Propulsion Subsystem Requirements for the Delfi-PQ Satellites

Description: This document includes the requirements for the propulsion system of the Delfi-PQ satellites.

Subsystem(s) involved:

OBC	EPS	COMMS	ADCS	µPS+	Struct	Thermal	Launch
				X			

Revision Record and Authorization

Issue	Date	Author / Editor	Reviewer checked	PM approved	Affected Section(s)	Description of change
1.0	12-05-2017	V. Pallichadath	X	X		First Delfi-PQ Version
2.0	01-02-2018	V. Pallichadath	X	X	All	Implemented comments from A. Cervone, B. Zandbergen , M. A. C. Silva and D. C. Guerrieri

Action Items

TBW	TBD	TBC	Applicable Section(s)	Description of action item

Important Note(s): The document is highly iterative and serves as an indication merely at the moment, due to the nature of the project. The design description of the systems will be added when consolidated.

Table of Contents

1. Introduction

This document serves as a leading document that includes all the requirements for the dual thruster micro-propulsion (DTMP) payload system for the Delfi-PQ satellites. The target for the micro-propulsion payload is to simultaneously test two different micro-resistojet technologies: one based on vaporization of slightly pressurized liquid water (VLM – Vaporizing Liquid Micro-resistojet) and one based on the free molecular acceleration of propellant molecules stored at very low pressure (LPM –Low-Pressure Micro-resistojet). The payload has common propellant storage for the two concepts, based on the use of the capillarity properties of water in small diameter tubes and two separate MEMS chips with their own dedicated valves (for heating and accelerating the propellant). The requirements to the propulsion system as a whole are divided into six main categories: General Requirements & Constraints (Section 3), Performance requirements (Section 4), Functional Requirements (Section 5), Interface Requirements(Section 6), Assembly, Integration, Verification And Testing (AIVT) / Reliability, Availability, Maintainability And Safety Requirements (RAMS) (Section 7) and Environment & Launch Load Requirements (Section 8)

The labels of any propulsion system requirements always start with "**PROP-**". It is followed by a four-letter or three-letter clause, respectively for the propulsion system level or subsystem levels. Finally, a three digit unique ID is given. The full standard of requirement labeling is shown in Table 1.

Table 1. Definition of labels.

First Clause	Second Clause	Requirement level	Third Clause	Requirement type
PROP -	SYST-	General requirements & Constraints Propulsion System	100	Mass budgets
			200	Volume budgets
			300	Power budgets
			400	Data budgets
			500	Life Time
			600	Development timeline
	PERF-	Performance requirements on Propulsion System Level	100	Delta-V requirements
			200	Maximum Thrust
			210	Minimum Thrust
			300	Leak rate
			400	Bus Voltage
	FUN-	Functional Requirements	100	Modes of Operation
			200	Thruster Operation
			300	Feed System Operation mode
			400	Payload Switch on/off
			500	Propellant Storage Empty

			600	Control electronics
			700	Sensing & Monitoring
	INT-	Interface Requirements	**100**	Mechanical
			200	Thermal
			300	Electrical
			400	Data Exchange
			500	Propellant Tank Fill
	AIVT- **RAMS-**	Assembly, Integration, Verification And Testing (AIVT) / Reliability, Availability, Maintainability And Safety Requirements (RAMS)	**100**	System Placement / Installation
			200	Internal Pressure
			300	Production / Materials
			310	Production / Materials
			320	Production / Materials
			400	Thermal Vacuum bake out
			500	Electrical ground
			600	Design factor for yield load
			700	Design factor for ultimate load
	ERL	Environment & Launch Load Requirements	**100**	Payload Compatibility
			200	Accelerations levels
			300	Vibration levels
			400	Ext. mech loads
			500	Flight Shocks
			600	Pre-launch thermal environment
			700	Aerodynamic heating
			800	Pressure levels
			900	Vacuum levels

2. Applicable and Reference Documents

2.1 Applicable Documents

AD01	DPQ-TUD-MA-001 [1.0] Launcher Loads for Small Satellites
AD02	DPQ-TUD-IC-01 [*latest version*] Delfi-PQ Software ICD
AD03	Thermal Budget
AD04	DPQ-TUD-BU-01 [0.3] Delfi-PQ Power Budget DPQ-TUD-BU-01 [0.3] Delfi-PQ Power Budget
AD05	PQ9 & CS14 Electrical and Mechanical Interface Standard [0.6]
AD06	
AD07	
AD08	

2.2 Reference Documents

RD01	DPQ-EXT-RF-005 Nanoracks ICD [December 2013]
RD02	DPQ-TUD-SE-02 [*latest version*] Delfi-PQ - Mission Definition Document
RD03	DPQ-TUD-TN-STS-01 [0.3] Structural Design
RD04	DPQ-TUD-TN-EPS-02 [0.5] Electric Design EPS
RD05	GRM-CPU-RS-0028 [12] CubeSat Design Specification
RD06	http://www.delfispace.nl/

3. General Requirements & Constraints

PROP-SYST-100	Mass
Type	Constraint
Description	The total wet mass of the propulsion system at launch shall be not higher than 75 g.
Verification	Review of Design, Inspection and Scale test
Rationale/ *Comment*	This value is based on the requirements given in the DPQ-TUD-BU-02 [3.0] from Delfi-PQ Mass & Volume budget. The approximate final mass with flight model contingency will be 75 g (assuming 0.1% contingency).

PROP-SYST-200	Volume
Type	Constraint
Description	The total size of the propulsion system shall be within 42 mm x 42 mm x 30 mm (including thrusters, valves, electronics board, harness, connectors & propellant storage tube).
Verification	Review of Design and Fit test
Rationale/ *Comment*	This value is based on the requirements (MIS-C-05) given in the DPQ-TUD-BU-02 [3.0] from Delfi-PQ mass & Volume budget and on the connector stacking options provided in PQ9 standard [AD05] (applicable for micro-propulsion option 7). See available connector stacking for micro-propulsion subsystem (option 7 in AD05): Maximum component height above PCB 4mm; Maximum component height below PCB 27-28mm; Board spacing distance: 32-33mm; Pin insert depth: 4.6-5/3.6-5mm; Total stacking height 33.6-34.6mm.

PROP-SYST-300	Power Consumption
Type	Constraint
Description	The peak power consumption of the propulsion system during ignition or heating shall be not higher than 4 W and duration shall not be longer than <TBD> per day.
Verification	Test: an interface test/stack test is needed to show compliance with this requirement.
Rationale/ *Comment*	This value is based on the requirements (SAT.2.1-C-03, SAT-C-12, SAT-C-13) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification Note

PROP-SYST-400	Data Volume
Type	Constraint
Description	The maximum amount of propulsion system data that can be stored in the memory storage unit on board the satellite is <TBD> GB.
Verification	Review of Design
Rationale/ *Comment*	This will be updated later TBD

PROP-SYST-500	Life Time
Type	General
Description	The critical mission lifetime of the propulsion system shall be equal to at least 3 months
Rationale/ *Comment*	This value is based on the requirements DPQ-TUD-SE-02 from the Delfi-PQ mission definition document. In this time span, the satellite core segment will need to prove its reliability whereas the advanced subsystem/payload will complete its mission. This is the absolute minimum for the mission lifetime. However, as follow up a target (MIS-T-05), the target lifetime should be equal to at least 2 years.

PROP-SYST-600	Development timeline
Type	General
Description	The time available for the development of the propulsion system is TBD
Rationale/ *Comment*	Delfi-PQ is expected to have the first launch in 2018 TBC Note: Currently no reference available

4. Performance Requirements

PROP-PERF-100	Delta –V
Type	Performance
Description	The first prototype shall be a technology demonstration.
Rationale/ *Comment*	*Note: No Δv requirement from mission side*

PROP-PERF-200	Maximum Thrust
Type	Performance
Description	The thrust provided by the propulsion system shall be 3 mN as a maximum.
Verification	Review of Design and interface/stack test
Rationale/ *Comment*	This requirement is strongly dependent on considering the maximum rotational rates of satellite is 360 degrees/second (all three axes together) (*this value is based on the requirements (SAT.1.7-F-01,) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note)* *Note: Assume thruster is placed in the middle but on the edge of the satellite the maximum estimated satellite rotation rates due to the maximum thrust (3mN) is 124 deg/s (worst case).*

PROP-PERF-210	Minimum Thrust
Type	Performance
Description	The thrust provided by the propulsion system shall be at least 0.12 mN.
Rationale/ *Comment*	The maximum estimated value of the drag force, calculated using an atmospheric density of 35 g/km^3, a drag coefficient of 4.6, a frontal area of 0.0025 m^2 and a satellite velocity of 7700 m/s, is approximately equal to 12 µN. The propulsion system shall deliver a thrust equal to at least 10 times this value of the drag, that is at least 0.12 mN.

PROP-PERF-300	Leak rate
Type	Performance
Description	The maximum leak rate shall be <TBD> at maximum operating pressure.
Verification	Review of Design; All verification tests.
Rationale/ *Comment*	Any leakage can damage other components and onboard experiments. *This is based on the requirements (SAT.2.1-C-06) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document*

PROP-PERF-400	Bus Voltage Regulation
Type	Performance
Description	The micro-propulsion system shall operate on a single unregulated supply voltage of 3[VDC] to 4.1[VDC].
Verification	Review of Design
Rationale/ *Comment*	DC-DC converters shall be locally used to regulate the voltage required for the all the propulsion devices including thrusters, feed system, sensors and propellant tank Based on the voltage specification defined by the Delfi-PQ [Ref will be published soon]

5. Functional Requirements

PROP-FUN-100	Modes of Operation
Type	Functional
Description	The micro-propulsion system shall have at least two modes: idle with max. power consumption 15 mW, and full thrust with max. power consumption 4W.
Verification	Testing of subsystem; Review of Design
Rationale/ *Comment*	The subsystem has to have an idle mode for the periods of time in which the experiment is starting and check-ups need to be done. The payload will be switched on only when the experiment starts and will be switched off when it finishes. In Idle mode, general sensor measurements can be performed. This value is based on the requirements (SAT.2.1-C-15, SAT-C-12, SAT-C-13) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note

PROP-FUN-200	Thruster Operation
Type	Functional
Description	The thruster shall be able to operate on gaseous N_2, as well as on liquid H_2O.
Verification	Review of Design
Rationale/ *Comment*	To uncouple the development of the thruster to that of other subsystems, either propellant may be supplied.

PROP-FUN-300	Feed System Operating mode
Type	Functional
Description	The feed system shall operate in a normally closed configuration.
Verification	Testing of subsystem, Review of Design
Rationale/ *Comment*	With no power applied to the system, the propulsion system should not flow propellant to the thruster.

PROP-FUN- 400	Payload Switch off
Type	Functional
Description	The micro-propulsion payload will be turned off if the system is not undergoing any type of demonstration/operations and also when the propellant storage tank is empty.
Verification	Testing of subsystem, Review of Design
Rationale/ *Comment*	*This is based on the requirements (SAT.2.1-C-12 & SAT.2.1-C-13) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document*

PROP-FUN-500	Propellant Storage Empty
Type	Constraint
Description	The propellant storage shall be left empty when the micro-propulsion payload demonstration is completed.
Verification	Testing of subsystem, Review of Design
Rationale/ *Comment*	The micro-propulsion will be turned off but in order to do so and to assure no contamination or potential leakage, before switching off, the tank must be empty. *this is based on the requirements (SAT.2.1-C-13) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document.*

PROP-FUN-600	Control Electronics
Type	Functional
Description	The control electronics shall have a Spike and Hold circuit, voltage & current monitoring circuit, Resistor heater circuit, microcontroller and sensor interfacing, overcurrent protection circuit.
Verification	Review of Design
Rationale/ *Comment*	Necessary for the operation of a valve (active control) & Sensor interfacing. The EPS shall include overcurrent protection on all independent power supply lines within the satellite. Having a fuse shall prevents too high currents as well as a means of resetting the system.

PROP-FUN-700	Sensing & Monitoring
Type	Functional
Description	The Micropropulsion system shall allow for the mounting of electronic sensing devices for the measurements of propellant temperature and pressure inside the tank, temperature and pressure measurements, IMU measurements (accelerometers & gyroscopes), Voltage Monitoring/ Current monitoring/ Temperature Measurement
Verification	Review of Design
Rationale/ *Comment*	Necessary for the monitoring of housekeeping data and sensor interfacing

6. Interface Requirements

PROP-INT-100	Mechanical Interface
Type	Interface
Description	The mechanical interface between the propulsion system and the satellite shall be compliant with option 7 from the PQ9 standard connector stacking and shall respect the PQ9 standard in PCB selection and sizing. For more information see AD[05].
Verification	Review of Design
Rationale/ *Comment*	Micro-propulsion payload has to be compatible with Delfi-PQ standard. *This is based on the requirements (SAT.2.1-I-01) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document*

PROP- INT-200	Thermal Interface
Type	Interface
Description	The thermal interface between the propulsion system and the satellite shall allow for the propulsion system components to stay in a temperature range between 5°C and +85 °C during all the mission phases when propulsion system operations are required. TBD
Verification	Thermal & Thermal Cycling test
Rationale/ *Comment*	Propulsion system performance is strongly dependant on the temperature. The effectiveness of the propellants storage can also be affected by too extreme temperatures and also to avoid risks of propellant freezing. *This requirement (SAT.2.1-C-07) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document is to assure safety on board and to make sure the tank does not crack/break due to the exterior temperature during an eclipse or during the launch.*

PROP- INT-300	Electrical Interface
Type	Interface
Description	The propulsion system shall be electrically connected to the satellite power subsystem through the standard RS-485 interface [AD10] and shall respect the mechanical and electrical interface of connector stacking option 7 from the PQ9 standard document [AD10].
Verification	Review of Design & Interface test
Rationale/ *Comment*	Delfi-PQ and the PQ9 standard uses RS485. *This is based on the requirements (SAT.2.1-I-02) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document*

PROP- INT- 400	Data Exchange Interface
Type	Interface
Description	The data exchange interface between the propulsion system and the satellite shall be RS-485, with a data transfer rate of <TBD> bit/s.
Verification	Review of Design
Rationale/ *Comment*	This will be updated in later stage TBD

PROP- INT-400	Propellant Tank Fill
Type	Interface
Description	The propellant storage system shall allow for filling and draining the propellants at any time when the fully assembled satellite is still accessible to human operators.
Verification	Review of Design
Rationale/ *Comment*	To allow for filling, ports must be available in the storage device structure. The exact amount, size and location of the fill and drain ports are TBC

7. Assembly, integration, verification and testing (AIVT) / reliability, availability, maintainability, and safety requirements (RAMS)

PROP- RAMS- 100	Propulsion System Placement/ Installation
Type	Assembly
Description	The propulsion system shall be installed in the middle unit of the PocketQube. The two thrusters shall be placed on the same side of the PQ or on two opposite sides.(This decision will be made available at the beginning of 2018 depending on the 3 stack or 1 stack configuration) TBD
Verification	Review of Design
Rationale/ *Comment*	An analysis is made that shall show where is the best location for the micro-propulsion system. One option is on top of the satellite and has the antenna as piggyback on the micro-propulsion board. Another option is to have it somewhere in the middle of the satellite. Nonetheless, it depends on where the exterior hole for the thruster output will be drilled in the panel. This value is based on the requirements (SAT.2.1-C-08) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document

PROP-RAMS-200	Internal Pressure
Type	Safety
Description	The internal pressure of all propulsion system components shall not be higher than 10 bar.
Verification	Review of Design
Rationale/ *Comment*	*This value is based on the maximum pressure the plastic tube(propellant tank) can withstand.*

	Note: Currently no requirements/reference(will be published soon) available from the Delfi-PQ side

PROP-RAMS-300	Production & Materials
Type	Safety
Description	The propulsion system shall not include any pyrotechnic devices.
Verification	Review of Design
Rationale/ *Comment*	This requirement is derived from common CubeSat design specifications and practice (no PocketQube standard available).

PROP-RAMS-310	Production & Materials
Type	Production & Materials
Description	Materials used in the thruster shall be compatible with liquid demineralized water in both liquid and vapor state, nitrogen gas and air.
Verification	Review of Design
Rationale/ *Comment*	This requirement is derived from common CubeSat design specifications and practice (no PocketQube standard available). They shall also be compatible with the space environment according to ESA ECSS standards.

PROP- RAMS-320	Production & Materials
Type	Safety
Description	Materials used in the propulsion system shall not be toxic, flammable, or in any way potentially hazardous for the operators or the other satellite subsystems.
Verification	Review of Design
Rationale/ *Comment*	This is a safety precaution that ensures people that need to handle the satellite will not have risk attached to hazardous materials. This requirement is derived from common CubeSat design specifications and practice (no PocketQube standard available) and from the Delfi-PQ requirement SAT.2.1-C-05. The development is carried out by students, without the expertise or budget to safely handle hazardous materials.

PROP- RAMS- 400	Thermal Vacuum bake-out
Type	Safety
Description	A thermal vacuum bake-out of the propulsion system shall be carried out before launch to ensure a proper outgassing of all its components.
Verification	Review of Design

Rationale/ *Comment*	this requirement is derived from common CubeSat design specifications and practice (no PocketQube standard available).

PROP- RAMS - 500	Electrical ground
Type	Safety
Description	All external parts of the thruster shall be electrically grounded.
Verification	Review of Design & Interface test
Rationale/ *Comment*	Current may leak through various paths, and charge build-up may damage other components *this is based on the requirements (SAT.2.1-C-09) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document*

PROP-RAMS-600	Design Factor for yield Load
Type	Safety
Description	The propulsion system shall have a design factor of safety higher than 1.6 for yield load.
Verification	Review of Design
Rationale/ *Comment*	As specified by Space Mission Analysis and Design

PROP- RAMS-700	Design Factor for ultimate Load
Type	Safety
Description	The propulsion system shall have a design factor of safety higher than 2.0 for the ultimate load.
Verification	Review of Design
Rationale/ *Comment*	As specified by Space Mission Analysis and Design

8. Environment & Launch Load Requirements

PROP-ERL-100	Payload compatibility
Type	Environment & Launch Loads

Description	The payload shall be compatible with a large range of launch opportunities as described in DPQ-TUD-MA-001[1.0].
Verification	Review of Design Analysis: before the launch procurement, the exact loads (and durations) for this requirement will not be known. Therefore AD01 will summarize an envelope of typical launchers for small satellites that can be used as input for the testing of the micro-propulsion payload.
Rationale/ *Comment*	The reference document contains an overview of the most common Launchers (relevant for small satellites) and the applicable interface requirements. However, for the micro-propulsion payload, Nanoracks is not an option since thrusters are not allowed on ISS. The following launchers shall be taken into consideration: Soyuz, Vega, ASLV/SLV/PSLV, Falcon, Electron. *This is based on the functional requirements (SAT.2.1-F-01) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document*

PROP- ERL-200	**Maximum axial and lateral accelerations**
Type	Environment & Launch Loads
Description	The maximum axial and lateral accelerations that the propulsion system shall withstand during the launch are as specified in the reference document (DPQ-TUD-MA-001[1.0]).
Verification	Review of Design & Test: A vibration and shock test is required to show compliance with this requirement.
Rationale/ *Comment*	The reference document (DPQ-TUD-MA-001[1.0]) contains an overview of the most common Launchers (relevant for small satellites) and the applicable interface requirements. However, for the micro-propulsion payload, Nanoracks is not an option since thrusters are not allowed on ISS. The following launchers shall be taken into consideration: Soyuz, Vega, ASLV/SLV/PSLV, Falcon, Electron

PROP- ERL-300	**Maximum vibration levels**
Type	Environment & Launch Loads
Description	The maximum vibration levels at the point of attachment of the satellite during the launch are as specified in the reference document (DPQ-TUD-MA-001[1.0]).
Verification	Review of Design & Test: A vibration test is required to show compliance with this requirement.
Rationale/ *Comment*	The reference document (DPQ-TUD-MA-001[1.0]) contains an overview of the most common Launchers (relevant for small satellites) and the applicable interface requirements. However, for the micro-propulsion payload, Nanoracks is not an

	option since thrusters are not allowed on ISS. The following launchers shall be taken into consideration: Soyuz, Vega, ASLV/SLV/PSLV, Falcon, Electron.

PROP-ERL-400	Maximum acoustic pressures and loads
Type	Environment & Launch Loads
Description	The maximum acoustic pressures and loads that the propulsion system shall withstand during the launch are as specified in the reference document (DPQ-TUD-MA-001[1.0]).
Verification	Review of Design & Test: A vibration and shock test is required to show compliance with this requirement.
Rationale/ *Comment*	The reference document (DPQ-TUD-MA-001[1.0]) contains an overview of the most common Launchers (relevant for small satellites) and the applicable interface requirements. However, for the micro-propulsion payload, Nanoracks is not an option since thrusters are not allowed on ISS. The following launchers shall be taken into consideration: Soyuz, Vega, ASLV/SLV/PSLV, Falcon, Electron.

PROP-ERL-500	Maximum flight shocks
Type	Environment & Launch Loads
Description	The maximum flight shocks that the propulsion system shall withstand during the launch are as specified in the reference document (DPQ-TUD-MA-001[1.0]).
Verification	Review of Design & Test: A vibration test is required to show compliance with this requirement.
Rationale/ *Comment*	The reference document (DPQ-TUD-MA-001[1.0]) contains an overview of the most common Launchers (relevant for small satellites) and the applicable interface requirements. However, for the micro-propulsion payload, Nanoracks is not an option since thrusters are not allowed on ISS. The following launchers shall be taken into consideration: Soyuz, Vega, ASLV/SLV/PSLV, Falcon, Electron.

PROP-ERL-600	Pre-launch thermal environment
Type	Environment & Launch Loads
Description	The pre-launch thermal environment within the launcher fairing is as specified in the reference document (DPQ-TUD-MA-001[1.0]).
Verification	Review of Design & Test
Rationale/ *Comment*	The reference document (DPQ-TUD-MA-001[1.0]) contains an overview of the most common Launchers (relevant for small satellites) and the applicable interface requirements. However, for the micro-propulsion payload, Nanoracks is not an option since thrusters are not allowed on ISS. The following launchers shall be taken into consideration: Soyuz, Vega, ASLV/SLV/PSLV, Falcon, Electron.

PROP-ERL-700	Maximum aerodynamic heating
Type	Environment & Launch Loads
Description	The maximum aerodynamic heating of the nose fairing during the launch is as specified in the reference document (DPQ-TUD-MA-001[1.0]).
Verification	Review of Design & Test
Rationale/ *Comment*	The reference document (DPQ-TUD-MA-001[1.0]) contains an overview of the most common Launchers (relevant for small satellites) and the applicable interface requirements. However, for the micro-propulsion payload, Nanoracks is not an option since thrusters are not allowed on ISS. The following launchers shall be taken into consideration: Soyuz, Vega, ASLV/SLV/PSLV, Falcon, Electron.

PROP-ERL-800	Maximum pressure changes
Type	Environment & Launch Loads
Description	The maximum pressure changes inside fairing that the propulsion system shall withstand during the launch are as specified in the reference document (DPQ-TUD-MA-001[1.0])
Verification	Review of Design & Test
Rationale/ *Comment*	The reference document (DPQ-TUD-MA-001[1.0]) contains an overview of the most common Launchers (relevant for small satellites) and the applicable interface requirements. However, for the micro-propulsion payload, Nanoracks is not an option since thrusters are not allowed on ISS. The following launchers shall be taken into consideration: Soyuz, Vega, ASLV/SLV/PSLV, Falcon, Electron.

PROP-ERL-900	Vacuum Levels
Type	Environment & Launch Loads
Description	The micro-propulsion subsystem shall be compatible with the vacuum and temperature levels of the space environment in Low Earth Orbit.
Verification	Verification tests: Thermal-cycling, Thermal-vacuum
Rationale/ *Comment*	The subsystem has to withstand space environment conditions. *this is based on the requirements (SAT.2.1-C-11) given in the DPQ-TUD-SE-01 [0.6] from Delfi-PQ Technical Requirement Specification note & DPQ-TUD-SE-03[0.6] Delfi-PQ System Specification Document*