



Space product assurance

Off-the-shelf items utilization in space systems

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This Standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, national space agencies and European industry associations for the purpose of developing and maintaining common standards. Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

This Standard has been prepared by the ECSS-Q-20-10 Working Group, reviewed by the ECSS Executive Secretariat and approved by the ECSS Technical Authority.

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Change log

First issue.

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1 Scope

This Standard is applicable to all European space projects using OTS items.

This Standard contains the requirements for the utilization of Off-The-Shelf (OTS) items, their selection, characterization, integration, procurement and qualification for space projects use.

For the purpose of this Standard, OTS items are commercial items that can be procured from the market which are not developed for space application and that can be procured and utilized in a space program.

This Standard cover the selection, characterization, integration, procurement and qualification of OTS items that are procured from commercial market, not developed for space application but that can be utilized in a space programme.

This Standard considers complex OTS items, as for example: motherboards, cards, data storage units/items, optical equipments, photo cameras and video units, LANs, mechanical/electrical and electromechanical devices, batteries, sensors, monitoring support units, medical equipments and items, laptops.

This Standard does not cover:

- software OTS,
- re-use of OTS items already qualified for space applications,

NOTE However, items not belonging to the same lot of the OTS item already evaluated using this standard, can be subjected to partial re-evaluation and re-qualification since, on the commercial market, fast evolution of the design occurs.

- Piece parts and materials, such as electrical, electronic and electromechanical (EEE) parts, thermocouples, rivets, fasteners, connectors, fittings, adhesives, insulation, wiring and plumbing.

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Normative references

The following dated normative documents are called by the requirements of this ECSS Standard and therefore constitute requirements to it. Subsequent amendments to, or revisions of any of these publications do not apply.

NOTE However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below.

ECSS-P-001B	ECSS - Glossary of Terms
ECSS-M-10C	Space project management – Project planning and implementation
ECSS-M-80C	Space project management – Risk management
ECSS-Q-10	Space product assurance – Product assurance management
ECSS-Q-30	Space product assurance – Dependability
ECSS-Q-40	Space product assurance – Safety
ECSS-Q-70	Space product assurance – Materials, mechanical parts and processes
ECSS-Q-70-28	Space product assurance – Repair and modification of PCB assemblies for space use
ECSS-Q-60	Space product assurance – Electrical, electronic and electromechanical (EEE) components
ECSS-10-02	Space engineering – Verification
ECSS-E-10-12	Space engineering – Methods for the calculation of radiation received and its effects, and a policy for design margins
ECSS-E-50-05	Space engineering – Radio frequency and modulation
ECSS-E-50 14	Space engineering – Spacecraft discrete interfaces
ECSS-E-20	Space engineering – Electrical and electronic
ECSS-E-31A	Space engineering – Thermal control
ECSS-E-32A	Space engineering – Structural

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Terms, definitions and abbreviated terms

3.1 Terms defined in other standards

For the purpose of this Standard, the terms and definitions from ECSS-P-001B apply.

3.2 Terms specific to the present standard**3.2.1 vendor**

industrial subject that has developed and produced the OTS item and makes it available on the market

3.3 Abbreviated terms

For the purpose of this Standard, the abbreviated terms from ECSS-P-001B and the following apply:

Abbreviation	Meaning
DCL	declared components list
EQSR	equipment qualification status review
FMEA	failure modes effects analysis
ISO	International Organization for Standardization
ITAR	licence restricted item
LCC	life cycle cost
LET	linear energy transfer
MTTF	mean time to failure
PMP	parts materials and processes
RAM	reliability, availability, maintainability
STD	standard
RFD	request for deviation
SEU	single event upset
TID	total ionising dose

4 Principles

4.1 Structure and organization of OTS selection process

4.1.1 OTS selection

This activity starts at the very beginning of the project with the preparation of the equipment specification. In case decision is made to verify the possibility of OTS utilization, an OTS plan is issued; at this point, the relevant market survey can be started. This phase ends with the selection of OTS candidates. In case at the end of this phase, the OTS approach is found unfeasible, the dedicated developed equipment approach is followed (first step of the make-or-buy phase). An OTS evaluation dossier for each candidate is initiated.

At the end of the selection process a limited number of OTS candidates is finally proposed for characterization (compatible with the project schedule and resources).

4.1.2 OTS characterization

For each OTS selected candidates characterization activity is performed which ends at the project PDR. During this phase the OTS characteristics are deeply investigated in order to verify the OTS capability to meet the equipment specification requirements or modification to be introduced in the OTS design (or in the system hosting it). At PDR the make-or-buy phase is completed. The OTS evaluation dossier collects all the information of this phase.

At the end of the characterization a very limited number of candidates (e.g. two /three) should be defined.

4.1.3 OTS procurement and qualification

After having selected the most suitable OTS, the procurement activity starts considering the lot constraints reported in this standard. The references for the qualification are both the OTS plan and the requirements defined in the equipment specification. Output of this phase is the completion of the evaluation dossier.

4.2 OTS evaluation process general principles

The identification of which function can be satisfied by use of OTS items is a project responsibility. These functions are identified early in the program and at the latest at system requirement review.

Prior to system requirement review, critical aspects of a project design that intend to utilize OTS items are identified and evaluated. This evaluation ensures that the criticality of the application, in terms of dependability and safety, is not compromised by the OTS.

It has to be highlighted the criticality of the decision of developing an OTS-based system in terms of schedule. Delay in identifying the OTS item meeting or not the project requirements, or late decision of abandoning the OTS way for coming back to a new-design for a specific application, can have heavy impact on the project in schedule and cost. It is therefore important that the OTS selection process is correctly inserted inside the overall project schedule to start as early as possible, get first result already at the SRR, and provide evidence that a specific OTS item is able to meet the project constraints and conclude the characterization before the PDR.

The main documents used to support the OTS selection process are the equipment specification, the OTS Plan and the OTS Evaluation Dossier. These three documents are updated as necessary in the course of the OTS selection and characterization life cycle.

Particular attention is be paid for the OTS application in the safety critical functions to guarantee the compliance to the program safety requirements. A safety assessment of the OTS item is developed and maintained to support the upper level safety analyses. It drives the evolution of the OTS application inside the project and wherever needed it identifies dedicated safety requirements and supports the application of those already defined (e.g. an evaluation is made performing dedicated trade-off's between system level and OTS item level implementation). This assessment also drives the make-or-buy criteria and it is part of the evaluation dossier.

As far as EEE parts are concerned, OTS item EEE parts can hardly be managed as requested by the nominal space EEE parts policy. Supplier can encounter difficulties to get specific information / data relevant to the EEE parts inside the OTS item, and even if some information is provided, no assurance can exist on the completeness and correctness of such information.

In the same manner, OTS item mechanical parts, materials and processes can hardly be man-aged as requested by the nominal PMP space policy. Supplier can encounter difficulties to get specific information on the materials and parts inside the item and has a very limited knowledge about the processes used for its production.

The activities aimed to cover this lack of information are addressed in Clause 5.

The Quality Assurance activities / requirements normally adopted in space projects are implemented / analyzed with respect to the specific OTS application in an OTS-based system, considering that the applicable QA requirements are the ones referring to the evaluation, acquisition and validation of a product to be found on the commercial or military market.

QA requirements relevant to design and manufacturing are not relevant to the OTS item acquisition process, unless the item is modified; in this case it has to be managed as normal work in space projects.

4.3 Engineering principles for the selection process

In the space project the equipment level requirements are identified via an apportionment of the system level requirements. A system using OTS equipment presents specific peculiarities that make difficult to implement such practice.

A OTS-using system is inseparably coupled to the evaluation of the candidate products that comprise it. It is not realistic to retain that an OTS item can fit a complex system in a “plug and play” mode, but a system is, in some way, designed around the OTS items.

On the same way, different candidate OTS items are evaluated with respect to the characteristics of the system and not only as a function of the characteristics of the products (e.g. criticality of the system applications).

For easy implementation of newly designed DC/DC converter and to cope with program power requirements, preference is given to those OTS having power supply board separated

from other functions/board. In the same way, preference is given to OTS not mixing different assembly technologies and to OTS not using complex assembly techniques in order to facilitate maintenance/modifications.

Moreover, in a system that makes use of OTS items, especially if multiple OTS items are fore-seen, many requirements become known only as the system develops. Introducing one product can influence the way other components are integrated, or the system overall design.

OTS evaluation is done on the basis of the OTS performance specification and evaluating “mandatory requirements” from “adaptable requirements” and from “nice-to-have requirements”.

The “**mandatory**” set of requirements includes all those requirements that can not be waived. Examples are the safety requirements or performance requirements essential for the item in subject. The fact that a “mandatory requirement” is not immediately met by the OTS item does not automatically mean that the item has to be disregarded but that a modification implemented by the customer or by the manufacturer is required. The feasibility of modifications can be assessed with respect to the technical, programmatic and economic issues.

The “**adaptable requirements**” set includes all those requirements that can be likely compensated, if not met, by the design at subsystem or system level. Examples are the interfaces of OTS items (e.g. power supply and data rate) where, in defined ranges, it is possible anyway to introduce the item in the system if it is possible to introduce a new interface between system and item.

The “**nice-to-have requirements**” set includes all those requirements allocated from the upper level specifications that either are already nice-to-have at system level, or more likely can be always compensated, if not met, by the design at subsystem or system level.

OTS item is subjected after upgrading to specific tests and inspections (eventually destructive) to verify the performance compliance to the specification requirement.

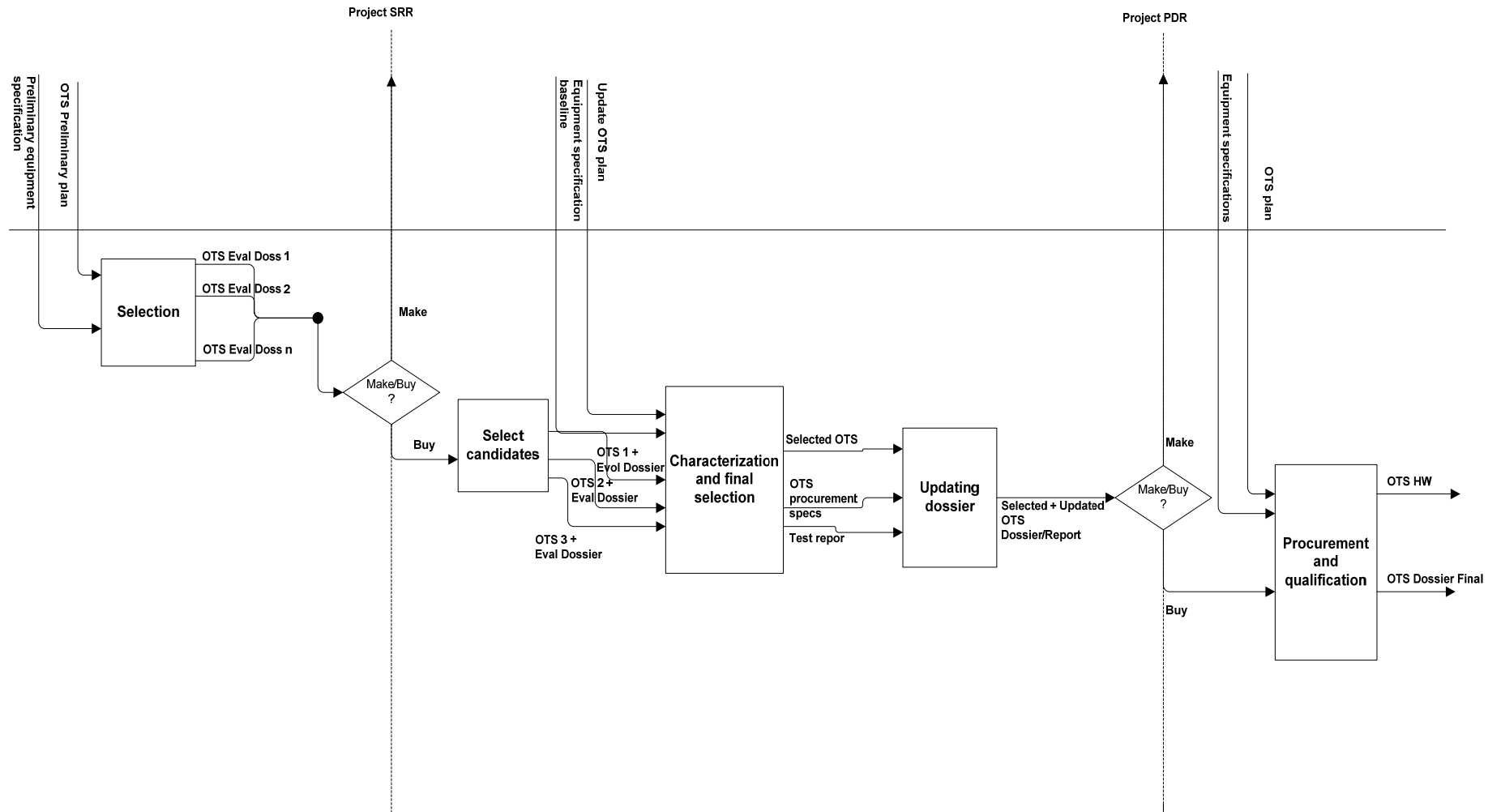


Figure 4-1: OTS selection process flow

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Requirements

5.1 Documentation

5.1.1 OTS plan

- a. When OTS are proposed or allowed, a dedicated OTS plan shall be established according to Annex A DRD.

NOTE The OTS plan describes the OTS process selection, characterisation and qualification activities in accordance with the contents of this ECSS. Contents are specified in the annex DRD.

- b. The OTS plan shall be submitted at the proposal phase but not later than the system SRR.
- c. OTS review phasing shall be synchronized with project review planning as per ECSS-M-10C.
- d. The PA of the supplier shall be responsible for the OTS plan.

5.1.2 Equipment specification

- a. A project generated equipment technical specification conforming to the higher level documents shall be used and maintained as the technical reference for the OTS.
- b. In case the OTS is part of an equipment but is not visible at system configuration level, the supplier shall use the closest higher level technical specification
- c. The compliance of the OTS under selection with the closest higher level technical specification shall be demonstrated and a dedicated OTS technical specification shall derived from the equipment specification.

5.1.3 OTS evaluation dossier

- a. For each OTS candidate, an OTS evaluation dossier shall be established and maintained, as per Annex B DRD.

NOTE This to collect all the OTS data from the beginning of the selection phase up to the OTS qualification.

- b. The OTS evaluation dossier shall contain a safety file containing all the safety related information relevant to the OTS
- c. Following the CDR, the OTS evaluation dossier shall be used for the subsequent OTS qualification phase.

- d. When the final candidate has been selected, the OTS evaluation dossier shall be supported and completed with a OTS report gathering all activities and outcomes from the OTS process.

NOTE This occurs at the end of the characterization phase in order to avoid the loss of information / data.

5.2 OTS selection

5.2.1 OTS selection approach

5.2.1.1 OTS criticality identification

- a. The PA of the first level supplier shall identify the criticality of the functions for which an OTS is candidate in accordance with ECSS-Q-40C and ECSS-Q-30B and with the specificity of the project mission success requirements.
- b. The PA of the supplier shall ensure that the OTS application shall not compromise approach/mitigation put in place to control the criticality of these functions.
- c. The PA of the supplier shall verify that the OTS does not introduce additional criticalities.

5.2.1.2 Criteria and activities

- a. The supplier shall identify the customized requirements that shall be satisfied by OTS design.
- b. The supplier shall ensure that the candidates do not contain unwanted functions that would be detrimental.
- c. The supplier shall verify with the vendor the OTS item design margins, and prefer those determined by test.
- d. The supplier shall check compliance of OTS standards with the projects standards.
- e. The supplier shall perform trade off among system (architecture, design, functions) and characteristics of the OTS candidates.
- f. The supplier together with the first level supplier shall identify design optimization to reach full compliance to the system requirements with the aim to minimize modification of the OTS.
- g. The supplier shall evaluate the qualification status of the OTS candidates toward projects requirements.
- h. In case the information from the OTS manufacturer are not enough, or in case there is the necessity to increase the knowledge for specific OTS characteristic with respect to project needs, dedicated tests shall be performed to support the OTS selection.
- i. The supplier shall evaluate vendor experience, its position in the business and its OTS commercial business practices, strategies in development, maintenance, distribution of updates, availability of spares, willingness of the vendor to collaborate with the buyer.
- j. The first level supplier shall estimate the global system OTS possession cost including market search, OTS selection process evaluation and qualification tests, integration and evolution for OTS potential version upgrade, OTS replacement, technology refresh, annual licensing fees.
- k. The first level supplier shall perform a risk analysis on using the OTS candidates, according to ECSS-M-80C.

NOTE These activities serve to decide if candidates OTS are available for the project and the results are collected in the OTS evaluation dossier.

5.2.2 Trade-off

5.2.2.1 Trade-off responsibility

- a. The OTS selection process shall be based on trade off analysis and be performed at two different levels:
 1. At OTS level, by supplier, to define the preliminary make-or-buy decision and in case of “buy” to propose the most suitable candidates.
 2. At system level, by first level supplier, to evaluate the possible solutions to adapt system or subsystem requirements, or system architecture in the aim of maximizing the opportunity to use the foreseen OTS.

NOTE The result is a make-or-buy decision and in case of “buy” a further screening of the OTS candidates.

5.2.2.2 Criteria for trade-off at OTS level

- a. The supplier shall perform this analysis considering the following criteria:
 1. OTS ability to provide the required capabilities / performances and to cope with the system design constraints.
 2. OTS compliance with the PA and Safety applicable project requirements.
 3. OTS compliance versus the function criticality at system level.
 4. OTS testability.
 5. OTS compliance with the interfaces.
 6. OTS ability to be procured/used without special restrictions.
 7. ITAR, exportability, and copyright.
 8. Short and long term cost impacts of using the OTS item.
 9. Technical, cost and schedule risks in using the OTS item
 10. Visibility on OTS proper documentation.

NOTE For example: Test results, configuration status, qualification status, user manual, C.E. marking, and NCR reporting.

11. Vendor experience and position in the business, willingness to cooperate, possibility to place contractual arrangement for vendor support during the system development and maintenance phase.

NOTE For example: Financial stability, strategic directions, and volatility of technologies.

12. Back-up solution if the OTS item becomes unavailable or evolve (obsolescence).
13. Inadequacy of the OTS candidate to cope with the system requirements

NOTE For example: Nonconformances.

5.2.2.3 Criteria for Trade-off at system level

- a. The first level supplier shall evaluate, for each proposed OTS candidate, the system compatibility (or modification) to adapt it considering the following criteria:
 1. Technical performances.

NOTE For example: Envelope, mass, interfaces, and environment.

2. Schedule impacts.
3. Involved cost.

NOTE For example: OTS costs, system modification costs, and possible OTS modification.

5.2.3 Risk management

- a. The first level supplier shall perform risk analysis at system level to support trade-off activity in accordance with ECSS-M-80C.
- b. Risk analysis shall evaluate risks linked with OTS specificities:
 1. Some topics to be considered: Vendor commercial business practices and strategies in development, maintenance, distribution;
 2. Specific modification of OTS or of the system to endorse the OTS;
 3. Shortfalls mitigation;
 4. Availability of spares, training, repair cycle policy;
 5. Licences, data technical property and exportability constraints;
 6. Skills, knowledge of the market place;
 7. Expertise need for OTS specific technology.

5.3 OTS characterization

5.3.1 General

- a. The OTS characterization activity shall be performed with regard to the equipment specification.
- b. In the frame of this OTS characterization, the supplier shall collect in the evaluation dossier the following:
 1. available users documentation;
 2. already available qualification status versus preliminary equipment specification;
 3. available test data;
 4. existing anomalies and analyse problem reports;
 5. potential on going evolutions (e.g. future vendor modifications).
- c. The first level supplier shall evaluate and agree the system architecture modifications that allow the usage of the OTS items minimizing the need of OTS modification.
- d. The output of the characterization phase shall be the make-or-buy decision

5.3.2 Product assurance evaluation for OTS characterization

5.3.2.1 Dependability

5.3.2.1.1 Criticality

- a. The supplier shall verify the system level RAM analyses to identify if OTS is used in critical function.
- b. The supplier shall assess the dependability criticality of the OTS item on the basis of the specific application.

NOTE For example: Experiments or P/L; satellites; manned modules; launchers; re-entry vehicles.
- c. The supplier shall identify the dependability technical risks in satisfying dependability requirements.

5.3.2.1.2 FMEA / FMECA

- a. The supplier shall analyse the OTS item in the FMECA as a black box.
- NOTE This in order to assess functions and interfaces criticalities versus the system requirements.
- b. The supplier shall get the analysis from the manufacturer when available or consult the available analysis or design files at manufacturer site.

5.3.2.1.3 Item monitors

- a. The supplier shall collect from manufacturer the OTS monitoring data.
- b. The supplier shall provide dedicated interfaces towards the OTS via ad-hoc data interface unit.
- c. The supplier shall co-ordinate with the first level supplier the compensations for the missing monitoring.

5.3.2.1.4 OTS operability

- a. The supplier shall verify capability to control the item in all operational conditions to prevent failures / hazards.
- b. The supplier shall verify the capability to switch-off the item in all conditions, considering also the case of internal item battery provision.
- c. The supplier shall verify compatibility of OTS warm-up time with respect to system performances.

5.3.2.1.5 Installation and maintenance

- a. The supplier shall verify OTS item maintenance requirements.
- b. The supplier shall verify provision of installation and maintenance features to prevent failure.

5.3.2.1.6 Internal redundancy / design for minimum risk

- a. The supplier shall prefer redundancy approach at system level for all the dependability critical functions.
- b. The supplier shall not use internally redundant OTS without the availability of the following information:
1. the reliability history;
 2. OTS internal redundancy management.
- c. The supplier shall perform reverse engineering

NOTE Reverse engineering is performed with the aim to provide all the missing information on the internal redundancy and design to minimum risk on the OTS (e.g. X-ray, NDI inspections, proof test, and functional test).

5.3.2.1.7 Reliability figure

- a. The supplier shall provide an OTS reliability figure.
- NOTE If the reliability figure is not provided by the manufacturer, it can be obtained e.g. by the following means:
- Search for data from lessons learned concerning item use in similar environment;
 - Assess data credibility via manufacturer interview and OTS evaluation;
 - Assess item reliability via prediction;
 - Assess item reliability via similarity;
 - Perform prediction (part count) when item EEE part list is available.

5.3.2.1.8 Life

- a. The supplier shall get data from manufacturer.

NOTE For example: Market feed back for the products, worst case analysis, possibility to get the internal parts activation energy characteristics and operating temperature.
- b. The supplier shall assess data credibility via manufacturer interview and item evaluation.
- c. The supplier shall assess the need of performing a life test at item level.

5.3.2.1.9 Derating

- a. The supplier shall assess if OTS derating is critical with respect to the mission duration.
- b. The supplier shall get derating analysis and data from manufacturer.
- c. The supplier shall assess OTS derating data compatibility with space requirements.
- d. In case requirements 5.3.2.1.9b and 5.3.2.1.9c. cannot be met, the supplier shall perform analysis and test on the item.

NOTE The use of board thermography is to get a rough estimation of thermal margin on the most critical components also via identification of temperature hot spots, generate thermal model of PCB and provide simulations.

5.3.2.2 Safety

5.3.2.2.1 Safety criticality

- a. The OTS item shall conform to the safety requirements of the function in which it is used.

5.3.2.2.2 OTS safety data

- a. The supplier shall provide safety data containing information on used materials, mechanical parts, electrical components, and in general all the information necessary to perform the Safety Analysis.

NOTE Electrical components include internal energy sources like batteries, shatterable materials.
- b. The supplier shall, for manned modules, ensure compatibility between pressure differential and fire control requirement (when depressurization is a fire control method).
- c. The supplier shall, in case information cannot be obtained from vendor, perform the necessary verification activities.

NOTE For example: X-Ray, NDI inspections, and proof test.

5.3.2.2.3 Internal redundancy / design for minimum risk

- a. The supplier shall, for critical functions, prefer the redundancy approach at system level.
- b. The supplier shall avoid the use of internally redundant OTS without having the detailed reliability information and evidences from vendor about failure detection and recovery criteria, redundancy management implementation, absence of single point failures.

5.3.2.3 EEE parts (inside OTS)

5.3.2.3.1 EEE part management

- a. The supplier shall, in case of part list provision, assess the information provided for each part.

- b. The supplier shall perform inspection on OTS item to evaluate confidence on provided part list or (if no list is provided) to identify constituent EEE parts.
- c. The supplier shall perform analysis or a test campaign to assess the whole item compliance to space requirements.

NOTE For example: Total dose radiation test.

- d. Evaluate the EEE parts with regards the environmental conditions like temperature, radiation and vacuum.
- e. The supplier shall perform PCB inspection to identify used parts.
- f. The supplier shall perform in-depth inspection.
- g. The supplier shall decide on risk reduction measures in order to solve the EEE parts potential issues.

NOTE For example: PCB coating, item segregation, exchange of parts, exchange of connectors and harness, introduction of epoxy adhesive for massive components of the PCB to allow the item surviving the acceleration and vibration test conditions.

5.3.2.3.2 Part quality

- a. The supplier shall assess part purchase policy applied by the OTS manufacturer.

NOTE Part quality level, multiple suppliers for each part type, part incoming inspection, burn in data, and mechanical tests.

- b. The supplier shall assess manufacturer part handling approach.

NOTE Storage and transport control, control of assembly process versus standard as function of part type characteristics, e.g. plastic parts)

5.3.2.4 Mechanical parts, materials and processes

5.3.2.4.1 Mechanical parts and materials management

- a. The supplier shall perform inspection on OTS item.

NOTE This inspection aims to evaluate confidence on provided part list and when no list is provided to identify constituent materials and mechanical parts.

- b. The supplier shall perform an analytical assessment or a test campaign to assess the whole item compliance to space requirements.

NOTE For example: Toxicity, flammability and outgassing tests .

- c. The supplier shall decide on risk reduction measures.

NOTE For example: Item segregation, exchange of parts if materials are non-compliant, conformal coating / potting of the PCBs with non-flammable compound, exchange of housing, exchange of specific flammable parts.

5.3.2.4.2 Prohibited materials

- a. The supplier shall perform OTS inspection to identify the presence of any prohibited materials.

- b. The supplier shall perform lab inspection

NOTE For example: Chemical, off-gassing, out-gassing, flammability.

- c. The supplier shall decide on risk reduction measures in order to solve the prohibited material issue.

5.4 Performance evaluation – Engineering related activities

5.4.1 Structural and mechanical evaluation

- a. The supplier shall verify that the OTS is able to operate in the mechanical environment foreseen by the specific application.
- b. The supplier shall verify that the OTS does not generate any detrimental mechanical effect towards the foreseen operational environment.
- c. The supplier shall identify that the modifications to be performed on the OTS, in order to cope with the foreseen mechanical environment, are justified and their adequacy is demonstrated.
- d. The supplier shall perform verification of the structural characteristics of the OTS in accordance with the requirements of ECSS-E-32A and its associated documents.

5.4.2 Thermal evaluation

- a. The supplier shall verify that OTS is able to operate in the thermal environment foreseen by the specific application.
- b. The supplier shall verify that the OTS thermal design is able to withstand those environmental factors encountered during all mission phases and take due account of any possible degradations caused by e.g. wear, non-condensable gas build-up, mechanical loads, and test environment.
- c. The supplier shall ensure that any OTS cooled by natural convection system is modified to a suitable alternative cooling method.
- d. The supplier shall analyse and identify any modification to be performed on the OTS in order to cope with the foreseen thermal environment.
- e. The supplier shall consider the safety related requirements like touch temperature, flammability problems and ignition hazards as driving criteria for the OTS acceptance or exclusion since the early phases of the evaluation process.
- f. The supplier shall verify its thermal requirements in accordance with ECSS-E-31A.

5.4.3 Electrical

5.4.3.1 General

- a. The OTS electrical design shall be verified to be able to operate in accordance with the intended application.
- b. Adequate analysis shall identify any modification to be performed on the OTS in order to cope with the foreseen electrical performances.
- c. All safety issues shall be considered as driving criteria for the OTS acceptance or exclusion since the early phases of the evaluation process.

NOTE Safety issues can be high voltages or high electrical powers, EMC/EMI, grounding, and radiation.

- d. Warm-up time of the OTS items shall be verified to ensure compatibility of the item with the system needs.

5.4.3.2 Electrical power requirements

- a. The supplier shall verify its electrical requirements in accordance with ECSS-E-20A.
- b. The AC/DC shall not be used in space application

NOTE This constraint forces to remove or to exclude the unit power supply and redesign it.

- c. The OTS new power supply shall be designed and manufactured according to the space environment and constraints in accordance with ECSS-E-20A
- d. The OTS where the already available DC/DC converter input power lines are compatible to spacecraft power bus shall be verified / modified according to the space environment and constraints as per ECSS-E-20A.
- e. Fuses whose performances are not in accordance with the ECSS-E-20A shall be removed and replaced with other fuses or other appropriate devices (e.g. current limiters).
- f. For OTS in which a rechargeable or not rechargeable battery is the only power source substitution by usage of space qualified cell shall be investigated.
- g. In case a substitution a per 5.4.3.2f. is not possible, a DC/DC converter shall be designed according to the space environment and constraints in accordance with ECSS-E-20A.

5.4.3.3 Data handling

- a. The supplier proposing the use of an OTS Data Handling System or of an OTS as a part of a DHS shall verify its design requirements according to ECSS-E-50-14.
- b. The supplier proposing an OTS interfacing with Data Handling System shall verify its interfaces performances according to ECSS-E-50-14.
- c. For OTS with not compatible data interface, a dedicated interface adapter shall be developed, in order to assure the compatibility, according to ECSS-E-50-14.

5.4.3.4 Radio frequency transmission and reception

- a. The supplier shall verify its RF compatibility according to ECSS-E-50-05A.
- b. The supplier shall implement the modifications on the OTS to comply with the RF requirements of ECSS- E-50-05A.

5.4.3.5 Electromagnetic compatibility

- a. The supplier shall verify its conformance to EMC requirements according to ECSS-E-20A.
- b. For OTS that exist in plastic case only, the viability of upgrading their housing to a metallic one shall be investigated and implemented where feasible.

5.4.3.6 High energy radiations

- a. The supplier shall verify its conformance to project applicable radiation environment.
- b. The analysis of OTS EEE internal parts for the Total Ionizing Dose (TID), Non-Ionising Energy Loss Fluence (NIEL) and the Single Event Effect (SEE) due to the heavy ions and high energy protons shall be performed in accordance with ECSS-E-10-12.
- c. The supplier shall perform a dedicated analysis to evaluate the criticalities from Single Event Upset (SEU) and Latch Up (LU) and provide adequate preventive or corrective actions.
- d. For OTS not specifically characterized for space applications in terms of radiation behaviour, a dedicated test campaign shall be conducted to measure the sensitivity of these equipment in terms of at least Total Ionising Dose with Gamma rays, Single Event Effects with Protons beams.

5.4.3.7 EEE quality and constraints

- a. The supplier shall identify any prohibited part as per ECSS-Q-60B for possible replacement or waiver generation.
- b. Printed circuit boards shall be repaired or modified according to ECSS-Q-70-28A.

- c. The supplier shall identify any materials, mechanical parts and processes prohibited by ECSS-Q-70 for possible substitution or request for approval.

5.4.4 Maintenance

- a. The supplier shall identify any maintenance requirements specific for OTS.

5.5 OTS procurement and qualification

5.5.1 OTS procurement

5.5.1.1 OTS procurement documentation

- a. The supplier shall identify the procurement document (which can be an OTS dedicated specification or the vendor bulletin) and freeze it in the OTS evaluation dossier.
- b. From the data of the OTS evaluation dossier a final OTS report shall be issued by the OTS supplier and approved by the first level supplier.

5.5.1.2 Batches

- a. The supplier shall purchase all OTS items from a single lot.
 - NOTE In order to minimize the risks deriving from OTS items developed at different times and with differences in terms of materials, internal parts (including EEE parts) and with differences in the development process.
- b. The supplier shall verify that lot variances do not impact the data contained in the OTS evaluation dossier.
- c. The supplier shall check that the number of OTS items purchased in the same lot comply with the project needs.
- d. The supplier shall make sure that the number of OTS purchased include spare parts and maintenance needs.

5.5.1.3 Configuration control of modified OTS item

- a. In case the final candidate needs modifications to meet the project requirements, these modifications shall be kept under control by the configuration control methods applicable to the project.
 - NOTE The above control is a responsibility of the entity implementing such OTS modification (vendor or the supplier pro-posing OTS).

5.5.1.4 Quality assurance

- a. Quality Assurance shall verify that the procured OTS items are in accordance with the relevant procurement documentation.

5.5.2 Qualification

- a. The OTS qualification requirements shall be derived from the equipment specification.

- b. The OTS qualification shall follow the project verification plan, rules and documentation outputs, in order to demonstrate the OTS adequacy to the project requirements.

NOTE For example: Test reports.

- c. The approved OTS evaluation dossier and the relevant OTS report shall be the reference for performing qualification activities.

Annex A(normative) OTS plan – DRD

A.1 DRD identification

A.1.1 Requirement identification and source document

ECSS-Q-20-10A, requirement 5.1.1a.

A.1.2 Purpose and objective

The OTS plan defines the OTS process selection, characterization and qualification activities.

A.2 Expected response

A.2.1 Scope and contents

<1> Introduction

- a. The OTS plan shall contain a description of the purpose, objective, content and the reason prompting its preparation.

<2> Applicable and reference documents

- a. The OTS plan shall list the applicable and reference documents in support to the generation of the document.

<3> Definitions and abbreviations

- a. The OTS plan shall list the applicable dictionary or glossary and the meaning of specific terms or abbreviations utilized in the document with the relevant meaning.

<4> Responsibility and organization

- a. The OTS plan shall describe the project team organization and the responsibilities for the activities and documentation.

<5> OTS selection

- a. The OTS plan shall describe the market survey, the data evaluation and the selection activities based on the requirements of ECSS-Q-20-10A Clause 5.2.

<6> OTS characterization

- a. The OTS plan shall present the OTS characterization activities for selection of the final candidate based on the requirements of ECSS-Q-20-10A Clause 5.3.

<7> OTS procurement and qualification

- a. The OTS plan shall describe:
 - 1. the procurement activities once the project has completed the OTS selection and characterization processes.
 - 2. the activities for the configuration control to track any OTS modification.
 - 3. the description of how the procurement verifications is implemented (e.g. quality assurance).
 - 4. the batch policy
 - 5. the qualification activities and logic according to ECSS-Q-20-10A, Clause 5.5.

Annex B(normative)

OTS evaluation dossier - DRD

B.1 DRD identification

B.1.1 Requirement identification and source document

ECSS-Q-20-10A, requirement 5.1.3.

B.1.2 Purpose and objective

The OTS evaluation dossier provides a detailed incremental overview of the OTS since the initial selection up to the OTS qualification and approval for its use in the specific project.

In order to avoid the loss of information / data, at the end of the characterization phase, when the final candidate has been selected, its evaluation dossier shall be formalized in a project document (report).

B.2 Expected response

B.2.1 Scope and contents

- a. The OTS evaluation dossier shall be a living document in a form of a folder(s), established for each OTS candidate.
- b. The OTS evaluation dossier contents shall contain as a minimum:
 1. all the data, documentation and information from / on the vendor;
 2. historical data;
 3. programmatic data (e.g. cost, procurement time, export limitation);
 4. OTS environmental characteristics;
 5. RAMS information (e.g. FMEA, Safety assessment, internal redundancy, reliability figures);
 6. Risk assessment;
 7. PMP and EEE information;
 8. eventual modification needed;
 9. procurement document;
 10. operation and logistic information (e.g. life; handling instruction, user's manual);

11. all the data/information / analyses / test results obtained during the characterization phase;
12. all the data / information / analyses / test results obtained during the qualification phase, including eventual non conformance report.