wires	Applicable	
4.7.8	Open-loop and closed-loop control system for mechanisms	Applicable	
4.8.2.2 to 4.8.2.8	Verification by analysis - Various	Applicable	
4.8.2.11	Shock generation and susceptibility	Applicable	
4.8.2.12	Disturbance generation (emission) and susceptibility	Partially applicable	Applicable only to micro-vibration sources where they may causes disturbance to micro-vibration sensitive items on the satellite.
4.8.3.1	Verification by test - General	Applicable	
4.8.3.3	Qualification testing	Partially applicable	4.8.3.3.1 to 4.8.3.3.5 are applicable. 4.8.3.3.8 a. is applicable. 4.8.3.3.9 a. is applicable. 4.8.3.3.10 to 4.8.3.3.17 are applicable.
4.8.3.4	Acceptance testing	Partially applicable	4.8.3.4.2 a., c and d. applicable. 4.8.3.4.4 applicable.

3.12 ECSS-E-ST-35-01C Liquid and electric propulsion for spacecraft

This document has been tailored for chemical propulsion only (electric propulsion not yet used in ESA IOD CubeSats). It is is NOT APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.2.1	Mission	Applicable	
4.2.2	Functions	Partially Applicable	All subsections are applicable, except b3, b4, b10, b11. These are TBD.
4.3.3	Induced and environmental temperatures	Applicable	
4.3.4	Thermal fluxes		
4.3.5	Thruster plume effects	Partially Applicable	Plume effects shall be evaluated and mitigated as necessary.
4.4	Interfaces	Partially Applicable	All subsections are applicable, except 4.4.a4 and 4.4.a5. These are TBD.
4.5.1.3a	Water-hammer effect	Partially Applicable	Evaluation shall be performed to confirm no water hammer issues and ensure proper propulsion system functioning. This shall include assessment of worst case pressure transients.
4.5.1.4a	Piping	Partially Applicable	A piping design evaluation shall be performed to including cross-coupling, leakage, pressure and eigen frequencies.
4.5.1.5	Closed volumes	Applicable	
4.5.1.6	Pressure vessels and pressurized components	Partially Applicable	Pressure vessels and pressurized components shall conform to the tailored version of ECSS-E-ST-32-02 and requirement 4.5.1.6.a.2.
4.5.1.7.a.	Multi-tanks	Applicable	
4.5.1.8	Cycles	Applicable	
4.5.2.2	General (selection)	Applicable	
4.5.2.3	Propellant selection	Applicable	
4.5.3	Sizing	Partially Applicable	The following subsections are applicable: a, b1-4& 6, and c.
4.5.4.1	General (design development)	Applicable	Verification during development shall include the following characteristics at a minimum: mass flow rate, dynamic and static pressure,

			response time.
4.5.5	Contamination	Partially Applicable	All applicable, except 4.5.5.1.b shall refer to the plume evaluation described in 4.3.5c note above.
4.5.6	Draining	Applicable	
4.5.7	Risk of explosion	Partially Applicable	a, b, & d are applicable for both risk of explosion and risk of fire. Evaluation shall substantiate compliance with these requirements. Evaluation may include analysis, testing or reference to documentation describing past analysis or testing for representative conditions.
4.5.8	Components guidelines	Partially Applicable	Assessment of failure risk/tolerance shall be peformed for propulsion system components using table 4-1 as a guide.
4.5.9.	Filters	Partially Applicable	For subsections a and b, reference to analyses performed shall be replaced by reference to evaluations performed in accordance with the tailoring as described above. Subsection c is applicable.
4.5.11.1	General (propellant tanks)	Partially Applicable	Subsections a, f, g, h are applicable. In addition, the spacecraft/propulsion system design and operational approach shall preclude unintended change of phase of the propellant (e.g. freezing, evaporation) and shall preclude overpressurization of the tank.
4.5.13	Flow calibration	Applicable	
4.5.14	Thrusters	Partially Applicable	4.5.14 and 4.5.14.2-4.5.14.4, 4.5.14.7.a and 4.5.14.8 are applicable. 4.5.14.5 applicability is TBD.
4.5.17	Mass imbalance	Applicable	

4.5.18	Monitoring and failure detection	Applicable	
4.5.19	Ground support equipment	Applicable	
4.6	Verification	Partially Applicable	Compliance of all requirements noted above shall be verified by analysis, testing, and/or similarity as agreed by the customer
4.6.2.1	Propellant and pressurant (verification by analysis)	Applicable	
4.6.2.2.2	Steady state characteristics (verification by analysis)	Partially Applicable	Subsections a1(a)&(c) are applicable.
4.6.3.1	Thruster firing test	Partially Applicable	Subsections a, b1, b3, b6, b7, b10, c, and d are applicable.
4.6.3.2	Proof pressure test	Partially Applicable	Subsections a, d, and f are applicable. Reference to other ECSS standards shall be in accordance with the tailored versions.
4.6.3.3	Burst pressure test	Partially Applicable	Burst tests shall be performed on pressure vessels and pressurized components for which EMs, EQMs or QMs are produced. Subsections b and d are applicable.
4.6.3.9	Flow test	Partially Applicable	Subsections a & b are applicable.
4.6.3.10	Leak test	Applicable	
4.6.3.11	Dryness	Applicable	
4.6.3.12	Electrical test	Applicable	
4.6.3.13	Thruster alignment	Applicable	
4.6.3.14	Calibration	Applicable	
4.7.2	Production and manufacturing process	Applicable	
4.8.2	Operations on ground	Partially Applicable	Subsections a and c are applicable
4.8.3a.	Tank operation	Applicable	

3.13 ECSS-E-ST-50C Communications

This document is APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
5.2.1.3	Space communication system engineering process – Requirements engineering – Outputs	Partially applicable	Communications subsystem requirements are defined in the project SRD. A separate CSRD is not required.
5.2.2.2	Analysis - Activities	Partially applicable	a 3. Criticality analysis Not applicable.
5.2.2.3	Analysis - Outputs	Partially applicable	a. Doppler margin analysis applicable only to Inter-Satellite Links. Analysis output is documented in the System Design Report. A separate CSAD is not required. b. not applicable. C & d. are part of the system AIV plan for the project. Therefore, a separate CSVP is not required.
5.2.3.2	Design and configuration - Activities	Partially applicable	a. 3 and 4 not applicable.
5.2.3.3	Design and configuration - Outputs	Partially applicable	a. design to be documented in the System Design Report. Separate documents are not required. b. Not applicable c. Simulation results to be documented in the System Design Report. Separate documents are not required. d. Not applicable.

5.2.4.3	Implementation - Outputs	Partially applicable	b. comms subsystem plans and definition of test and check-out equipment to be documented in System AIV Plan. Separate documents are not required.
			c. Comms subsystem to be tested as part of System functional and end-to-end tests with ground station. Relevant procedures to be included in the system test procedures. Separate documents are not required.
			d. Relevant simulations and demonstrations to be included in update to System Design Report. Separate documents are not required.
			e. Comms subsystem to be tested as part of System functional and end-to-end tests with ground station. Relevant test results to be included in the system test reports. Separate documents are not required.
			f. Not applicable. Covered by RFD in case of changes to design under configuration control. Separate documents are not required.

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5.2.5.3	Verification - Outputs	Partially applicable	a. Comms subsystem to be tested as part of System functional and end-to-end tests with ground station. Relevant test results to be included in the system test reports. Separate documents are not required. b. Not applicable.
5.2.6	Operations	Not applicable	
5.4.4	Telecommanding – Essential command distribution	Partially applicable	b. not applicable
5.4.5	Command authentication	Not applicable	
5.4.6	Command encryption	Not applicable	
5.5.2	Telemetry – Essential telemetry acquisition	Partially applicable	b. not applicable
5.5.6	Telemetry – Simultaneous support of differing source rates	Partially applicable	a. not applicable
5.6.2	Directionality	Not applicable	
5.6.9	Mixed isosynchronous and asynchronous traffic	Not applicable	
5.6.10	Mixed housekeeping and payload data	Applicable	In addition, IOD CubeSats may transmit housekeeping data and payload data on two separate channels on different frequency bands (e.g. UHF and S-band).
5.6.11.2	Space link performance – Operation during tumbling	Partially applicable	Only one simulation is required.
5.6.11.3	Tolerance of run lengths and transition densities	Not applicable	
5.6.11.4	Failure modes	Not applicable	
5.6.11.10	Low delay	Not applicable	
5.6.12.1	Space link frequency – space link media	Not applicable	
5.6.13.2	Data unit identifier	Not applicable	

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5.6.13.4	Error detection	Not applicable	
5.6.13.5	ARQ settings	Not applicable	
5.6.14.1 to 5.6.14.5	Space link service - various	Not applicable	
5.6.14.7	Ranging	Partially applicable	CubeSats do not normally use ranging for orbit determination. Only applicable if required by the mission.
5.6.14.9	Space link exception reporting	Partially applicable	To the extent possible with a CubeSat system
5.7	Space network	Partially applicable	Intra-satellite communication in a CubeSat is covered by the data handling subsystem. Only applicable to CubeSats with Inter-Satellite Links.
5.8.1	Ground network - Overview	Not applicable	
5.8.3	Security	Not applicable	
Annex A to I	Various DRDs	Not applicable	Informative only.

3.14   ECSS-E-ST-50-05C Radiofrequency and modulation

This document is NOT APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
4.1	Frequency allocations to the Space Operation, Space Research and Earth Exploration-Satellite services	Applicable	Frequency listed in the standard are not exhaustive of all possibilities foreseen by ITU. If one (or more) of the listed frequency allocation is selected, conditions given in related sub-section and in 4.2 shall be followed.
4.2	Specific conditions for the use of certain frequency bands	Applicable	Depending on the selected band, pertinent sub-section to be applied.
5.5	Emissions	Applicable	These sections is derived from ITU/RR that are not tailorable. Depending on the specific frequency allocation in use specific sub-section may only apply.
8.3	Link Budget Tables	Applicable	

3.15 ECSS-E-ST-60-30C Satellite attitude and orbit control system (AOCS) requirements

This document is APPLICABLE with the following exceptions:

Section	Title	Applicability	Note
5.1.2.2	Hardware and software redundancy scheme	Partially Applicable	a. Not applicable due to limited or no redundancy on CubeSats; b. Applicable only for different sensors/actuators used in safe mode.
5.2.2.2	Housekeeping TM	Partially Applicable	a. Applicable; b. Applicable; c. Not applicable, depending on the mission needs
5.2.2.3	Diagnostic and event TM	Partially Applicable	a. Applicable; b. Not applicable due to limited or no redundancy on CubeSats; c. Not applicable due to limited or no redundancy on CubeSats;
5.3	Performance requirements	Informative	Performance requirements for CubeSats are specified at system-level in the project MRD/SRD. Such system-level requirements may use one or more of the requirements specified in this section.
5.4.3	Verification facilities	Applicable	A separate AOCS test bench may be used instead of an avionics test bench at system-level, in case that the AOCS functions are implemented on a dedicated AOCS computer (common for most CubeSats).

5.4.6	Verification at satellite level	Partially Applicable	Test shall be conducted according to the tailored version of ECSS-E-ST-10-03 as specified in this document.
5.4.7	AOCS-ground interface verification	Partially Applicable	Separate ground flight dynamics system not implemented for CubeSats. The interface test shall be limited to TM/TC exchange between AOCS software and Mission Control software only.
5.4.8	In-flight verification	Partially Applicable	a-d. Applicable e. Not applicable
5.5.2	Required Documentation	Partially Applicable	a. 1-7 as part of system-level documentation as per CubeSat-specific DRD, User Manual not required unless AOCS supplier is different to system integrator. b. to f. Not applicable.
Annex A to D	DRDs	Not Applicable	
Annex F	AOCS Documentation delivery per Phase	Informative	Comments column not relevant since the AOCS documentation is provided as inputs to system-level documentation, with exception of AOCS Simulation and Test Report which are separate documents in the CubeSat-specific DRD.