

## Chapter 12 Items to be Delivered by the Customer

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## 12 Items to be Delivered by the Customer

This chapter summarises and describes the main software (documents, data and software-models) and hardware (flight units, dummies and ground equipment) which shall be supplied by the Customer as a minimum. The times and destinations for shipments are also described. Delivery times and destinations of additional items which the Customer wants to use, e. g.

mission insignias for the launch vehicle or container-external surfaces, are to be agreed on in the first two mission preparation phases. Wherever possible, submission of data in electronic format is preferred by EUROCKOT in order to improve shipment times and accessibility of the data.

Table 12-1 provides a summary of all documents to be supplied by the Customer during the various mission phases. Further explanations regarding their definition can be found in the following sections.

| Documents to be provided  | Date (typically)                  |                       |
|---|-----------------------------------|-----------------------|
|   | Preliminary                       | Final                 |
| Interface Requirements Document (IRD)   | L - 24 months                     |                       |
| Safety submission (Phase I, II, III)  | I: L-18 months<br>II: L-12 months | III: L- 6 months      |
| Spacecraft mechanical environment test plan   | L - 16 months                     |                       |
| Spacecraft dynamic model (Preliminary)  | L - 23 months                     | L - 11 months         |
| Spacecraft thermal model (Preliminary)  | L - 23 months                     | L - 11 months         |
| Response to questionnaire: Input to Mission Design and Mission Analysis   | L - 23 months                     | L - 11 months         |
| Launch license documentation  |                                   | L - 10 months         |
| Spacecraft Operations Plan  | L - 17 months                     |                       |
| Spacecraft mechanical environment qualification test results  | L - 6 months                      |                       |
| Technical readiness documentation: SC technical readiness certificate, SC readiness package for launch campaign operations within the integration facility, launch pad and launch | L - 6 months                      | L - 3 months          |
| Final customs documentation   |                                   | SC shipment - 1 month |
| Final spacecraft mass properties  | L - 7 days                        |                       |
| Orbital Tracking Operation Report   | L + 2 weeks                       |                       |

**Table 12-1 Summary of documents to be supplied by the Customer.**

## 12.1 General Documents

### 12.1.1 Interface Requirements Document

|                                 |             |
|---------------------------------|-------------|
| Interface Requirements Document | L-24 months |
|---------------------------------|-------------|

The Interface Requirements Document (IRD) will be the technical baseline document for the first mission phase as long as no Interface Control Document has been established and agreed. The IRD will be created by the Customer and is generally one of the parts of the technical annexes of the launch services contract. EUROCKOT can supply a generic IRD template for customers to use, if required.

With this document, the Customer will also describe the mission and spacecraft characteristics as already defined. This focuses on mass properties, interface dimensions, and mission and orbit characteristics in particular. Within the outline provided by EUROCKOT, all chapters which have to be completed with information for contract signature will be marked.

Figure 12-1 shows the typical table of contents for this. Nevertheless, modifications according to dedicated demands of the mission can be implemented on the basis of joint agreements.

|         |                                       |
|---------|---------------------------------------|
| 1       | INTRODUCTION                          |
| 1.1     | Objective                             |
| 1.2     | Mission Description                   |
| 1.3     | Project Summary                       |
| 2       | APPLICABLE DOCUMENTS                  |
| 2.1     | Government Documents                  |
| 2.2     | Customer Documents                    |
| 2.3     | Reference Documents                   |
| 3       | REQUIREMENTS                          |
| 3.1     | MISSION REQUIREMENTS                  |
| 3.1.2   | Launch Requirements                   |
| 3.1.2.1 | Launch Date                           |
| 3.1.2.2 | Launch Time                           |
| 3.1.3   | Injection Orbit Requirement           |
| 3.2     | SEPARATION REQUIREMENTS               |
| 3.2.1   | Separation velocity                   |
| 3.2.2   | Angular velocities                    |
| 3.2.3   | Separation monitoring                 |
| 3.3     | INTERFACE REQUIREMENTS                |
| 3.3.1   | Mass Properties                       |
| 3.3.2   | Mechanical Interfaces                 |
| 3.3.2.1 | Static Envelope and Clearances        |
| 3.3.2.2 | Satellite to Launch Vehicle Interface |
| 3.3.2.3 | Satellite Stiffness                   |
| 3.3.3   | Electrical Interfaces                 |
| 3.3.4   | RF Link (if applicable)               |
| 3.4     | LAUNCH SITE OPERATIONAL REQUIREMENTS  |
| 3.4.1   | Transportation                        |
| 3.4.2   | Payload Processing Facility           |
| 3.4.3   | Launch Pad                            |
| 3.5     | MECHANICAL ENVIRONMENTS               |
| 3.5.1   | Static Loads                          |
| 3.5.2   | Low Frequency Vibration               |
| 3.5.3   | Acoustic Noise                        |
| 3.5.4   | Separation Shock                      |
|         | APPENDICES AND DRAWINGS               |

**Figure 12-1 Interface Requirements Document table of contents.**

### 12.1.2 Orbit Tracking Operation Report

|                                 |           |
|---------------------------------|-----------|
| Orbit Tracking Operation Report | L+2 weeks |
|---------------------------------|-----------|

In order to confirm *Rockot* performance with regard to orbit injection accuracy, the Customer is requested to submit spacecraft tracking data after third stage burnout before and subsequent to separation as far as such data are available. This must include a complete set of orbital parameters and their estimation accuracy.

## 12.2 Input to Mission Design and Mission Analysis

### 12.2.1 Response to Questionnaire

|  |             |
|--|-------------|
| Response to Questionnaire:<br>Input to Mission Design and Mission Analysis |             |
| Preliminary:   | L-23 months |
| Final:   | L-11 months |

In addition to the dynamic and thermal models for coupled loads and thermal analyses, EUROCKOT requires additional input data and information to adequately perform the preliminary and final mission design and analyses. It should be noted that some of this data will probably be contained within the customer supplied IRD and the resulting ICD that is established. However, all the required data is repeated here for completeness.

- Flight programme specification including
  - Required injection orbit and allowable errors

- Requirements (if any) of spacecraft attitude to the sun during coast phases of upper stage
- Manoeuvres during upper stage coast phase, e.g. thermal manoeuvres.
- Separation attitude of spacecraft
- Requirements to the launch vehicle after separation, e.g. collision avoidance manoeuvres, constraints on thrusters operations etc.
- Requirements to the launch window and allowable launch window duration (if not specified by other parameters)
- Spacecraft characteristics
  - Payload designation
  - Dimensions of spacecraft stowed in launch configuration and when deployed
  - Mass and inertial characteristics of dry and fuelled spacecraft
  - Propellant characteristic, viscosity, density etc.
  - Fuel sloshing analysis inputs (if applicable)
  - Thermal model
  - Dynamic model
- Ground and launch environments
  - Quasi-static and dynamic loads in flight
  - Transportation loads
  - Separation shock loads
  - Acoustic loads
  - Ground temperature / humidity constraints
  - Flight temperature constraints / fairing internal surface temperature constraints

- 
- Spacecraft cleanliness requirements, i. e. particles, surface cleanliness, organics (if applicable)
  - Pressure / venting constraints within payload fairing
  - Free molecular heating rate constraints after payload fairing jettison.
  - RF/ EMI constraints
  - Spacecraft Interfaces
    - Spacecraft coordinate system and reference to launcher coordinate system
    - Spacecraft static envelope (stowed, in launch configuration), critical points of spacecraft envelope relative to fairing.
    - Preferences for spacecraft location and clocking within payload fairing
    - Flight mechanical interfaces, including spacecraft to launcher interface flanges / points.
    - Ground mechanical interfaces, e. g. to handling dolly, fuelling platform etc.
    - Electrical interfaces including quantity, type and location of umbilical connectors
    - Umbilical connector separation force
    - Content and parameters of umbilical lines for flight
    - Electrical interfaces for ground operations
    - Telemetry parameters to be recorded during flight
    - Grounding and bonding requirements
    - Injection orbit data reporting formats
  - Launch site requirements
    - Spacecraft transportation provisions
    - Processing area requirements
    - Spacecraft fuelling area requirements
    - Personnel accommodation office in facilities / hotel requirements
    - Technical support requirements at launch base
    - Communication requirements, e.g. LAN interfaces, internet access, mobile walkie-talkies etc.
    - Spacecraft ground support equipment quantity / size etc.
    - Required consumables (gases etc.)
    - Security requirements
  - Campaign schedule/ operations
  - Drawings of spacecraft handling units and transport containers
  - Requirements for installation
  - Points for hoisting and fixing
  - Requirements for the separation system
  - Data on the payload elements which have to be jettisoned or deployed
  - Pyrotechnic devices and related constraints
  - Orbital parameters for the payload
  - Requirements for injection accuracy and payload orientation prior to its deployment
  - Acceptable range for thermal environments during the payload injection phase
  - Requirements for protection of optical surfaces

- Thermal control requirements
- Parameters of payload / ground support equipment interfaces
- Characteristics of the payload telemetry and telecommand system and other RF systems
- Payload and related GSE input data:
  - Allowable thermal conditioning interruptions for the payload, batteries and propellant containers
  - Payload processing cycle duration in integration facility and at launch pad
  - Payload ambient temperature, humidity and contamination control requirements during operations
  - Spacecraft battery charging/trickle charging cycles in integration facility and at launch pad.

### 12.2.2 Spacecraft Dynamic Model

|                          |                         |
|--------------------------|-------------------------|
| Spacecraft Dynamic Model | Preliminary L-23 months |
|                          | Final L-11 months       |

As described in section 8.4, structural compatibility will be demonstrated with preliminary and final CLA. Customer inputs, in particular structural models of the spacecraft, are requested for both preliminary and final CLA steps.

The spacecraft mathematical models must be provided by the Customer in the form of stiffness matrices and masses of non-fixed structures, mathematically reduced to a Craig-Bampton model. For detailed descriptions, refer to section 8.4.1 and to EUROCKOT document ESPE-0008.

Other presentations of the mathematical models, e. g. a spring mass model, are to be agreed with EUROCKOT.

### 12.2.3 Thermal Model

|               |                         |
|---------------|-------------------------|
| Thermal Model | Preliminary L-23 months |
|               | Final L-11 months       |

Section 8.5 describes which thermal environment studies are required to verify thermal compatibility through out the mission. This study will be implemented using a thermal model provided by the Customer. As this study covers the period from integration of the payload onto the dispenser within the integration facility, up to spacecraft separation, the Customer has to provide the following:

- A thermal model of the spacecraft containing
  - a description of the thermal nodes (heat capacities, mass type, etc.)
  - internal thermal couplings of nodes (conductive, radiative and convective)
  - heat dissipation for all applicable modes of operation during the covered mission phases
- interface descriptions (areas of contact, conductive and/or radiative properties)
- thermal requirements for the environment to be fulfilled during integration, launch and flight

For detailed descriptions, refer to section 8.5 and EUROCKOT document ESPE-0009.

## 12.3 Safety

|                    |        |             |
|--------------------|--------|-------------|
| Safety Submissions | Step 1 | L-18 months |
|                    | Step 2 | L-12 months |
|                    | Step 3 | L-6 months  |

During the mission phases, safety submissions have to be provided by the Customer in three steps. The content and format of the data to be supplied are described in more detail in chapter 9 and in the EUROCKOT Safety Handbook EHB-0004.

Generally, all areas generating risks for personal safety such as pressurised systems, explosives (propellants, pyrotechnical devices, etc.), radioactive material, RF sources and toxic substances have to be covered, as well as safety-relevant operations to be performed during ground preparations. It has to be proven with all available information, how risks to people involved can be minimised to acceptable levels, which safety factors have been applied and how they have been or will be verified, and which precautions are envisaged.

|                                      |            |
|--------------------------------------|------------|
| SC Technical Readiness Documentation |            |
| Preliminary                          | L-6 months |
| Final                                | L-3 months |

Spacecraft Technical Readiness Documentation submitted by the Customer should include:

- The spacecraft technical readiness certificate for launch campaign operations within the integration facility, on the launch pad and for launch. This certificate ensures that the spacecraft is designed and checked in compliance with the ability to take all environmental loads, specified in ICD, and is ready for launch campaign operations at Ple-

setsk Cosmodrome and for launch on the *Rocket/Breeze-KM* launch vehicle.

The spacecraft readiness data package providing information necessary to justify spacecraft readiness for ground operations and flight certificate.

## 12.4 Payload Environmental Test Documents

|   |            |
|---|------------|
| Spacecraft Mechanical Environment Qualification Test Report | L-6 months |
|---|------------|

After the performing of structural qualification, test results shall be submitted to EUROCKOT for a review of compliance with the structural model supplied for the coupled loads analysis. If any discrepancies regarding loads, strength or stiffness were identified during qualification testing, corrective actions have to be agreed on.

Certainly, just as for the acceptance test results below, the extent to be provided is subject to mutual agreements as far as proprietary or technology export issues are involved.

## 12.5 Operations Documents for Spacecraft

For the organisation of work within the integration facility and on the launch pad, the following documents are required:

|                            |             |
|----------------------------|-------------|
| Spacecraft Operations Plan | L-17 months |
|----------------------------|-------------|

The purpose of the SOP is to define the activities to be performed on the spacecraft during the launch campaign and the relevant support and facilities required at the range. The document shall also be for-

warded to EUROCKOT to establish the launch campaign Joint Operations Plan (JOP) which is agreed between cosmodrome authorities, EUROCKOT, KSRC and the Customer. The JOP is further discussed in chapter 7. An outline version of a typical SOP document is given in Figure 12-2.

For spacecraft shipment and customs clearance the customer has to prepare and deliver the final pro-forma invoice accompanied by the detailed packing list of the spacecraft shipment not later than one month prior to the spacecraft shipment. Information about hazardous materials in internationally accepted formats also have to be provided, if applicable.

|  |
|--|
| 1. Introduction  |
| 2. Applicable Documents  |
| 3. General   |
| 4. Operations/ Baseline Schedule including                                 |
| • Test plan, day-by-day planning   |
| • Preparations and check-out to be carried out in the integration facility |
| • Assembly of the payload with the upper stage                             |
| • Payload fuelling procedure SC  |
| • Payload control and monitoring on the launch pad                         |
| • Warning regarding handling   |
| • Launch constraints   |
| • Launch window  |
| • Equipment associated with spacecraft                                     |
| • Electrical wiring requirements   |
| • Installations (buildings etc.)   |
| • Logistics  |

Figure 12-2 Spacecraft Operations Plan table of contents.

## 12.6 Contractual / Higher Level Documents

As well as technical documents other inputs will be requested from the Customer for obtaining the launch license.

- An End User Certificate that briefly describes the intended purpose of the mission, end user and the instrumentation of the spacecraft is to be provided 10 months prior the launch.
- The Customer is also responsible for obtaining the export license and the appropriate approval for use of radio frequencies in the intended orbit in a timely manner.

## 12.7 Models, GSE

As a minimum, two hardware models have to be available for testing (for more details refer to section 7.2.1.2).

|                          |             |
|--------------------------|-------------|
| Mass Frequency Simulator | L-12 months |
|--------------------------|-------------|

A spacecraft model simulating at least mechanical interfaces, mass and CoG position has to be provided by the Customer. It also has to be mutually agreed how far and with which tolerances, Mols and stiffness characteristics have to be simulated. As a baseline, the main natural frequencies should be simulated.

|                       |             |
|-----------------------|-------------|
| Fit Check/Dummy (TBC) | L-12 months |
|-----------------------|-------------|

In case of very low geometrical clearance between the spacecraft and the payload fairing, an advanced mock-up model similar to the flight unit regarding geometrical and mechanical interfaces has to be supplied for testing at KSRC's premises in Moscow. The fit of overall dimensions with the accommodation envelope (upper stage cover, dispenser, adapter and fairing) would be verified during this test. If it is obvious that there are no clearance issues regarding the fairing, a fairing fit check and

a spacecraft geometrical model are not required. Potentially, the fit check dummy could be provided in the form of the mass frequency simulator and geometric adapter mentioned above.

|                                |            |
|--------------------------------|------------|
| Flight Unit for Matchmate Test | L-5 months |
|--------------------------------|------------|

The Matchmate test with the launch vehicle adapter flight unit and the spacecraft flight unit shall be performed at the facilities of the spacecraft manufacturer in order to prove mechanical, electrical and operational compliance of this interface. A time slot as well as personal and technical resources have to be provided by the Customer and/or spacecraft manufacturer of the flight unit.

|                                |             |
|--------------------------------|-------------|
| Master Gauge / Drill Templates | L-18 months |
|--------------------------------|-------------|

For point attachment interfaces it has to be mutually agreed whether and by whom tools will be provided to enable precision positioning of attachment/fixing points at the spacecraft and the dispenser. This will not be necessary, if the same degree of precision can be achieved by fulfilling drawing requirements only or if a clamp band separation system is used.

|        |
|--------|
| Others |
|--------|

Shipments of other items which the Customer requires for ground operations (e. g. unit testers for integration facilities and launch pad, pathfinder spacecraft or containers, special transportation and handling equipment, fuelling equipment as well as personal safety equipment and fuel itself) as well as their storage and application are matters for dedicated arrangements between the Customer, EUROCKOT and the range operation organisations.

## 12.8 Hardware, Software and Document Time Schedule

A summary of all hardware, software and documents to be provided by the Customer is shown in Figure 12-3.

Generally, EUROCKOT is open to agreements on any modification imposed by special mission requirements if it is possible to consider it within the overall schedule.



