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DOCUMENT

Review Objectives for ESA In-Orbit Demonstration (IOD) CubeSat Projects

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1 INTRODUCTION

1.1 Purpose and Scope

The purpose of this document is to define the objectives applicable to different reviews conducted by the Agency on ESA In-Orbit Demonstration (IOD) CubeSat Projects throughout the project lifecycle.

The scope of the project review typically covers the mission, satellite, internal interfaces between platform and payloads, external interfaces with the launcher, and the ground segment.

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)

1.3 Review classification

As agreed with the ESA Project Reviews Office, IOD CubeSat project reviews are conducted at project-level, based on the Category III review process [AD2], due to the small, low cost nature of the project.

1.4 Applicable Documents

[AD1] CubeSat Design Specification, revision 12, California Polytechnic, 1 August 2009.
[AD2] “POLICY FOR ESA PROJECT REVIEWS” ref. ESA/ADMIN/IPOL(2008)3.

2 DESCRIPTION OF REVIEW OBJECTIVES

2.1 Preliminary Design Review

The objectives of the Preliminary Design Review are to:

1. Verify the proper translation and allocation of the mission requirements into a set of system technical specifications, including relevant analysis documents, in terms of completeness, adequacy and consistency.
2. Verify the completeness, adequacy, and consistency of the system development plan with the development schedule.
3. Verify that the proposed system design and predicted performances meet the defined system requirements for all mission phases, including launcher compatibility, with adequate margins and within allocated system budgets.
4. Verify the completeness and adequacy of the Product Assurance documents, in particular the critical item list, the qualification status list, and the PA plan.
5. To verify completeness, adequacy and consistency of the internal and external interfaces from system level, down to segment and subsystem level.
6. Verify the completeness of the risk register and that all technical and programmatic risks have been identified and that adequate mitigation actions are in place, including critical technologies to be developed.
7. Verify the completeness and adequacy of the mission operations concept.
8. Verify the completeness and adequacy of the Space Debris mitigation report and its compliance with the ESA Space Debris Mitigation requirements.
9. Verify that the Project has taken all identified lessons learned of other Projects into account and propose potentially applicable recommendations to other programs. Such lessons learned items will be handled in the ESA Lessons Learned process.

2.2 Critical Design Review

The objectives of the Critical Design Review are to:

1. Verify that the proposed detailed system design and predicted performances meet the requirements for all mission phases, including launcher compatibility, and that the allocation of the performances, budgets and margins to the various elements of the System are compliant with the system level requirements.
2. Verify the completeness, adequacy and coherence of the qualification and validation status of the critical processes, subsystem/equipment and their readiness for deployment for phase D.
3. Verify that the overall verification and validation programme, as well as the planning and preparation for the manufacturing and AIT activities are adequate.
4. Verify the completeness, adequacy and consistency of the internal and external interfaces from system level, down to segment and subsystem level.
5. Verify and confirm that the launcher arrangements are compatible with the mission requirements specifications.
6. Verify all technical and programmatic risks have been identified and that adequate mitigation actions are in place.
7. Verify the completeness and adequacy of the Product Assurance documents, in particular the critical item list, the qualification status list, and their compliance with the system requirements and the PA plan.
8. Verify the completeness and adequacy of the Space Debris mitigation report and its compliance with the ESA Space Debris Mitigation requirements.

9. Verify that the Project has taken all identified lessons learned of other Projects into account and propose potentially applicable recommendations to other programs. Such lessons learned items will be handled in the ESA Lessons Learned process.

2.3 Qualification & Acceptance Review

The objectives of the Qualification & Acceptance Review are to:

1. Confirm that the verification process has demonstrated that the design, including margins, meets the applicable requirements, including those relating to external interfaces (launch and ground segments).
2. Verify that the qualification of the satellite and its on-board software, subsystems, instruments, equipment's and units has been successfully achieved.
3. Verify that the verification record is complete.
4. Confirm the approval status of all request for waivers and deviations.
5. Confirm that the verification process has demonstrated that the product is free of workmanship errors and is ready for subsequent operational use.
6. Confirm that all sub-systems and equipment's have been through their acceptance process, and that any open work is properly identified.
7. Verify the "as-built" product and its constituent components against the required "as designed" product and its constituent components.
8. Verify the readiness of the ground segment to operate the satellite as required during the subsequent operations phase.
9. Verify the completeness and adequacy of the Space Debris mitigation report and design compliance with the ESA Space Debris Mitigation requirements.
10. Confirm that all non-conformances have been satisfactorily closed or that an adequate closure plan has been established.
11. Verify the completeness, adequacy and coherence of the Qualification & Acceptance Data-Package.
12. Verify that the Project has taken all identified lessons learned of other Projects into account and propose potentially applicable recommendations to other programs. Such lessons learned items will be handled in the ESA Lessons Learned process.

2.4 In-Orbit Commissioning Review

The objectives of the In-Orbit Commissioning Review are to:

1. Verify the completeness of the implementation of the in orbit commissioning of the space segment;
2. Verify the completeness of the implementation of the in orbit commissioning of the operation ground segment;
3. Verify that the overall mission performances at the end of the commissioning meet the mission requirements.

2.5 Post-Flight Review

The objectives of the Post-Flight Review are to:

1. Assess the mission operations results with respect to the achievement of the mission objectives
2. Make recommendations for the future exploitation of the technology demonstrated in the mission
3. Identify and capture all lessons learned from the project lifecycle for feeding into the implementation of future projects. Such lessons learned items will be handled in the ESA Lessons Learned process.