1. (normative)  
   Product user manual (PUM or UM) - DRD
   1. DRD identification
      1. Requirement identification and source document

This DRD is called from ECSS-E-ST-10 requirement 5.4.1.4c.

* + 1. Purpose and objective

The objective of the product user manual (PUM) is to provide information on design, operations and data of the product that is required by the user to handle, install, operate, maintain and dispose the product during its life time.

* 1. Expected response
     1. Scope and content

Introduction

The introduction shall describe the purpose and objective of the PUM.

Applicable and reference documents

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

Product function definition

Product expected functions

The PUM shall provide a general description of the expected functions of the product during its lifetime in expected operational context and environment.

Product functional constraints

The PUM shall describe all product functional constraints.

Life time phases and purposes

The PUM shall address the whole product life cycle and all its modes:

Handling

Storage

Installation

Operations (nominal and contingency)

Maintenance

Disposal.

The PUM shall consider potential consequences of the environment on those sequences (e.g. sensor blinding, eclipses);

Product description

Design summary

The PUM shall include the following:

summary of the product design, showing the definition of the product, its constituents, the distribution of functions and the major interfaces;

block diagram of the product;

top-level description of the product software architecture;

description of nominal product operations scenarios and constraints e.g. mutually exclusive modes of operation, power or resource sharing.

Product level autonomy

The PUM shall include the following:

description of product-level autonomy provisions in the areas of fault management (FDIR);

definition, for each autonomous function, of the logic or rules used and of its internal (product constituents) and external interfaces.

Product configurations

The PUM shall include the following:

drawings of the overall product configuration in all product modes;

definition of the product reference axes system(s);

drawings of the product layouts.

Product budgets

The PUM shall provide the distribution (or allocation) of the following budgets, per product constituent, or per operating mode, as appropriate:

mass properties;

alignment;

power consumption for all operational modes;

thermal budget and constraints and predictions;

Description of interfaces and related budgets. (e.g. RF links);

telemetry and telecommand date rates;

memory;

timing.

Interface specifications

The PUM shall provide a cross-reference to the applicable version of the ICD.

Handling

The PUM shall describe the conditions and procedures for the handling of the product, be it integrated or stand-alone.

The PUM shall describe the specific design features, transport and environmental conditions, required GSE, and limitations for the handling of the product.

Storage

The PUM shall describe the conditions and procedures for the storage of the product, be it integrated or stand-alone.

The PUM shall describe the specific design features, environmental conditions, required GSE, monitoring requirements, life-limited items, health maintenance procedures (activation, monitoring) and limitations for the storage of the product.

Installation

The PUM shall describe the conditions and procedures for the installation of the product, be it integrated or stand-alone.

The PUM shall describe the specific design features, required GSE, modes, environmental conditions, and limitations for the installation of the product.

Product operations

<4.9.1> General

The PUM shall include timelines, modes and procedures, constraints to operate the product during its life cycle in nominal and contingency conditions, and highlight critical operations.

* 1. 1 When the product is a space segment, the product operations aspects are included in a specific part of the UM called Flight Operations Manual (FOM).
  2. 2 The implementation of the FOM by the ground segment responsible organisation is contained in the Mission Operations Plan (MOP, as defined in ECSS-E-ST-70 Annex G).

<4.9.2> Timelines

The PUM shall include:

Baseline event timelines for all nominal and contingency modes and phases.

Related constraints.

Each timeline shall contain a detailed description (i.e. down to the level of each single operational action) of the complete sequence of operations to be carried out, including a description of the rationale behind the chosen sequence of events, a definition of any constraints (e.g. absolute timing, relative timing) and the interrelationships between operations in the sequence.

<4.9.3> Product modes

The PUM shall describe all nominal and contingency modes, including:

their purpose (i.e. circumstances under which they are used),

the related procedures,

operational constraints,

resource utilization,

the definition of the associated modes, and

monitoring requirements.

The PUM shall describe the allowable mode transitions and the operations procedure corresponding to each such transition.

Appropriate cross-reference shall be made to product constituent modes and procedures.

<4.9.4> Product failure analysis

The PUM shall provide the results of the product failure modes, effects and criticality analysis (FMECA) and the resulting list of single point failures.

Potential product failures shall be identified by means of a fault-tree analysis (FTA).

Maintenance

The PUM shall describe the conditions, procedures and logistics for the maintenance of the product, be it integrated or stand-alone.

1. The description can refer to the document that conforms to the Integrated Logistic Support Plan in conformance with ECSS-M-ST-70.

Disposal

The PUM shall describe the conditions and procedures for the disposal of the product, be it integrated or stand-alone.

The procedures shall include passivation, as relevant.

The PUM shall identify the risks during and after disposal.

Products constituents description

General

The information specified in P.2.1<5.2> to P.2.1<5.9> shall be provided for each product constituent.

Product constituent design summary

The PUM shall describe the product constituent including:

the overall functions of the product constituent and the definition of its operational modes during the different mission phases;

description of any product constituent management functions, fault management concept and redundancy provisions;

a summary description of the component units/equipment and software including the functions which each supports;

product constituent functional block diagrams and a diagram showing the source of telemetry outputs and the sink of telecommand inputs;

interfaces;

budgets.

Product constituent design definition

The following shall be provided for each product constituent:

a detailed design description, including block diagrams, functional diagrams, logic and circuit diagrams;

physical characteristics including location and connections to the support structure, axes definition and alignment where relevant, dimensions and mass properties;

principle of operation and operational constraints of the product constituent;

lower level of breakdown for products composed of many complex elements.

Software

The PUM shall include:

description of software design,

product constituent software,

application process service software, and

memory map.

The PUM shall describe the organization of the software and its physical mapping onto hardware.

The PUM shall describe the details of each software component i.e. scheduler, interrupt handler, I/O system, telecommand packet handling system, telemetry packet handling system, including for each component its functions, component routines, input/output interfaces, timing and performance characteristics, flowcharts and details of any operational constraints.

For the application process service software, the PUM shall:

describe the services implemented making cross-reference to ECSS-E-ST-70-41 “Telemetry and telecommand packet utilization”, as tailored for the mission;

summarize all telemetry and telecommand structures (e.g. packets) including the conditions under which they are generated, the generation frequency, content and interpretation.

For each memory block, a map shall be provided showing RAM and ROM address areas, areas allocated for program code, buffer space and working parameters (e.g. content of protected memory).

Product component performance

The PUM shall describe all relevant product constituent performance characteristics, define the expected performance degradation as a function of time during the mission, and identify the resulting impact in terms of modifications to operational requirements or constraints.

Product component telemetry and telecommand lists

For each product constituent, the following lists shall be provided:

a list of the housekeeping telemetry parameters;

a list of the telecommands.

Each housekeeping telemetry shall have a functional description with validity conditions, telecommand relationship, and all technical information necessary for using it.

Each telecommand shall have a functional description with utilization conditions (e.g. pre-transmission validity, criticality level), command parameters (syntax and semantics) and execution verification in telemetry.

Product component failure analysis

The PUM shall describe:

Identification of potential product constituent failures by means of a systematic failure analysis (including a subsystem FMECA and FTA).

Identification of the methods by which the higher levels can identify a failure condition from analysis of the telemetry data and isolate the source of the failure.

Product components operations

The PUM shall describe:

product constituent modes;

nominal operational procedures;

contingency procedures.

product constituent modes shall be defined for all distinct nominal and back-up modes of the subsystem including:

purpose (i.e. conditions under which each is used);

operational constraints;

resource utilization;

the definition of the associated modes for each product constituent and its software functions;

higher level monitoring requirements;

identification of the allowable mode transitions and any product constituent operational constraints.

Nominal operational procedures shall be defined for each nominal mode transition identified under P.2.1<5.8>b.6.

For each procedure described in P.2.1<5.8>c., the following shall be provided:

an introduction describing the purpose of the procedure and the phase(s) or conditions when applicable;

the body of the procedure, structured according to operational steps, including:

pre-conditions for the start of the step defining, where applicable:

* product or product constituent level pre-requisites (e.g. configuration and resource requirements, such as power, fuel);
* external interfacing products pre-requisites.

telecommands to be sent;

telemetry data to be monitored to verify correct execution of the step;

interrelationships between steps (e.g. conditional branching within the procedure, timing requirements or constraints, hold and check points);

conditions for completion of the step.

Contingency procedures shall be defined for each failure case identified in the product constituent failure analysis (FMECA/FTA).

1. This can utilize a nominal operational procedure already identified in P.2.1<5.8>c. above.

For contingency procedures, the same details shall be provided as for nominal operational procedures in P.2.1<5.8>d. above.

Where the recovery method for a failure or group of failures is mode, mission, or phase dependent, separate procedures shall be described for each mode/mission phase.

Product component data definition

For each operational mode of the product constituent, sensor output data, conditions under which they are generated, their contents, and data rate shall be described.

Required on-board processing performed on sensor data and algorithms used for this shall be described.

* + 1. Special remarks

Where the objective is to allow for the accommodation of equipment designed a posteriori w.r.t an existing platform or vehicle, the following documents shall be part of the UM:

The accommodation handbook describing the location, mounting, all interfaces and clearances of equipment in a platform or vehicle.

The installation plan describing the approach, methods, procedures, resources and organization to install, commission, and check the operation of the equipment in its fixed operational environment.