1. (normative)  
   System engineering plan (SEP) - DRD
   1. DRD identification
      1. Requirement identification and source document

This DRD is called from ECSS-E-ST-10, requirements 5.1a and 5.3.4a.

* + 1. Purpose and objective

The objective of the system engineering plan (SEP) is to define the approach, methods, procedures, resources and organization to co-ordinate and manage all technical activities necessary to specify, design, verify, operate and maintain a system or product in conformance with the customer’s requirements. In particular the SEP is established to fulfil the major technical project objectives, taking into account the defined project phases and milestones (as defined in ECSS-M-ST-10).

The SEP covers the full project lifecycle according to the scope of the business agreement. It is established for each item of the product tree (as defined in ECSS-M-ST-10).

It highlights the risks, the critical elements, the specified technologies, as well as potential commonalities, possibilities of reuse and standardization, and provides means for handling these issues.

The SEP is an element of the project management plan (as defined in ECSS-M-ST-10).

1. It is important to adapt the SEP content to the phase of the project, with more information on risk analysis and new technologies in early phases 0, A and B, and more information on verification and validation aspects in phases C, D.
   1. Expected response
      1. Scope and content

Introduction

The SEP shall contain a description of the purpose, objective, content and the reason prompting its preparation (e.g. programme or project reference and phase).

Applicable and reference documents

The SEP shall list the applicable and reference documents in support to the generation of the document.

The SEP shall include the references to the following applicable documents:

Business agreement

Project management plan, as defined in ECSS-M-ST-10 Annex A

Product assurance plan, as defined in ECSS-Q-ST-10 Annex A

Configuration management plan, as defined in ECSS-M-ST-40 Annex A

Production plan

Mission operations plan, as defined in ECSS-E-ST-70 Annex G

ILS plan.

Project overview

Project objectives and constraints

The SEP shall contain the following description of:

The project objective and the main elements that characterize the user’s need.

The objective of the system or product as established by the TS (as defined in the ECSS-E-ST-10-06 Annex A).

The main elements of the system architecture (i.e. first level elements of the architecture adopted for the system and identification of their reuse constraints).

The principal characteristics of the project lifecycle and the incremental development of the system (e.g. successive versions, progressive implementation of the functions of the system).

The main elements supporting the project lifecycle (e.g. ground support equipment, and facilities).

The organizational constraints impacting system engineering activities (e.g. the external and internal industrial organization (e.g. contractors, partners, suppliers, own company) constraints).

The list of the critical issues identified at the beginning of the project phase(s).

The list of national and international regulations.

The capacity for verification and validation of the product, taking into account the means available, e.g. for tests, analysis, or simulation.

Product evolution logic

The SEP shall detail the incremental development of the system:

progressive implementation of system functionalities,

identification of possible successive versions,

objectives and strategy for the implementation of the successive versions.

Project phase(s), reviews and planning

The SEP shall provide an implementation and schedule of the system engineering activities and identify for the considered phase(s), as a minimum:

the main project milestones driving the system engineering process,

the phase(s) of the project lifecycle and the main reviews in accordance to project management plan.

The SEP shall provide dates of milestones or the duration of phases and the critical path according to the project master schedule.

Procurement approach

The SEP shall describe the strategy for acquisition of the items of the system or products defined in the product tree (e.g. make or buy, product line, incremental development).

Initial critical issues

The SEP shall list the critical issues identified at the beginning of the project phase(s) covered in the SEP (e.g. any specific issues, problems, critical subjects, which require dedicated attention, investigation, action and planning).

System design approach

System engineering inputs

The SEP shall list the driving inputs for the system engineering activities described and defined by the:

business agreement,

outputs from previous phase(s) or expected under the heading of activities which are not controlled within the context of this SEP (e.g. data provided by the customer, data coming from other projects, upstream or predevelopment studies, product lines),

project management plan, product assurance plan, risk management plan, and configuration and documentation management plans.

The SEP shall list the external means and facilities (e.g. equipment, software, and premises) made available by the customer or by any other entity external to the supplier that is responsible of this SEP, and, for each identified mean or facility, identify the applicable interface requirements (e.g. interface control documentation) as well as the authority in charge of it.

The SEP shall list the internal means and facilities (e.g. equipment, software, and premises) made available by the organization in charge of the development of the system or product.

The SEP shall contain the Coordinate System Document (as defined in ECSS-E-ST-10-09 Annex A).

The SEP shall define the units system to be used in the project.

System engineering outputs

The SEP shall list the specified system engineering outputs as defined in ECSS-E-ST-10 clause 6 for the specific project phase(s) covered in the SEP.

1. An overview of document delivery is given in Annex A.

The SEP shall describe the following:

The strategy for the system engineering activities in line with the guidelines addressed by the management plan. In particular, identifying intermediate technical events for each phase in compliance with the master program schedule.

The system design activities, with their objectives and major outputs according to the phase.

The major engineering activities for each intermediate technical events, showing their mutual interactions and their relationships with the principal milestones (i.e. internal or contractual) of the project.

The model philosophy (as defined in ECSS-E-ST-10-02 clause 4.2.5) in terms of number and characterization of models, from system to the requested lower level, necessary to achieve a high confidence in the product verification.

The margin policy according to project phase, product category and maturity level.

The SEP shall also describe

the method(s) and process(es) considered for the engineering activities (e.g. concurrent engineering, value analysis, or iteration cycle),

the interrelation between the different engineering disciplines and other project activities (e.g. production, quality assurance, and operations and logistics),

the interaction with other actors (e.g. customer and suppliers),

the consistency and coherency of simultaneous activities (e.g. performed in parallel),

which and how, control activities are implemented,

Assessment of potential COTS usage

In the case of a system incremental evolution, the SEP shall describe the design strategy for the:

development of the initial release of the product,

development, the verification of subsequent releases and their deployment,

introduction of new technologies,

tools and methods used for analysis,

control of the evolutions for each release.

System engineering team responsibilities and organization

The SEP shall contain the following:

Definition of the entities participating in the system engineering activities and the corresponding functions according to the project management plan.

Identification of key engineering roles and responsibilities (e.g. system engineers, disciplines engineers, and technical managers).

Description of the co-operative work amongst the different teams participating in the system design.

System engineering coordination

The SEP shall describe the external and internal coordination in line with the project management plan.

Implementation and related plans

System engineering tasks description

<5.1.1> System engineering process description

The SEP shall describe the system engineering process tailored to the specifics of the considered project, and identify all the system engineering tasks to be implemented from the starting conditions (e.g. kick-off) to the closing event (e.g. review), their relationship, and their interfaces with other actors of the project, and identify and describe any existing iteration within the process.

For each task, the input information and their origin, the document(s) delivered (i.e. expected output) and their destination, the system engineering function(s) performed and the contribution of other actors shall be identified.

<5.1.2> Engineering disciplines integration

The SEP shall address the following activities that concern the different engineering disciplines, recalling the relevant applicable standards and ancillary dedicated plans that are considered integral part of this SEP.

The SEP shall define the process and control to be put in place to meet requirements for the thermal, structures, mechanisms, environmental control and life support, propulsion, pyrotechnics, mechanical parts, and materials functions and interfaces.

1. These requirements refer to Mechanical engineering as defined in ECSS-E-ST-3x series of standards.

The SEP shall define the process and control to be put in place to meet requirements for electrical and electronic engineering, covering all electrical and electronic aspects of the relevant space product, including functions such as power generation, storage, conversion and distribution, and optical, avionics and microwave domains, electromagnetic compatibility, and electrical interfaces.

1. These requirements refer to Electrical and electronic engineering as defined in ECSS-E-ST-20.

The SEP shall define process and control to be put in place to meet requirements for software engineering, covering, amongst others, flight and ground software, checkout software and simulation software.

1. These requirements refer to Software engineering as defined in ECSS-E-ST-40.

The SEP shall define process and control to be put in place to meet requirements for communication engineering, covering, amongst others, spacecraft-to-ground, spacecraft-to-spacecraft, ground-to-ground and on-board communications links.

* 1. 1 These requirements refer for Communications engineering as defined in ECSS-E-ST-50.
  2. 2 It includes aspects such link budgets, data management, RF, audio and video communications and protocols.

The SEP shall define process and control to be put in place to meet requirements for control engineering, covering, amongst others, AOCS, robotics, rendez-vous and docking.

The SEP shall define the process and control to be put in place to meet requirements specifying natural environment for all space regimes (e.g. debris regulations, or planetary contamination protection) and general models and rules for determining the local induced environment

1. These requirements refer to Space environment as defined in ECSS-E-ST-10-04.

The SEP shall define the process and control to be put in place to meet requirements for the approach, methods, procedures, organization and resources to be implemented to ensure proper technical interfaces between system engineering and production.

The SEP shall define the process and control to be put in place to meet requirements of operations of the space segment, covering, amongst others:

mission operation definition and preparation,

mission and trajectory analysis, and

operability analysis (e.g. autonomy, operational scenario, nominal and non-nominal modes, failure detection isolation and recovery).

1. These requirements refer to Operations engineering as defined in ECSS-E-ST-70.

The SEP shall define the process and control to be put in place to meet requirements for ground and in-orbit logistics and maintenance, addressing, amongst others, technical activities, related engineering standards, methods and analyses to be performed to ensure that the development of space systems (i.e. manned and unmanned) properly takes into account and integrates the supportability and support aspects for the whole life cycle.

The SEP shall define the process and control to be put in place to meet requirements for human activities and environments associated with space systems.

1. These requirements refer to Human factors engineering as defined in ECSS-E-ST-10-11.

The SEP shall define process and control to be put in place to meet requirements for implementation of design selections relating to humans for any item with associated human interface, including computer based system and equipment.

<5.1.3> Work package

The SEP shall define and describe the work package(s) for the relevant engineering tasks, which are maintained in the work breakdown structure.

Related plans

When the SEP includes sub-plans covering parts of system engineering activities, these sub-plans shall be annexed to the SEP.

The SEP shall identify the other plans relevant to system engineering function activity belonging to the following categories:

Programmatic plans

Verification plans

Engineering discipline plans

Operations plans

* 1. 1 Some of these plans can be integrated in the SEP in the early phases of a project.
  2. 2 Note to item 1: Examples of programmatic plans are: the SEP plans of sub-products constituting the system or product, Industrial procurement plan, risk management plan, off-the-shelf plan (see ECSS-Q-ST-20-10).
  3. 3 Notes to item 2:
     + Examples of verification plans are: verification plan (VP), AIT plan, AIV plan and technology plan, system calibration plan, Security Aspects Verification Plan. Some of those DRDs are defined in this document, in ECSS-E-ST-10-02 or ECSS-E-ST-10-03.
     + VP and AIT plans can be integral parts of the SEP, or rolled out separately (without overlap), or combined as the AIV Plan which can also be rolled out separately. However, the existence of the AIV Plan excludes independent VP and AIT plans.
  4. 4 Note to item 3: Examples of engineering discipline plans are: Fracture Control Plan (see ECSS-E-ST-32), Micro-gravity Control Plan, Electro-Magnetic Compatibility Plan (see ECSS-E-ST-20), Audible Noise Control Plan, Radio Frequency Plan, Alignment Requirements and Control Plan, System Performance Simulations Plan, Software Development Plan, Orbital Debris Mitigation Plan and Disposal Plan (as defined in ISO 24113:2011), Planetary protection Plan, Cleanliness and Contamination Control Plan.
  5. 5 Note to item 4: Examples of operation plans are: launch site operations and logistics plan, system commissioning and operation support plan.

The SEP shall describe the constraints and the interactions impacting the system engineering activities derived from the analysis of the plans identified as relevant in D.2.1<5.2>b.

System engineering methods, tools and models

The SEP shall list and briefly describe the methods, tools, and data models that the system engineering team uses in performing their tasks.

In relation to requirements traceability and demonstration of verification (compliance with requirements, VCD), the specific methods and tools shall be described (including interfaces to next lower level suppliers), and reuse of elements (e.g. COTS) identified.

Critical issues

The SEP shall describe any specific issues, problems requiring dedicated attention, investigations or actions during the current phase and identify risks, and risk mitigation measures.

System engineering for the following phase(s)

The SEP shall introduce the system engineering activities, to be conducted during subsequent phase(s) of the project, and as a minimum, list any identified critical issue and risk to be mitigated during the subsequent phase(s).

* + 1. Special remarks

None.