

7 *Mission Management*

7.1 *Mission Management Overview*

Mission Management is conceived by EUROCKOT to fulfil all Customer requirements to the greatest possible extent by provision of the following activities:

- Definition of all payload/launch vehicle interfaces
- Performing of mission analyses
- Supply of the launch vehicle with appropriate interfaces and fairings
- Supply of payload attachment and separation system
- Supply of appropriate payload preparation facilities at the range
- Conducting of pre-launch operations and launch
- Performing of trajectory tracking and payload telemetry data reception, as required

7.2 *Organisation and Responsibilities*

EUROCKOT is responsible to the Customer for all commercial and technical activities within all countries concerned (Customer, EUROCKOT, launch site) launch contract conclusion and implementation as the single prime contractor towards the Customer and as the Customer's sole industrial partner for all aspects of the law. EUROCKOT is a com-

pany governed by German law and offers all legal safeguards provided by a Western company.

As a constituent company of EUROCKOT, Khrunichev State Research and Production Space Center (KSRC) of Russia provides the launch vehicle and the launch services as well as the launch site adaptation. The engineering, quality assurance and commercial departments of Astrium Space Infrastructure, which is the second parent company and is located directly beside EUROCKOT, offer online support to EUROCKOT. The distribution of the relevant activities among EUROCKOT, KSRC and Astrium is depicted in Figure 7-1.

For Mission Management, EUROCKOT has adopted a scheme (Figure 7-2) which has proven extremely successful in the past.

Customers will conclude a launch services agreement (LSA) directly with EUROCKOT launch services. EUROCKOT will provide the single point of focus for the Customer through a designated Mission Manager (MM). The Mission Manager will be responsible for the programme management of all Launch Service tasks. The Mission Manager has full programme authority and is responsible for all coordination required to implement the launch contract. The Mission Manager is responsible for ensuring that all payload launch requirements are met and is in continuous contact with the Customer from contract signature up to launch.

At the range, he acts as the day-to-day intermediary between the Customer and the range authority for the purpose of satisfying the Customer's requirements. The Mission Manager reports to the EUROCKOT Mission Manager (EMM), who in turn reports directly to the EUROCKOT Chief Executive Officer (CEO). The MM will be supported by the Launch Vehicle Manager (LVM), who is responsible for LV interfaces, by the Launch Site / Ground Operations Manager (LS/GO), who will be responsible for preparation and coordination of the launch site operations, and by the Contracts and Finance Manager, who is responsible for all contractual, commercial and financial matters.

In addition, engineering support provided by the parent organisation Astrium will be used to support various activities, e.g. mission analysis, quality/mission assurance etc. Within EUROCKOT, the Mission Manager represents the interests of the Customer; towards the Customer he represents the interests of EUROCKOT. The Launch Vehicle Manager of EUROCKOT has the responsibility for the procurement of a technically sound launch vehicle, meeting the payload interfaces and requirements.

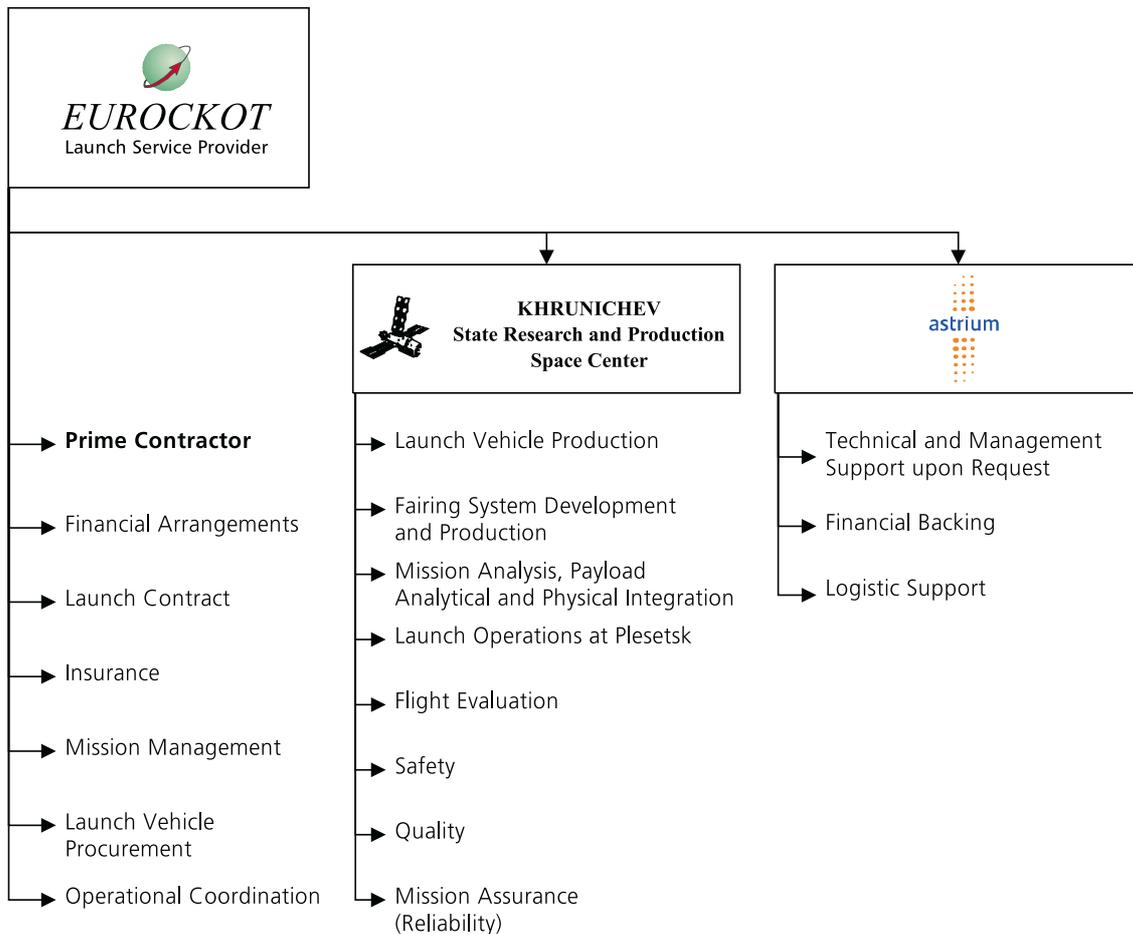


Figure 7-1: Industrial Organisation of EUROCKOT and its Subcontractors

The Launch Site / Ground Operations Manager has the responsibility for launch operations planning, procedures and launch execution. At the range, the launch decision is the responsibility of a Management Group consisting of representatives of EUROCKOT, KSRC, the Customer and the Range Authority.

7.2.1.1 *Mission Integration/ Mission Analysis*

EUROCKOT responsibility includes definition of the spacecraft / launch vehicle interfaces and performing of the mission analysis (see Chapter 8 of this document). The results of mission analysis are examined and agreed between EUROCKOT and the Customer at preliminary and final mission analysis reviews. All interface requirements common to the launch system and the payload and all specifications resulting from mission analysis are collated in a document entitled "Interface Control Document" (ICD), which will be approved by EUROCKOT, the Customer, Khrunichev and the spacecraft subcontractor.

7.2.1 *EUROCKOT Mission Responsibilities*

EUROCKOT will manage all mission-related activities from first preliminary estimations before launch contract signature through postlaunch evaluation and review with the emphasis on Customer satisfaction.

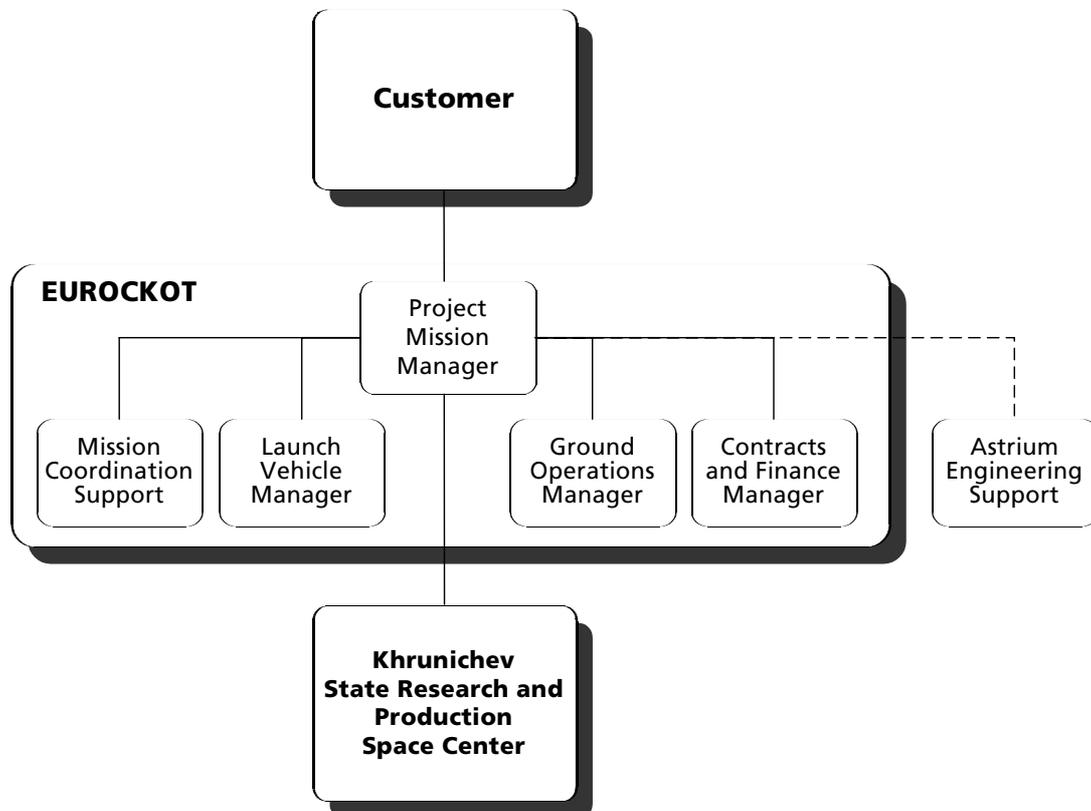


Figure 7-2: EUROCKOT Mission Management Organisation

The ICD is maintained under formal configuration control until launch. This document also includes relevant technical specifications relating to payload preparation facilities at the range, extracted from the Interface Requirements Document (IRD), to be provided by the Customer, see Section 7.2.2 and Chapter 12.

7.2.1.2 *Interface Verification*

The design of the interface between the LV upper stage and the spacecraft, i.e. the dispenser consisting of adapter, attachment and separation system, is one of the first activities to be started after technical kick-off. Compliance of the design with the Customer requirements stated in the IRD and with the environmental constraints is demonstrated in the PDR and CDR. A successful CDR signifies dispenser design approval and the manufacturing go-ahead. If, on the other hand, design changes are necessary because of the CDR, this go-ahead is given when these design changes are successfully completed.

However, owing to time constraints, the procurement of long lead items and initiation of piece part manufacturing can start earlier. Like the necessary effort for qualification, this depends mainly on the degree of individuality of the dispenser for each mission. Ideally, qualification and flight units are produced together. On the basis of the existence of a fully qualified launch vehicle including *Breeze-KM* upper stage and payload fairing, only the mission-specific interface has to be verified. Depending on

the degree of individuality of the dispenser as requested to fulfil specific spacecraft designs, a qualification test program will be set up consisting of some of the following test steps:

- Static Tests
- Dynamic Tests
- Spacecraft Separation Tests
- Fit Check (dispenser only, or volume fit check with fairing)

The necessity and extent of each test depend mainly on spacecraft mass and stiffness properties, geometrical interfaces environment sensitivities etc.

To verify correct attachment interface and integration feasibility, two means can be selected in addition to the Fit Check as mentioned above:

- A master gauge / drill template, produced by either the spacecraft contractor or EUROCKOT, ensures that the correct positions of the fixing points are achieved not only by compliance with the interface drawings but also by using the same, identical tool for applying them on the test and flight hardware.
- A so-called “matchmate test”, preferably using the flight spacecraft and the flight dispenser or an identical model thereof, is performed at the spacecraft manufacturer’s premises, demonstrating that the mating and separation of mechanical and electrical joints comply with the ICD requirements.

7.2.1.3 *Configuration Control*

Programme-specific configuration control and data management procedures begin immediately upon contract signature with EUROCKOT and cover all documents and data exchanged with the Customer. These documents are defined in Chapter 7.3. The overall programme configuration control of the launch vehicle and launch service is an extension of the KSRC Quality and Mission Assurance Plan for booster recertification, modification and launch. Data management is an integral part of this plan. A unique programme configuration control plan will be prepared and approved. This plan will show:

- Responsibilities for configuration management in each organisation
- Documentation subject to configuration management
- Change orders issued
- Orders processed
- The constitution of the joint change board

7.2.1.4 *Launch Vehicle Procurement*

EUROCKOT monitors the launch vehicle production progress according to the schedule, attends and approves launch vehicle acceptance and is responsible for

specification and provision of the launch vehicle/spacecraft interfaces and, if applicable, adaptation of the fairing.

7.2.1.5 *Spacecraft Preparation/ Launch Operations*

EUROCKOT defines the Launch Operations Schedule (LOS) for the range and the Combined Operations Plan (COP) for all operations involving the integrated launch vehicle and spacecraft, i.e. beginning with the upper composite integration. The Spacecraft Operation Plan (SOP) (see Section 7.2.2) provided by the Customer will be adhered to. Final launch operations lead to lift-off (see Chapter 11).

7.2.1.6 *Post-Launch Activities*

State vectors of the upper stage at burn-out and of each satellite separation event will be provided as preliminary data 30 minutes after separation, and as detailed state vectors after one week. Six weeks after launch, EUROCKOT provides a Launch Evaluation Report (LER), showing the performance achieved and the behaviour of the launch vehicle. This report is based on processed launch vehicle telemetry and tracking data, as well as on spacecraft orbit data provided by the Customer.

7.2.1.7 *Quality Assurance/ Mission Assurance*

Quality and Mission Assurance is guaranteed by EUROCKOT assisted by experts from Astrium's Quality Department. At KSRC the Deputy Director for Quality Assurance, reporting directly to the General Director, ensures and supervises compliance with all relevant requirements. Quality audits and procedures maintain rigorous adherence to all elements in the factory and launch site operations. Incoming materials and subcontractors are certified and continuously reviewed and inspected. A system of procedures which has proven its efficiency in the past assures detailed analysis of discrepancies as well as related dispositions and verification of their execution.

7.2.1.8 *Safety Provisions*

EUROCKOT will provide the single focal point for all system and range safety matters. The Customer will provide the necessary data as described in Chapters 9 and 12 to enable EUROCKOT to obtain spacecraft safety approval for the launch campaign.

7.2.1.9 *Risk Management*

Risk management by EUROCKOT covers the following risk in particular:

Political Risk: The EUROCKOT programme is part of the German-Russian space cooperation agreement, backed by high level guarantees from the

German and Russian Governments, explicitly including the Russian Space Agency and the Space Forces.

Commercial Risk: Astrium and the German Federal Government are financial backers for all required funding.

Technical Risk: The first two stages (SS-19) undergo extensive tests (DPA / test firing) on a yearly basis. The commercial *Rocket* configuration, including *Breeze-KM* and the large payload fairing, was successfully flight-qualified for the first time in May 2000. Co-production of *Breeze-KM* and *Breeze-M* (Proton) ensures programme continuity.

Launch Risk: Launchers which are held in stock for rapid replenishment ensure short reaction launches in the case of satellite problems and immediate relaunch in the case of launch failure after completion of a failure investigation. In the unlikely event of a launch failure, a contingency plan previously reviewed and tailored to the specific mission would control the total process providing a failure action list from data review, through anomaly identification and the setting up of analysis and review boards, up to final explanation and corrective action dispositions.

Almost 1500 launches from Plesetsk combined with the PROTON experience of KSRC and the ARIANE experience of Astrium further reduce technical risks for the Customer.

7.2.1.10 *Technology Transfer/ Security*

EUROCKOT is committed to meeting government and Customer-imposed requirements concerning technology transfer issues and the physical security of the spacecraft, its support equipment and associated documentation during the mission integration process and the launch campaign. For this purpose, the mission integration process and launch site activities conducted by EUROCKOT, for instance all technical interchange meetings (TIM), data transfer from the spacecraft contractor, e.g. drawings and mathematical models, and activities at the launch site will be governed by the EUROCKOT security plan EPL-0001.

For the majority of spacecraft contractors the plan will be based to a large extent on US requirements issued by the Office of the Secretary of Defense Threat Reduction Agency (DTRA).

For spacecraft coming under DTRA jurisdiction, special measures will be taken to meet these requirements. In the case of technology transfer issues, it is recommended that a Technical Assistance Agreement (TAA) with DTRA be concluded very early on in the programme to allow for technical interchanges between the spacecraft contractor and the launch service companies, e.g. EUROCKOT, KSRC and their subcontractors. Physical security of the spacecraft, of its associated support hardware and of documentation at the launch site is assured by physical barriers such as con-

trolled entry doors, round-the-clock guarding of the hardware by security guards and agreed procedures.

7.2.2 *Customer Mission Responsibilities*

The Customer is required to designate a Payload Mission Manager who will be the single point of contact for the Mission Manager at EUROCKOT. Early in the contract implementation process, the Customer is required to provide an Interface Requirements Document (IRD- for a detailed description refer to Section 12.1) covering the following aspects:

- Required mission characteristics
- Spacecraft characteristics (dimensional, electrical, thermal, environmental, etc.)
- Spacecraft launch preparations requirements

Early in the mission analysis process, the Customer submits a payload development and test plan to meet the *Rockot* environmental conditions. Additionally, the Customer has to provide several spacecraft software models, especially for integrated structural and thermal analyses (see Chapter 8 and Section 12.2). During the Mission Analysis process, the Customer is requested to submit environment test results (see Section 12.3). The Customer attends the Preliminary and Final Mission Analysis Reviews.

As an input to the planning of the Combined Operations Plan (COP) and the Launch Operations Schedule (LOS), the Customer will issue the Spacecraft Operations Plan (SOP). For the operational activities at the range, the Customer will provide procedures for the various operations on the spacecraft for safety examination by the range authority (see Section 12.4).

A safety review based on three safety submissions (Phases I, II and III) by the Customer or Spacecraft Contractor must also be completed during the launch preparation phase. A Phase I Safety Submission is expected at the start of the contract phase. For details, see Chapter 9 and Section 12.2.

Hardware models which have to be provided, especially the mass/frequency model and, if necessary, the volume fit check dummy, are described in Section 12.4. In general, all items to be provided by the Customer, documents, software and hardware models are summarised in Chapter 12 of this document.

7.3 *Reviews and Documentation*

Within each phase of the launch service implementation there are various activities and milestones planned to enable successful fulfilment of the contract. These activities include regular meetings with the Customer and Spacecraft Contractor and also the generation of documents and analyses for review and approval. The activities are coordinated by the EUROCKOT Mission Manager at the start of the contract.

In addition to the main programme reviews (System Requirements Review SRR), Preliminary Design Review PDR and Critical Design Review CDR in particular the Preliminary and Final Mission Analysis Review PMAR/FMAR), Safety Reviews and Launch Readiness Review will be held at Customer, EUROCKOT or KSRC premises depending on the specific purpose. A summary of reviews and their typical allocation within the mission schedule is given in Table 7.3-1.

The aim is, where possible, to combine some of these reviews in order to optimise the time and cost involved for all parties. An overall summary of documents to be supplied by EUROCKOT and the Customer, as well as their typical release dates is given in Section 7.4.

Meetings / Reviews Schedule	Date
Contract signature meeting	L - 18 months
Technical Kick-off meeting/IRD Review	L - 18 months
Launch Vehicle / Spacecraft SRR + ICD (draft) Review	L - 16.5 months
ICD Review (initial issue)	L - 14.5 months
Preliminary Mission Analysis Review (PMAR) Launch Vehicle / Spacecraft PDR	L - 14.5 months L - 14.5 months
SOP Review (optional)	L - 9 months
Launch Vehicle / Spacecraft CDR (LV, flight adapter,...) LOS+COP Review (draft issue) Final Mission Analysis Review (FMAR)	L - 8.5 months L - 8.5 months L - 8.5 months
Campaign Preparation Status meeting ICD Review (final issue)	L - 4 months L - 4 months
Spacecraft Shipment Readiness Review	To be agreed
Launch Site / Launch Vehicle Readiness review LOS+COP (final issue) Review	To be agreed
Go / No Go Criteria meeting Pre-Combined Operations meeting	L - 2 weeks L - 6 days
Launch Readiness Review (LRR) Launch Decision meeting (State Commission)	L - 0 day
Launch quick-look assessment meeting Range wash-up meeting	L + 1 day L + 2 days

Table 7.3-1: Typical Launch Services Reviews and Meetings

7.3.1 *EUROCKOT Documents*

The main documents to be established by EUROCKOT are summarised below:

Interface Control Document	L - 4 months
----------------------------	--------------

The ICD is the document that guarantees, to the spacecraft Customer and to EUROCKOT, the technical definition and control of all interfaces between the launch system and the

payload composite. In addition, the ICD is intended to establish the operational requirements for a launch campaign. The document will be updated regularly with inputs from the Customer and updated by the EUROCKOT-assigned Mission Manager in agreement with all parties. The ICD is a living document, being constantly updated to reflect the latest status of the launch services. A typical ICD structure is depicted in Table 7.3.1-1.

1. Introduction
2. Applicable and reference documents
3. Document amendment procedure
4. Mission characteristics
5. Fairing interfaces
6. Adapter / spacecraft interfaces
7. Vehicle equipment bay to payload interfaces
8. Launch site to spacecraft interfaces
9. Payload preparation complex to spacecraft interfaces
10. General services provided by EUROCKOT on the range
11. Documentation items and reviews
12. Launch vehicle/spacecraft compatibility tests

Table 7.3.1-1: Typical ICD Structure

Preliminary Mission Analysis Document	L - 15 months
---------------------------------------	---------------

The results of the Preliminary Mission Analysis are documented in the PMAD:

- Trajectory and Mission Sequence
- Flight Mechanics Study
- Dynamic Coupled Loads Analysis
- Radio Frequency Compatibility
- Thermal Environment

Final Mission Analysis Document	L - 5 months
---------------------------------	--------------

The results of the Final Mission Analysis are documented in the FMAD:

- Trajectory and Mission Sequence
- Flight Mechanics Study
- Dynamic Coupled Loads Analysis
- Radio Frequency Compatibility
- Thermal Environment

Launch Operations Schedule	L - 4 months
Combined Operations Plan	

The LOS schedules activities beginning with spacecraft arrival up to spacecraft-specific operations in the payload preparation complex, excluding combined operations.

The COP covers all operations involving the integrated launch vehicle and spacecraft from the beginning of encapsulation to lift-off.

Note: Specific spacecraft operations are the responsibility of the Customer (SOP).

Safety Reply, Phases I; II; III	L - 17; 11; 4 months
---------------------------------	----------------------

Contents:

- Assessment of Customer Safety Submissions
- Classification of hazardous systems
- Safety constraints tailored to dedicated spacecraft
- Specific verification guidelines
- Launch licence (Phase III)

Please refer to Chapter 9.

Launch Evaluation Report	L + 2 months
--------------------------	--------------

Contents:

- Launch vehicle performance based on telemetry and tracking data
- Launch vehicle behaviour
- Launch vehicle/spacecraft interface aspects (this part submitted to Customer)

7.3.2 Customer Documents

The documents to be provided by the Customer are described in detail in Chapter 12 of this User's Guide; they are summarised in Table 7.3.2-1:

Documents to be Provided	Date (typically)
Interface Requirements Document (IRD)	L - 18 months
Safety Submission (Phase I)	L - 18 months
Spacecraft Dynamic Model (Preliminary)	L - 18 months
Spacecraft Mechanical Environment Test	L - 17 months
Programme/Plan	
Spacecraft Thermal Model	L - 16 months
Spacecraft Dynamic Model (Final)	L - 13 months
Safety Submission (Phase II)	L - 12 months
Updated Mission and Spacecraft Data (for Final Mission Analysis)	L - 8 months
Spacecraft Operations Plan	L - 8 months
Spacecraft Mechanical Environment Qualification Test Results	L - 8 months
Spacecraft Acceptance Test Procedures	L - 8 months
Spacecraft Operation Procedures at Range	L - 6 months
Safety Submission (Phase III)	L - 5 months
Spacecraft Mechanical Environment Acceptance Test Results	L - 4 months
Final Spacecraft Mass Properties	L - 7 days
Orbital Tracking Operation Report	L + 2 weeks

Table 7.3.2-1: Documents to be Supplied by the Customer

7.4 Overall Mission Schedule

Overall mission planning is designed to provide the Customer with a reasonably short lead-time of 18 months from contract signature to launch, while still allowing for thorough technical preparation, in particular through mission analysis. If a repeat launch for a similar spacecraft and comparable orbit characteristics is requested by the Customer, lead-times of 15 months should be achievable and would be the subject of specific agreements.

The mission schedule of a typical mission with an 18-month lead-time is depicted in Figure 7-3. Nevertheless, the mission-specific schedule will be established during the mission kick-off meeting. It will address in particular the spacecraft development and qualification schedule as well as other Customer wishes. The launch campaign schedule itself is described in Chapter 10.

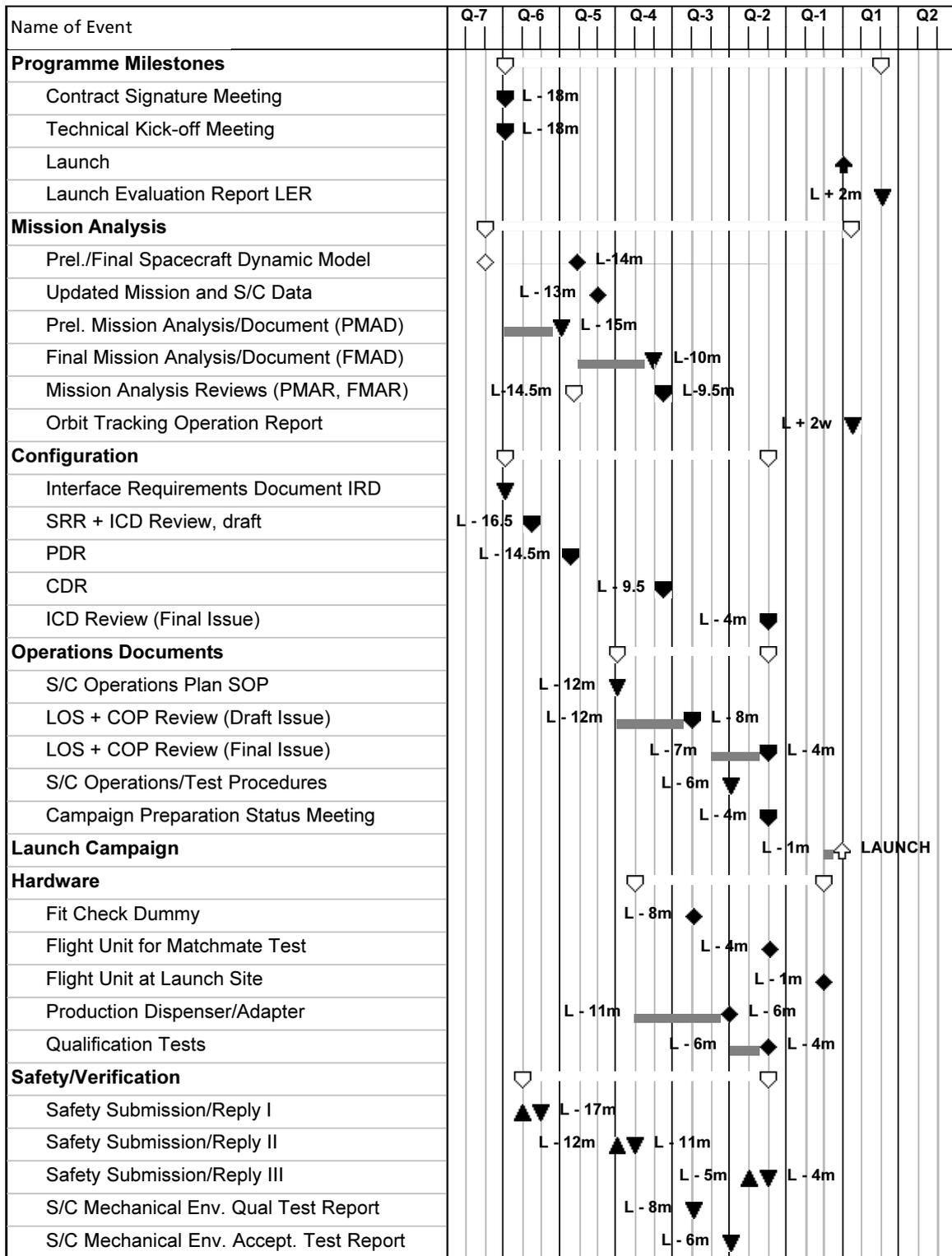


Figure 7-3: Typical Mission Schedule