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**Space systems — Functional and  
technical specifications**

*Systèmes spatiaux — Cahier des charges fonctionnel et spécification  
technique de besoin*

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Tel. + 41 22 749 01 11  
Fax + 41 22 749 09 47  
E-mail [copyright@iso.org](mailto:copyright@iso.org)  
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## Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 21351 was prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read “...this European Standard...” to mean “...this International Standard...”.

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## Foreword

This document (EN ISO 21351:2005) has been prepared by European Cooperation for Space Standardization (ECSS), the secretariat of which is held by CMC, in collaboration with Technical Committee ISO/TC 20 "Aircraft and space vehicles".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2005, and conflicting national standards shall be withdrawn at the latest by November 2005.

It is based on a previous version<sup>1)</sup> originally prepared by the ECSS Functional and Technical Specification Working Group, reviewed by the ECSS Engineering Panel and approved by the ECSS Steering Board. The 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.

This European Standard is one of the series of space standards intended to be applied together for the management, engineering and product assurance in space projects and applications.

Requirements in this document 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.

The formulation of this document takes into account the existing EN ISO 9000 family of documents.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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1) ECSS-E-10 Part 6.

## Introduction

This document introduces the strategy of establishing and positioning the Functional Specification (FS) and the Technical Specification (TS) in a project process to improve the effectiveness of its management in terms of performance, cost, schedule and risk.

These two specifications are recommended in ISO 14300-1 in order to focus to customer (or user) needs and to allocate proper time and resources for investigating and comparing a sensible range of candidate concepts, and selecting a preferred solution to be developed or to be purchased.

The FS is the baseline for investigating and comparing candidate concepts, while the TS is the baseline of the business agreement to develop or purchase the selected solution.

NOTE Functional Specification is also referred as "Functional Performance Specification (FPS)" in EN 1325-1.

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## 1 Scope

This document provides an overview of the respective purposes and positions of functional and technical specifications, their required contents, and the process for developing these documents.

This document is applicable to all types of space systems, all product elements, and projects.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13701:2001, *Space systems — Glossary of terms*.

EN ISO 17666:2003, *Space systems — Risk management (ISO 17666:2003)*.

## 3 Terms, definitions and abbreviations

### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13701:2001 and the following apply.

#### 3.1.1

##### **constraint**

characteristic, result or design feature which is made compulsory or has been prohibited for any reason

NOTE 1 Constraints are generally restrictions on the choice of solutions in a system.

NOTE 2 Two kinds of constraints are considered, those which concern solutions, and those which concern the use of the system.

NOTE 3 For example constraints can come from environmental and operational conditions, law, standards, market demand, investments and means availability, or the organization's policy.

NOTE 4 Adapted from EN 1325-1.

#### 3.1.2

##### **environment, noun**

<product> natural conditions (such as weather, climate, ocean conditions, terrain, vegetation, dust, light and radiation) and induced conditions (such as electromagnetic interference, heat, vibration, pollution and contamination) that constrain the design definitions for end products and their enabling products

#### 3.1.3

##### **environment, noun**

<project> external factors affecting an enterprise or project

#### 3.1.4

##### **environment, noun**

<development> external factors affecting development tools, methods, or processes

#### 3.1.5

##### **function**

intended effect of a system, subsystem, product or part

NOTE 1 Adapted from EN 1325-1.

NOTE 2 Functions should have a single definite purpose. Function names should have a declarative structure (e.g. "Validate Telecommands"), and say "what" is to be done rather than "how". Good naming allows design components with strong cohesion to be easily derived.

### 3.1.6

#### **functional analysis**

technique of identifying and describing all functions of a system

NOTE Adapted from EN 1325-1.

### 3.1.7

#### **functional specification**

document by which the customer establishes the intended purpose of a product, its associated constraints and environment, the operational and performances features, and the permissible flexibility

NOTE 1 This document contains a complete set of provisional technical requirements for a product.

NOTE 2 This term is equivalent to "functional performance specification" as defined in EN 1325-1.

### 3.1.8

#### **life cycle**

time interval between the conceptual exploration of the product introduction to its withdrawal from service

### 3.1.9

#### **need**

what is necessary for, or desired by, the user

NOTE 1 A need can be declared or undeclared; it can be an existing or a potential one.

NOTE 2 The user is a person or an organization for which the product is designed and which exploits at least one of its functions at any time during its life cycle.

NOTE 3 For the space community, the needs are often called mission statement.

NOTE 4 Adapted from EN 1325-1.

### 3.1.10

#### **specification**

document stating requirements

NOTE 1 A specification can be related to activities (e.g. procedure document, process specification and test specification), or products (e.g. functional specification, technical specification)

NOTE 2 Adapted from ISO 9000:2000.

### 3.1.11

#### **technical specification**

specification expressing technical requirements for designing and developing the solution to be implemented

NOTE The technical specification evolves from the functional specification and defines the technical requirements for the selected solution as part of a business agreement.

### 3.1.12

#### **verification matrix**

matrix that defines the verification strategy for each product technical requirement in terms of methods, level and stages

### 3.2 Abbreviated terms

The following abbreviated terms are defined and used within this document:

Abbreviation	Meaning
IEC	International Electrotechnical Commission
FS	functional specification
PA	product assurance
TS	technical specification

## 4 Functional specification and technical specification purpose and description

### 4.1 Functional specification purpose and description

A functional specification is a document through which a customer expresses his needs (or those that he is responsible for expressing) and the related environment and constraints in terms of technical requirements.

The FS is used for searching for possible concepts, evaluating them and selecting a preferred solution.

The technical requirements contained in the FS provide flexibility to:

- allow potential suppliers to propose the best technical and programmatic solutions;
- facilitate the adjustment among the need or mission statement, the context (e.g. programmatic elements and environmental constraints) and possible solutions.

NOTE The intention of the functional specification is not to assume or refer to specific solutions.

### 4.2 Technical specification purpose and description

The technical specification evolves from the functional specification and defines the technical performances for the proposed solution as part of a business agreement.

The TS is the technical reference for the acceptance of the definition and for the acceptance of the end product.

In that scope, the technical requirements contained in the TS have no flexibility. They are attainable and verifiable, and for each technical requirement, the method of verification (e.g. by test, by analysis) is specified.

### 4.3 FS and TS content

A specification (FS or TS) is typically composed of three major sets of information:

- General information related to the context of the document (e.g. administrative information, normative documents and informative documents);
- General information related to the context of the project, the product or system;
- Technical requirements (described in Clauses 6 and 8).

The specification provides the general information related to its context:

- Administrative information: to provide all the information regarding, for example, the owner, status, identification, distribution list, and management rule;

- Scope: to define without ambiguity the subject of the FS and TS and aspects covered, thereby indicating limits of applicability;
- References: to list all the normative (applicable) documents and standards, with titles, issue revision, and dates that are referred to in the FS;
- Terms, definitions and abbreviated terms: to list the specific terms and abbreviated terms used in the FS.

It also provides general information related to the context of the project, product or system:

- to provide a clear and rapid understanding of the project and the main needs or mission statements;
- to give indications of the market as additional information, as well as information about the context of the project and the objectives (situation of the project in a larger programme, further developments);
- to provide information on the environment and its constraints;
- to detail the different situations of the product or system life cycle.

## 5 Process for establishing a functional specification and a technical specification

### 5.1 General

The management of a programme necessitates the establishment of a set of successive states of a product and a network of customer and supplier relationships. At any intermediate level, the supplier of an item acts as customer in specifying components towards its suppliers.

The two first states - the functional state and the specified state - are expressed in a FS and in a TS.

The procurement of products is governed by business agreements constituting the contract between two parties - the customer and the supplier.

A business agreement results from a negotiation process between a customer with a problem to solve, and a supplier with potential solutions. This results in a set of requirements that engages both parties. The list of requirements constitutes an important part of the business agreement and is adapted to the nature of the expected outcome.

Figures through 2 to 5 are provided to help supporting the understanding of a process for establishing a functional specification and a technical specification. The model used for these figures is presented in Figure 1.

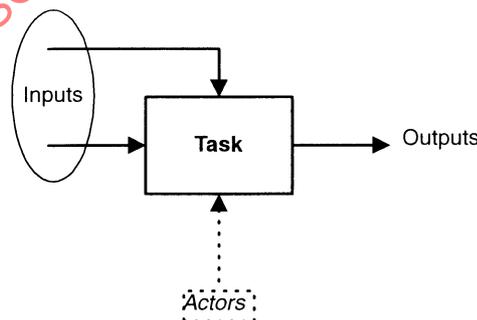


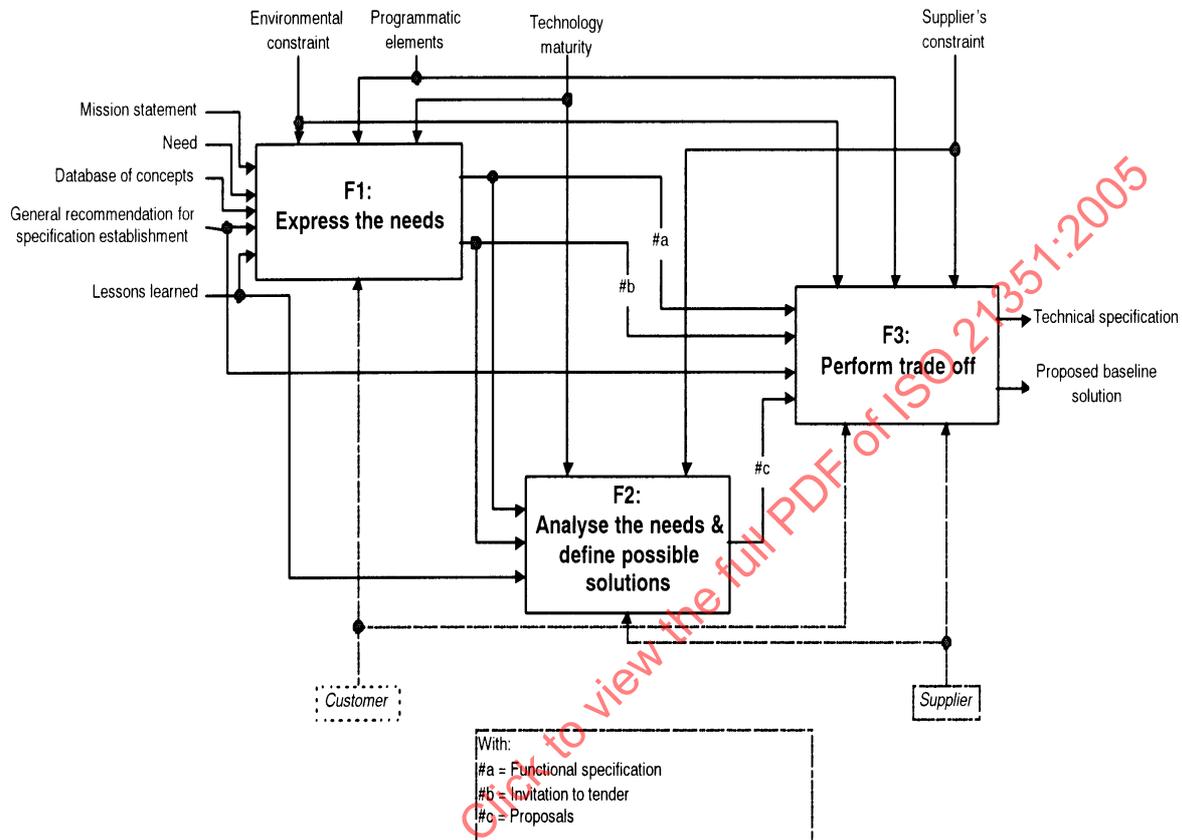
Figure 1 — Model presentations

Where:

- The box represents the task to be performed;
- The left- and top-side arrows represent the necessary inputs to the task;
- An arrow on the right-side represents the output produced by the task;
- An arrow coming from below represent the actor involved in performing the task.

Figure 2 presents the macro-process that generates the functional and technical specifications.

This principle can be used at different system levels.



**Figure 2 — Relationship between the FS and the TS**

Where:

- F1 task: the customer expresses the need in a FS (see 4.2);
- F2 task: each bidder analyses this FS and establishes one or more proposals. This task is presented to ensure a consistent approach between the bidders and the customer;
- F3 task: the customer select the supplier/solution and releases the TS (see 4.3).

As part of a business agreement, the customer establishes his needs for the development of a product or a system in a technical specification.

The FS clarifies the global needs (mission statement) and is the technical reference for invitations to tender and consultations.

An FS is also used when a design-to-cost process applies to help in defining the best compromised solution. Moreover, it facilitates the selection of “off-the-shelf” items because it forces to define the needs and constraints even if solutions are preselected.

The technical specification derives from the FS and is compatible with the proposed baseline solution. It is the result of the business negotiation process. It is the baseline for the product or system development.

A TS defines the related set of technical requirements established and used to develop or procure a product or a system as part of the business agreement.

The TS is the technical reference for the design definition and the end product acceptance.

The technical requirements are usually negotiated with the customer and take into account the technical feasibility, availability and cost of the proposed solution.

### 5.2 Process for establishing a functional specification

For space projects, this process can be divided into two steps:

- establishment of the first issue of the FS;
- identification, evaluation of the different possible concepts to establish the final issue of the FS.

The first step consists of an initial assessment of the project and results in the first issue of the FS, as illustrated in Figure 3. The purpose of this first issue of the FS is to express the customer's need mission statement, associated environmental constraint and programmatic element in terms of technical requirements (i.e. the problem to solve). This document serves as a basis to initiate the next step.

NOTE A functional analysis can be performed to capture the FS requirements (see EN 12973).

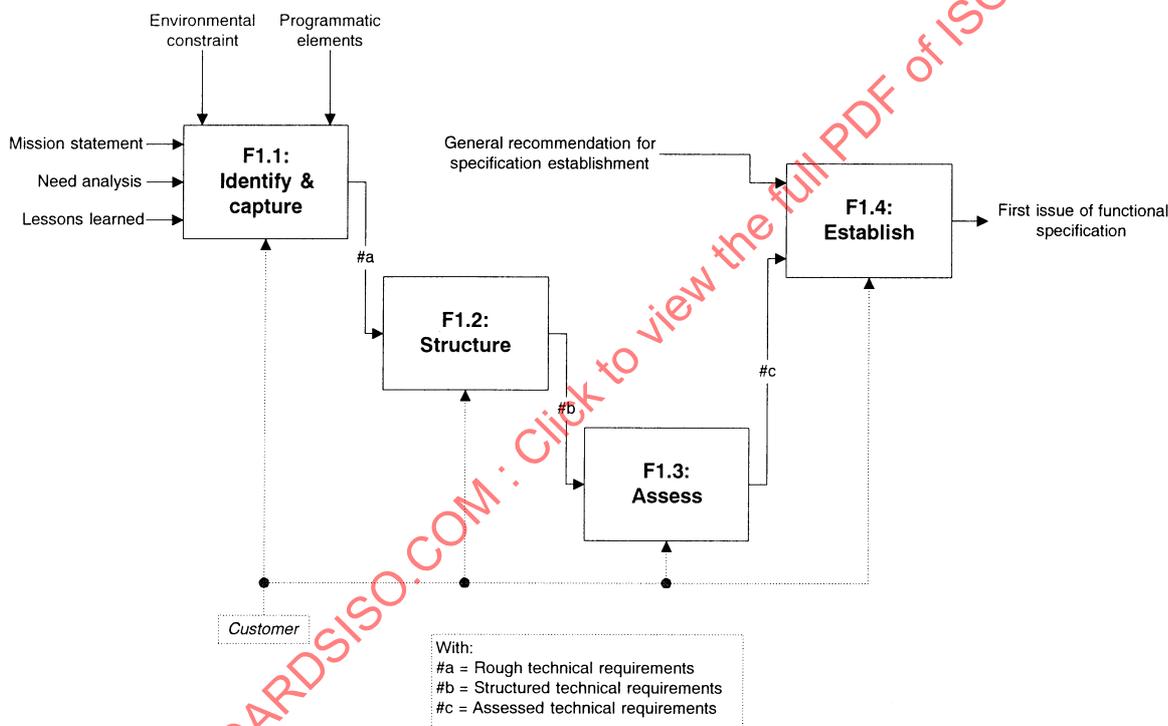


Figure 3 — Process to establish the first issue of the FS

Where:

- The F1.1 task: The customer identifies and captures the user's needs or mission statements, associated environments and constraints. He expresses these in terms of technical requirements;
- The F1.2 task: The customer structures, classifies and justifies (see 8.1.1) individual technical requirements;
- The F1.3 task: The customer assesses the entire set of technical requirements for correctness, consistency and suitability for the intended use;
- The F1.4 task: The customer establishes the first issue of the FS and releases it.

The second step consists of the exploration among the different possible concepts ensuring the conformity to the defined needs, then the selection of one concept and results in the final issue of the FS. This final version

is progressively drafted from the first issue of the FS and takes into account the induced constraints from the possible concepts. Figure 4 illustrates this process.

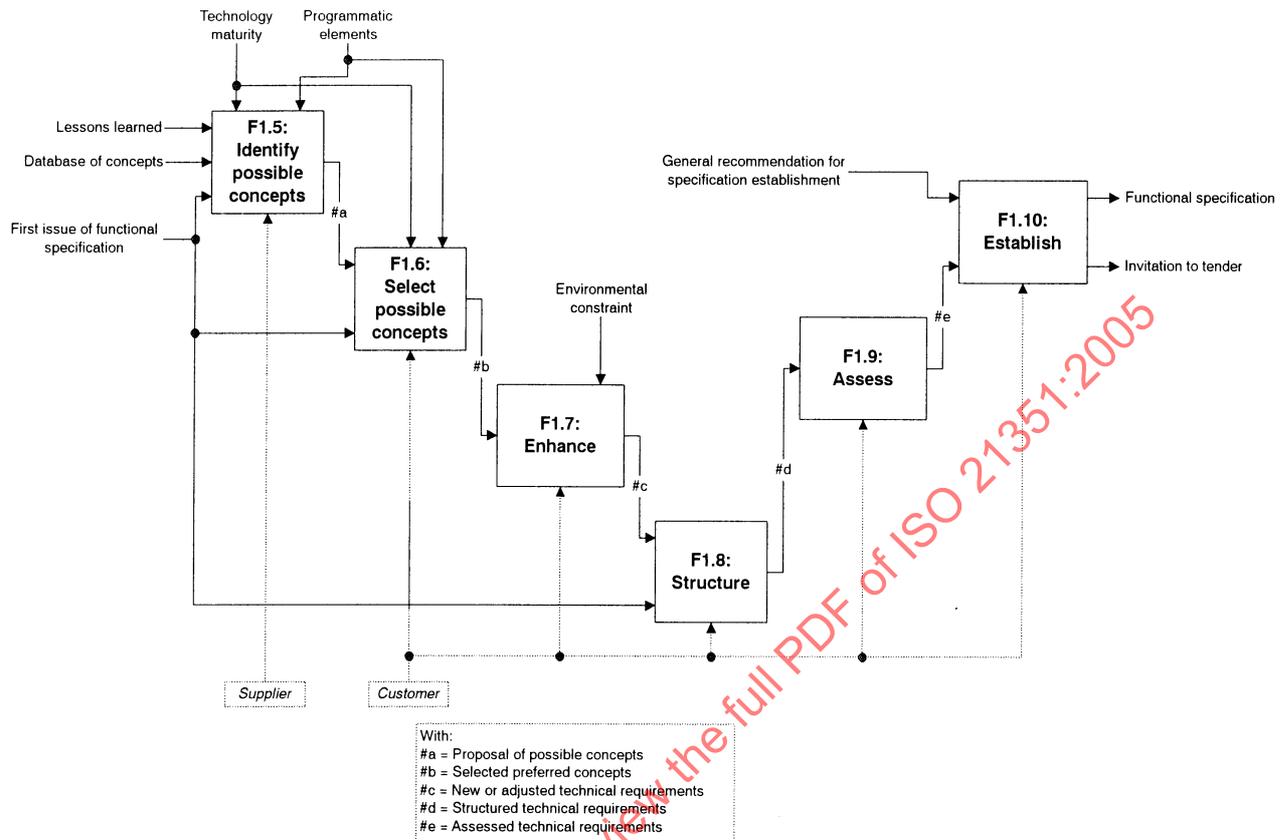


Figure 4 — Process to establish the final issue of the FS

Where:

- The F1.5 task: Each candidate supplier reviews the first issue of the FS, identifies and proposes possible concepts;
- The F1.6 task: The customer evaluates and selects preferred concepts;
- The F1.7 task: The customer identifies the need for changes to the first issue of the FS taking into account the limitations and possibilities induced by the selected preferred concepts. Then, he expresses the adjusted or new individual technical requirements;
- The F1.8 task: The customer structures, classifies and justifies (see 8.1.1) the individual technical requirements;
- The F1.9 task: The customer assesses the entire set of technical requirements for correctness, consistency and suitability for the intended use;
- The F1.10 task: The customer establishes the final issue of the FS and releases it.

### 5.3 Process for establishing a technical specification

A technical specification is a contractual document drafted under the customer's responsibility. As a result of the negotiation process, it expresses the technical requirements in terms compatible with the FS and the capabilities of the selected solution, taking into account the performances, costs and schedule constraints.

Figure 5 presents the TS establishment process. This process takes into account environmental and suppliers' constraints and programmatic elements (including the cost and schedule) and the FS. It allows the customer and the supplier to find a compromise and agree upon the TS.

The process described is independent of the point where the solution to be developed is chosen.

The outcome of this process is an agreed set of technical requirements to be included in the business agreement for development.

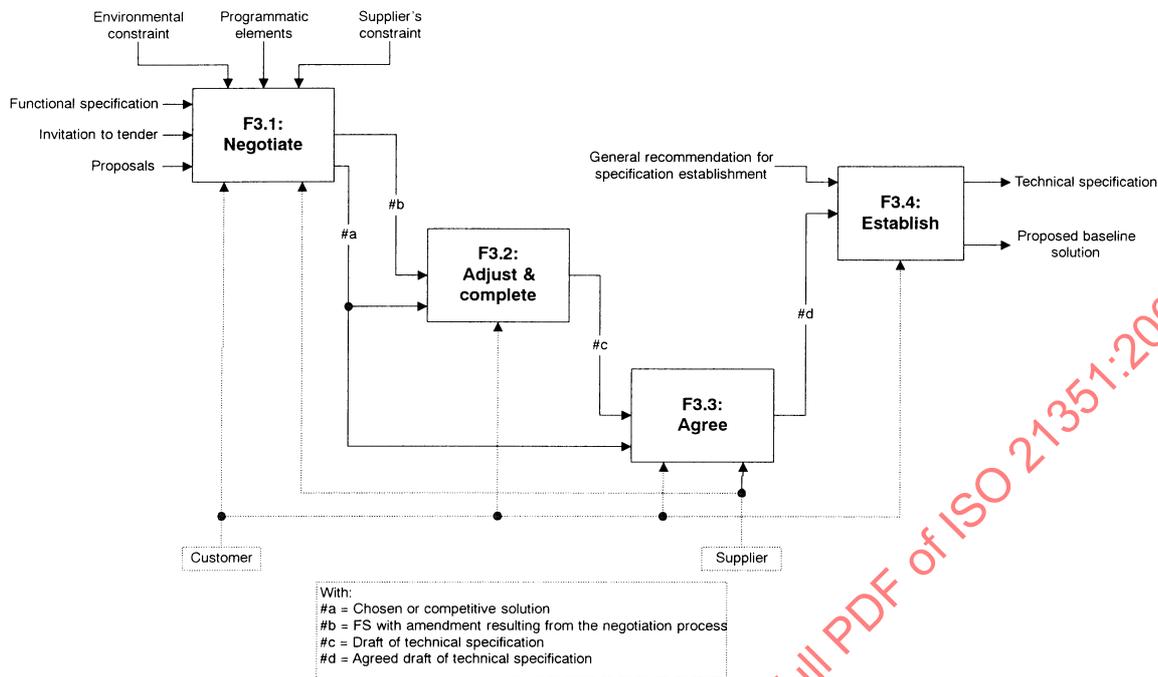


Figure 5 — Process to establish the TS

Where:

- The F3.1 task: Both the customer and each candidate supplier negotiate to establish amendments to the technical requirements;
- The F3.2 task: The technical requirements are adjusted and completed according to the result of the negotiation step;
- The F3.3 task: Both the customer and each candidate supplier agree upon the technical requirements contained in the draft issue of the TS;
- The F3.4 task: The technical specification is established as a baseline for the solution to be developed by the signature of the business agreement.

## 6 Technical requirements description

### 6.1 General description

The management of the technical requirements is based upon recognition of the attributes of technical requirements.

### 6.2 Identification of attributes assigned to technical requirements

#### 6.2.1 Introduction

The differing types of technical requirements contained in the FS and in the TS are as follows

- functional requirements,
- mission requirements,
- interface requirements,

- environmental requirements,
- physical requirements,
- operational requirements,
- human factor requirements,
- (integrated) logistics support requirements,
- product assurance (PA) requirements,
- configuration requirements, and
- design requirements.

NOTE These different technical requirements used for the FS are called “user related functions” and constraints in EN 1325-1

### 6.2.2 Functional requirements description

Functional requirements are statements that define a function that the product shall perform, in order to conform to the needs and requirements of the user.

EXAMPLE 1 The product shall be able to put a satellite into orbit.

EXAMPLE 2 The product shall analyse the surface of Mars and transmit the data so that it is at the disposal of the scientific community.

### 6.2.3 Mission requirements description

Requirements related to a task, a function or an action performed by a product that yields a specified and observable result.

EXAMPLE The product shall be designed to be put in its final position after a transfer duration shorter than 90 days.

### 6.2.4 Interface requirements description

Requirements related to the interconnection or relationship characteristics between the product and other items.

NOTE This includes different types of interfaces (e.g. physical, thermal, electrical, and protocol).

EXAMPLE The product shall dialogue with the ground segment using telemetry.

### 6.2.5 Environmental requirements description

Requirements related to a product or the system environment during its life cycle; this includes the natural environments (e.g. planet interactions, free space and dust) and induced environments (e.g. radiation, electromagnetic, heat, vibration and contamination).

EXAMPLE The product shall operate within the temperature range from 30 °C to 50 °C.

### 6.2.6 Physical requirements description

Requirements that establish the boundary conditions to ensure physical compatibility and that are not defined by the interface requirements, design and construction requirements, or referenced drawings.

NOTE This includes requirements related to mechanical characteristics, electrical isolation and chemical composition (e.g. weight and dimensional limits).

EXAMPLE The product shall have a mass of (30 ± 0,1) kg.

### 6.2.7 Operational requirements description

Requirements related to the system operability.

NOTE This includes operational profiles and the utilization environment and events to which the product shall respond (e.g. autonomy, control and contingency) for each operational profile.

EXAMPLE The product shall be designed to accept control of the viewing function from the ground segment.

### 6.2.8 Human factor requirements description

Requirements related to a product or a process adapted to human capabilities considering basic human characteristics.

NOTE This includes the following basic human capability characteristics:

- decision making,
- muscular strength, coordination and craftsmanship,
- body dimensions,
- perception and judgement,
- workload, and
- comfort and freedom from environmental stress.

EXAMPLE The product shall display the information with no more than two windows on the screen at the same time.

### 6.2.9 (Integrated) logistics support requirements description

Requirements related to the (integrated) logistics support considerations to ensure the effective and economical support of a system for its life cycle.

NOTE This includes the following subjects:

- the constraints concerning the maintenance (e.g. minimum periodicity, intervention duration, infrastructure, tooling, intervention modes),
- packaging, transportation, handling and storage,
- training of product users,
- user documentation,
- implementation of the product at the user's site, and
- reuse of the product or its elements.

EXAMPLE The product shall be designed to be installed at the customer's site within two days.

### 6.2.10 Product assurance (PA) requirements description

Requirements related to the relevant activities covered by the product assurance.

NOTE This can include the following subjects:

- Reliability, availability, maintainability,

- Safety, and
- Quality assurance.

EXAMPLE The product shall conform to the preferred parts list (PPL).

### 6.2.11 Configuration requirements description

Requirements related to the composition of the product or its organization.

EXAMPLE The product shall have 7 power modules with 2 power outlets per engine.

### 6.2.12 Design requirements description

Requirements related to the imposed design and construction standards such as design standards, selection list of components or materials, interchangeability, safety or margins.

EXAMPLE The receiver shall use a phase-lock loop (PLL).

## 7 Requirements and recommendations for functional specifications and technical specifications

### 7.1 Requirements and recommendations common to FS and TS

#### 7.1.1 General

- Technical requirements in the FS (respectively the TS) shall be formulated as defined in Clause 8 as applicable to the FS (respectively the TS).
- The specification shall be identifiable, referable and related to a product or a system.

#### 7.1.2 Responsibility

- An entity shall be identified to be responsible for the specification.
- The responsible entity shall define access policy and rights, and distribution list for the specification.
- The responsible entity of the specification shall define the content and format of the attributes listed in Clause 8.

#### 7.1.3 Technical requirements organisation

- The technical requirements should be grouped by type or in accordance with the different situations of the product or system life cycle in regard of the needs, the environmental conditions and the constraints.
- The technical requirements shall be unambiguous and not in conflict with the other associated requirements in contractual documentation.
- The technical requirements shall be consistent (e.g. not in conflict with the other requirements within the specification).
- Compounded technical requirements should be avoided.
- Abbreviated terms used in requirements shall be defined in a dedicated section of the specification.

#### 7.1.4 Unique technical reference

- a) The specification shall be complete in terms of applicable requirements and reference to applicable documents.
- b) A technical requirement shall not call for more than one technical requirement in an applicable referred document.
- c) The link to an applicable document shall be stated in the technical requirements.
- d) The reference number of the applicable documents cited in the specification shall contain the revision identifier.

#### 7.1.5 Configuration management

The specification shall be under configuration management.

#### 7.1.6 Format

The specification shall be established to be readily exchanged according to the established access policy and rights.

#### 7.1.7 Supplementary information

If a (sub)clause is stated to be informative or descriptive, then this (sub)clause shall not contain any requirement or recommendation.

#### 7.1.8 Restrictions

Functional and technical specifications shall only include technical requirements and exclude requirements such as cost, methods of payment, quantity required, time or place of delivery.

#### 7.1.9 Severity classification

The specification shall provide the scoring scheme for the severity of risk consequences according to EN ISO 17666.

### 7.2 Requirement specific to the functional specification

In order to allow potential suppliers to propose the best technical and programmatic solutions, a functional specification shall provide flexibility on requirements to facilitate the adjustment of the need, mission statement, programmatic and any possible solutions.

NOTE Good practice avoids proposing or referring to a specific solution in the FS.

## 8 Requirements and recommendations for characterizing the technical requirements

### 8.1 Requirements and recommendations for the characteristics of a technical requirement common to FS and TS

#### 8.1.1 Performance

- a) Each technical requirement shall be described in quantifiable terms.