
Documentation

Chapter 6

This chapter describes the documentation which will become applicable when the Ariane launch system is adopted by a User.

6.1. The Ariane mission integration schedule

The documentation system and activities associated with an Ariane mission typically cover a 24 months period as shown [in figure 6.1.a](#). This schedule may be modified to suit the User's requirements.

The activities shown [in figure 6.1.a](#) are typical for a first-time Ariane mission; repeat missions of an identical nature may only require the reviews and an update of the analyses and associated documents.

6.2. Interface management

Interface Management is based on the Interface Control Document (DCI) which is issued by Arianespace using inputs extracted from the technical annexes of the Launch Service Contract and from the "Application to Use Ariane" (DUA) provided by the User.

6.2.1. Application to use Ariane

("Demande d'Utilisation Ariane" - DUA)

[Refer to annex 4.](#)

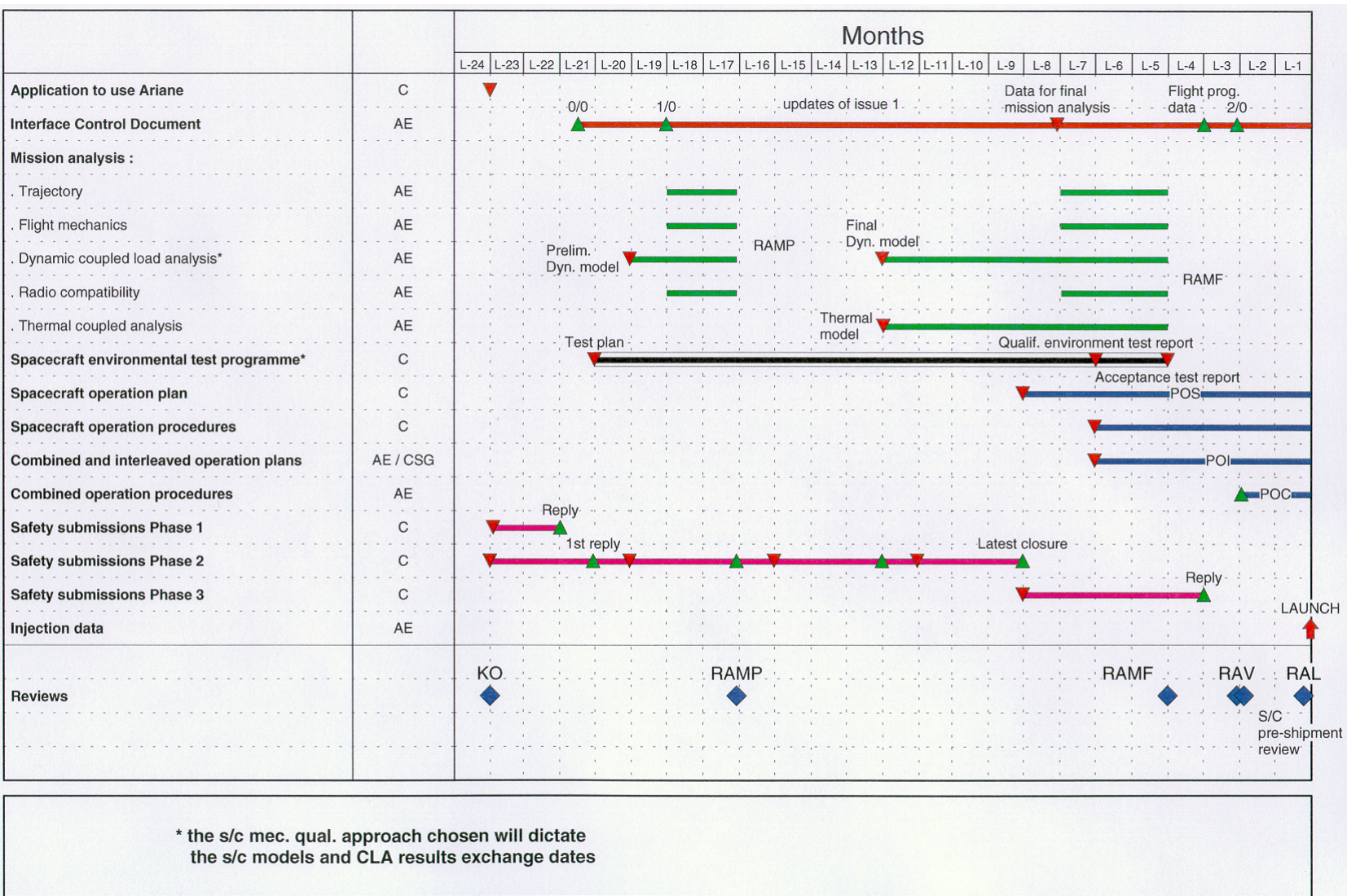
The User is required to issue a DUA in which the spacecraft interfaces with the launch system are defined i.e.:

- a) Mission characteristics (orbit, orientation at separation, operations after separation,...),
- b) Spacecraft data (mass, alignment, inertias, geometrical data, electrical and radio electrical interfaces, hazardous systems,...).

- c) Launch preparation at CSG (use of EPCU buildings including storage areas, communications networks requirements, spacecraft prelaunch operations on the launch site and countdown operations).

- d) Spacecraft development and test plan.

DUA detailed contents list can be provided to the User on request.



6.2.2. Interface Control Document

("Dossier de Contrôle d'Interface" - DCI)

Arianespace prepares the DCI in response to the DUA and the technical annexes of the launch Service Contract. The DCI collates all interface requirements common to the launch system and the spacecraft, and illustrates their respective compatibility.

The DCI is approved by both Arianespace and the User and is maintained under formal configuration control until the launch.

After approval, the DCI becomes the basic and sole working document with respect to technical aspects and identification of the operational activities.

6.3. Safety Baseline Documents

6.3.1. General

CSG is responsible for drawing up Safety Regulations, and ensuring that they are observed. All launches from the CSG require approvals from Ground and Flight Safety Departments; these approvals cover launch vehicle-payload hazardous systems and the flight plan respectively. In order to obtain this approval, a User has to demonstrate that his equipment and its utilization comply with the provisions of the Safety Regulations. This demonstration is achieved in a number of stages, by the submission of documents defining and describing the hazardous elements and their operation. Submission documents are prepared by the User and forwarded to the Ariane Authority.

6.3.2. Submission procedure

This procedure, defined in C.S.G. Safety Regulations RS, CSG Vol.2 - Fasc.3 and summarized hereafter, aims at a mutual understanding of problems, and their solutions, from the start of the project onwards in order to avoid loss of time and money resulting from the need for late modifications to the design or manufacture of systems classified as hazardous by CSG. Documents related to a given project are submitted in three phases:

Phase 1 Submission:

The User prepares a file containing all the documents necessary to inform CSG of his plans with respect to hazardous systems.

This file contains a description of the hazardous systems. It responds to all questions on the hazardous items check list given here after.

A safety check list is given in the CSG Safety Regulations to help for the establishment of the submission documents, its deals with the following topics:

1. ELECTRO-EXPLOSIVE DEVICES

- 1.1. Description
- 1.2. Location, function, date and place where fitted to spacecraft
- 1.3. Safety

2. SOLID PROPELLANT MOTORS

- 2.1. International classification
- 2.2. Manufacturer and references
- 2.3. Has it been used previously ?
- 2.4. Description
- 2.5. Ignition system
- 2.6. Firing and monitoring circuit
- 2.7. Storage and transfer containers
- 2.8. Associated ground support equipment

3. LIQUID PROPELLANT MOTORS

- 3.1. Nature and quantity of propellants
- 3.2. Propulsion system
- 3.3. Associated ground support equipment

4. ATTITUDE CONTROL (see § 3)**5. PRESSURE LEVELS**

- 5.1. Nature of fluids
- 5.2. Tanks
- 5.3. Associated ground support equipment

The document shall cover all safety related activities: component choice, safety and warning devices, fault trees for catastrophic events, and in general all data enabling risk level to be evaluated.

6. GROUND SUPPORT EQUIPMENT**7. BATTERIES**

- 7.1. Type, description
- 7.2. Pressurization (§ 5)
- 7.3. Hazardous fluids
- 7.4. Charge

8. RADIATIONS

- 8.1. Non-ionising radiations
- 8.2. Ionising radiations

9. INTERFACES

- 9.1. Mechanical interfaces
- 9.2. Electrical interfaces

10. MISCELLANEOUS

- Waivers
- Other safety problems not so far dealt with

CSG will study this submission, classify the hazardous systems described, and declare any special requirements imposed by its Safety Departments.

Phase 2 Submission:

The User submits the hazardous systems manufacturing, qualification and acceptance documentation as soon as it becomes available. This must satisfy the requirements laid down by CSG at the end of Phase 1. This documentation gives the requirements for providing EPCU equipment or facilities to be used during the launch campaign, and all other documents required by CSG during phase 1 and 2 submissions. It also defines the policy for checking and operating all systems classified as hazardous.

CSG checks that the documentation delivered in phase 2 complies with the requirements specified in Phase 1, states its intentions concerning verification of systems classified as hazardous, and defines the draft procedure to be applied during spacecraft activities in Guiana.

Phase 3 Submission:

The User submits a verification and operating procedures for systems classified as hazardous, with detailed description of verification policy and its execution.

After implementation of all changes that are considered necessary, CSG accepts the procedure. This becomes the sole authorized document to be applied by the User during the launch campaign, under the supervision of CSG Ground Safety Department.

6.3.3. Time schedule for safety activities

It is of general interest that the User completes the safety questionnaire well ahead of the formal submission phases, so that the earliest possible allowance can be made in designing the spacecraft on-board and ground equipment.

The following time-schedule for formal submissions shows the requested deadlines working backwards from the launch date L.

| SAFETY SUBMISSIONS TIME SCHEDULE | | |
|--|--|--|
| Typical schedule | Safety Submissions | Spacecraft Milestone |
| Earlier than L-24 months | Phase 0 preliminary submission | <pre> graph TD Contract --> PDR PDR --> CDR CDR --> RAVS RAVS --> CDR </pre> |
| L-24 months | Phase 1 submission | |
| L-21 months (or 3 months after submission phase 1) | Response to phase 1 submission with classification of hazardous systems | |
| As soon as available | Phase 2 submission (definition documents for systems classified as hazardous) | |
| 3 months later | Response to phase 2 submission | |
| L-8 months L-3 months | Phase 3 submission (hazardous procedures) CSG approval of hazardous procedures | |

Note: For an already developed spacecraft, phase 1 and phase 2 submissions are initiated as soon as the documentation is supplied by the User. The Safety Departments response is then provided within 3 to 4 months in order to be available for the spacecraft CDR. Such a short safety procedure allows the launch of a qualified spacecraft to be considered only 12 months after the Ariane launch system has been selected by the User.

Safety meetings between CSG safety departments and the User are recommended before CSG's response to submission phases.

6.4. Mission analysis

6.4.1. Introduction

A Mission Analysis is conducted to ensure that the mission objective can be achieved (reliable spacecraft injection into the required orbit and in the correct attitude).

The studies relate to flight plan and environment and are organized in two stages:

- A Preliminary Mission Analysis mainly concerned with the compatibility of the spacecraft design with the Ariane environment ([see para. 6.4.2](#)).
- A Final Mission Analysis mainly concerned with the actual flight plan and the final flight predictions covering, when applicable, the dual launch configuration ([see para 6.4.3](#)).

At the completion of each step, a Mission Analysis Review (RAM "Revue d'Analyse de Mission") is held based upon the issued Mission Analysis Documentation (DAM "'Dossier d'Analyse de Mission").

6.4.2. Preliminary Mission Analysis

Arianespace performs a Preliminary Mission Analysis which includes the following studies:

- preliminary trajectory and mission sequence,
 - preliminary flight mechanics study,
 - preliminary dynamic coupled loads analysis,
 - preliminary radio frequency compatibility study.
- a) In the case of a non-standard GTO mission the *preliminary trajectory study* enables the feasibility of the required orbit and the associated performance margin to be established. The resulting trajectory is then used as input data for various analysis such as orbit dispersion, loads, thermal, separation sequence and safety.

For a standard GTO mission, the standard trajectory document is issued to the User.

- b) The *preliminary flight mechanics study* allows Arianespace to:
- verify the feasibility of the required orientation,
 - define the necessary separation energy,
 - verify the clearance at separation,
 - determine the kinematic conditions after separation,
 - issue a preliminary sequence of events,

- verify the orbital long-term clearance; in the event that a problem area is identified, corrective action will be recommended to the User.

c) The *preliminary dynamic coupled load analysis* allows Arianespace to produce the first prediction of the in-flight loads applicable to the User's spacecraft Using a preliminary spacecraft dynamic model provided by the User and conforming to the Ariane specification SG-0-01, this study:

- performs the modal analysis for the composite launch vehicle and its payload,
- describes the dynamic responses of the spacecraft for the most severe longitudinal and lateral load cases induced by the launch vehicle,
- gives, at the nodes selected by the User, min-max tables and time histories for forces, accelerations and relative deflections, as well as Ariane/Spacecraft interface acceleration and force time histories,
- allows the User to verify the validity of spacecraft dimensioning and to adjust its qualification test plan if necessary, after discussion with the Ariane Authority.

d) The *preliminary radio frequency compatibility study* allows Arianespace to check the compatibility between frequencies (and their harmonics) used by the launch vehicle, the ground stations and the spacecraft during launch operations (including flight). This study is based upon a spacecraft frequency plan (including intermediate frequencies) that the User has to provide within the DUA. The housekeeping telemetry and telecommand of the spacecraft may be subject to change on request of ARIANESPACE up to 20 months before launch.

6.4.3. Final Mission Analysis

Arianespace performs the Final Mission Analysis covering the following studies:

- Final trajectory and mission sequence,
- Final flight mechanics analysis,
- Final dynamic loads analysis,
- Thermal environment,
- Final radio frequency compatibility,
- and, when applicable, dual launch compatibility.

a) The *final trajectory study* defines:

- The actual launch vehicle data to be used (mass breakdown, propulsion parameters adjustments), the actual launch vehicle payload data and the associated launch vehicle performance,
- The flight event sequence for the on-board computer,
- The guidance parameters for the on-board computer,
- The position, velocity and attitude of the vehicle during the boosted phase.

b) The *final flight mechanics study* repeats the studies performed during the preliminary analysis but takes into account the actual Ariane payload parameters and so enables Arianespace to:

- define the data to be used by the on-board computer for the orbital phase (manoeuvres, sequence),
- predict the clearance between the separated elements in orbital flight.

c) The *final coupled loads analysis* enables Arianespace to define the final prediction for in flight loads. Using a test-validated model provided by the User conforming to the Ariane specification SG-0-01, this study allows Arianespace:

- to verify, or adjust if necessary, the Spacecraft Acceptance Test Plan, and associated notching procedure when applicable,
- to verify that the Ariane payload does not affect the behaviour of the launch vehicle or its stability.

d) The *thermal environment study* is required to predict the temperatures during count down and flight. Using a thermal model provided by the User conforming to the Ariane specification SG-1-26, this study covers the period from spacecraft on Ariane in the launch tower up to the injection into the desired orbit.

The study allows Arianespace to adjust the ventilation parameters during count down (tower removed) in order to satisfy, in so far as the system allows it, the temperature limitations specified for the spacecraft.

e) The *final radio frequency compatibility study* considers the actual launch configuration.

The study involves the examination of possible spurious emission frequencies and the susceptible frequencies of the receivers; in case of conflict the study will extend to the analysis of possible solutions either on the launch vehicle or on the payload.

f) The *dual launch compatibility study* analyses the results of all mission analysis studies to ensure compatibility between spacecraft to be launched as a combined Ariane payload.

The aspects covered in the particular studies mentioned earlier are reviewed during the course of this study and are analysed with the focus on possible interference between spacecraft.

A simulation is performed of the motion of the elements after separation and up to apogee motor firing (for geostationary launches), including spacecraft manoeuvres in GTO, in order to check long term collision avoidance, thermal flux and contamination aspects (due to AKM firings).

6.4.4. Spacecraft environment test file

The User is required to provide the Ariane authority with the spacecraft environment test plan, describing the test called for [in paragraph 4.6.1](#). This plan is analysed at the time of the final Mission Analysis Review.

The User will then submit analysis and synthesis files resulting from the tests. These files are analysed at the Spacecraft Flight Readiness Review ("Revue d'Aptitude au Vol Satellite").

6.4.5. Payload mass characteristics

The mass of the payload in its final launch configuration must be notified to the Ariane authority prior to the Launch Readiness Review (RAL).

6.4.6. Post-launch documents

6.4.6.1. Inspection data

Arianespace will give first diagnosis and information sheets to the User before H0 + 60 min., concerning the orbit characteristics

at injection (3rd stage cut-off) and attitude of the spacecraft just before the spacecraft separation.

6.4.6.2. Orbital tracking operation report

Arianespace requires the User to provide orbital tracking data on the initial spacecraft orbits including attitude just after separation, for back-up evaluation of launch vehicle performance.

6.4.6.3. Launch evaluation report.

Arianespace draws up a report on the launch operations, based on processed launch vehicle telemetry and tracking data, showing the performance achieved and reporting on the behaviour of the launch vehicle and its subsystems.

A section of this report covering all launch vehicle/payload interface aspects is distributed to the User.

6.5. Launch preparation and range operations

The documentation necessary for launch operations is generated from the Launch Requirements Document (DL). As far as the spacecraft is concerned, the following data are used as input for writing the DL:

- the approved DCI, taken as a specification,
- the Spacecraft Operations Plan (POS) provided by the User,
- the Interleaved Operation Plan (POI),
- and the master-schedule of the Combined Operation Plan (POC) issued by Arianespace and taking account of both the POS and the Launch Vehicle Operation plan.

The POI and the POC master schedules are submitted to the User for approval. The Ariane Payload Sections of the DL are submitted to the User for comment.

In parallel with this activity, procedures are issued, and phase 3 safety formalities are completed in order to have all the necessary documentation prepared and approved in time for the Flight Readiness Review (RAV).

6.5.1. Spacecraft Operations Plan.

("Plan des Operations Satellite – POS")

The User has to prepare a Spacecraft Operations Plan for the CSG, defining the operations to be executed on the spacecraft from arrival in Guiana: including transport, integration and checkout before assembly, and operations on the Ariane launch site. The POS defines the arrangements for these operations, and describes the facilities required for their execution.

A typical format for this document is shown here below.

1. GENERAL

- 1 1. Introduction
- 1 2. Applicable documents

2. MANAGEMENT

- 2.1. Time-schedule
- 2.2. Table of weekly activities
- 2.3. Meetings - Organization - Interface.

3. PERSONNEL

- 3 1. Organizational chart for spacecraft operations team
- 3 2. Definition of responsibilities and tasks
- 3 3. Spacecraft organizational chart for countdown

4. OPERATIONS

- 4 1. Handling and transport requirements for spacecraft and ancillary equipment
- 4 2. Tasks for launch operations

5. EQUIPMENT ASSOCIATED WITH THE SPACECRAFT

- 5.1. Brief description of equipment for launch operations
- 5.2. Description of hazardous equipment (with diagrams)
- 5.3. Description of special equipment (Launch Centre, Launch Tower)

6. INSTALLATIONS

- 6.1. Surface areas
- 6.2. Buildings (technical and logistic aspects)
- 6.3. Communications
- 6.4. Location of offices, assignment of personnel

7. LOGISTICS

- 7.1. Accommodation
- 7.2. Transport facilities
- 7.3. Packing list

6.5.2. Interleaved Operation Plan

("Planning des Opérations Imbriquées POI")

Prepared by the DDO, the POI presents the spacecraft operations range support schedule from the time of arrival of the spacecraft equipment at Cayenne until the POC is started. The POI is submitted to the User(s) for approval.

6.5.3. Combined Operations Plan

("Plan des Opérations Combinées – POC")

The POC identifies all activities involving a spacecraft and a part of the launch vehicle (operations in S3B building when the spacecraft is encapsulated and in the Launch Tower).

Prepared by the COEL from the POS(s) and the Launch Vehicle Operation Plan, insofar as the launch vehicle payload is concerned, this document details the technical characteristics of the launch operations based upon the requirements imposed by both the payload and the launch vehicle.

The POC Master Schedule presents all spacecraft/Ariane activities from the time of spacecraft mating onto the Ariane adaptor until launch. All spacecraft operations during the countdown phase (RF tests, Arming sequences, on board power supply switching,...) are included.

The POC Schedule is submitted to the User(s) for approval at the beginning of the campaign.

6.5.4. Launch Requirements Document

("Demande de Lancement" - DL)

The Launch Requirements Document prepared by the Arianespace Mission Director (CM) together with the Range Operations Manager (DDO) is a synthesis of both launch vehicle and payload aspects in terms of launch campaign preparation.

It defines the mission objectives, launch characteristics, general organization, time schedule and assistance required in terms of personnel, facilities, supply of fluids and support equipment. It is addressed to CSG, and Arianespace/Kourou and to the customer for information.

The inputs for the DL regarding spacecraft related requirements are defined in the DCI, the POS, the POI and the POC master-schedules.

6.5.5. Spacecraft operation procedures for the CSG

These procedures are prepared by the User for each operation defined in the Spacecraft Operations Plan (POS). All procedures covering the operation of systems classified as hazardous or those concerning personnel safety have to be submitted to the CSG Safety Departments for approval ([see phase 3 submission](#)).

6.5.6. Combined launch vehicle/payload operation procedures

Two types of combined operation are identified: those requiring procedures specific to each Authority, and those requiring common procedures. Common procedures are prepared by the Ariane Authority, and submitted to the Payload Authority(ies) for approval.

6.6. Launch vehicle/payload reviews

Reviews are held, in accordance [with fig. 6.1](#), to conclude mission analyses phases, and to authorize blocks of work in the progress of the launch operations.

6.6.1. Mission Analysis Reviews

These reviews are conducted by Arianespace

- a) The Preliminary Mission Analysis Review ("Revue d'Analyse de Mission Préliminaire" - RAMP) is based upon the Preliminary Mission Analysis Documentation (DAMP) comprising all reports issued during the Preliminary Mission Analysis ([see para. 6.4.2](#)).

The Spacecraft Authority attends the RAMP. Conclusions from the RAMP lead to the updating of the DCI, and agreement on the spacecraft environmental test plan.

- b) The Final Mission Analysis Review ("Revue d'Analyse de Mission Finale" - RAMF)

In addition to aspects specific to the launch vehicle, the objectives of this review are to check the compatibility of spacecraft qualification status with the mission analysis results, to agree on applicable acceptance test procedures and to confirm the main mission parameters.

This review is held in relation to the Final Mission Analysis Documentation (DAMF) and when applicable, the *dual launch compatibility analysis*. In the latter case, the review is conducted in two stages, the second one involving both Spacecraft Authorities.

The conclusions of the RAMF lead to the updating of the DCI(s) and the release of data for the launch vehicle flight programme.

6.6.2. Launch-vehicle Flight Readiness Review

(Revue d'aptitude au vol du lanceur - RAV)

The purpose of this review is to verify that the launch vehicle, following acceptance tests in Europe, is technically capable of executing its mission. One activity covered by the RAV concerns the examination of launch-vehicle/payload interfaces, with particular reference to the DCI, and the status of the launch preparation documentation ([see para. 6.5](#)).

The review is conducted by the Ariane Authority, and shipment of the launch vehicle to the CSG is contingent on a satisfactory conclusion.

The User is invited to attend the RAV.

6.6.3. Spacecraft Flight Readiness Review

("Revue d'aptitude au vol du satellite")

Arianespace requires to be represented at this review, normally held by the User before shipment of the satellite to the CSG. In particular, the Ariane Authority uses this opportunity to obtain the results of environmental acceptance tests, and the actual inertial and mass characteristics of the spacecraft.

6.6.4. EPCU Configuration Acceptance Review

The purpose of this review, held just before the arrival of the spacecraft and associated equipment at the CSG, is to verify that the buildings are configured according to the requirements contained in the Launch Requirements Document.

The configuration status is documented through a compliance certificate issued by CSG and approved by its Quality Control Department.

6.6.5. Combined Operation Release

A technical assessment of the related launch vehicle and spacecraft hardware is held to clear implementation of the POC. This meeting involves the safety department, the User and the COEL for the launch vehicle, with the CM as chairman.

6.6.6. Range Readiness Review

This review is held before the Launch Readiness Review ([see para 6.6.7](#)). Its purpose is to check the validation of the range, down-range stations and associated networks. The review is chaired by the CSG in presence of the CM who approves the configuration on behalf of the General Director of Arianespace.

6.6.7. Launch Readiness Review

("Revue d'aptitude au lancement" – RAL)

This review, conducted by the Ariane Authority, is held at CSG in order to review the overall status of all checks carried out on launch vehicle, payload and launch facilities and to authorize the final operations leading up to launch. The RAL normally takes place just after the launch rehearsal.

A dedicated payload session is requested by the CM to prepare for the main meeting.