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## Chapter 9 Safety

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## 9 Safety

### 9.1 Introduction

EUROCKOT is responsible for ensuring the compliance of the spacecraft, ground support equipment and launch site operations with the requirements of the standards of the Russian Federation and of countries where the spacecraft and support equipment are developed. For more detailed information refer to the EUROCKOT Safety Handbook EHB-0004. The purpose of these regulations is to ensure the safety of the environment, population, service personnel, ground equipment and facilities and the *Rockot/Breeze-KM* launch vehicle.

It is the responsibility of the Customer and the spacecraft designer to ensure compliance with the safety requirements in the design of the spacecraft, ground support equipment and applicable processes. KSRC will review each submission and issue an assessment report that will be subject to approval by EUROCKOT. A spacecraft safety certificate and a safety data package approved by EUROCKOT are pre-requisites for obtaining a launch licence from KSRC.

### 9.2 Submission Procedure

To ensure early identification of the constraints of the safety requirements upon the spacecraft, support equipment design and operations, the safety submissions are split into three phases with the initial phase I undertaken as soon as possible after contract signature. This allows the spacecraft contractor and Customer sufficient

time to take into account design constraints and measures necessary to meet the regulations and reduce the impact of costly design changes late in the project. Figure 9-1 provides a schematic view of the submissions process.

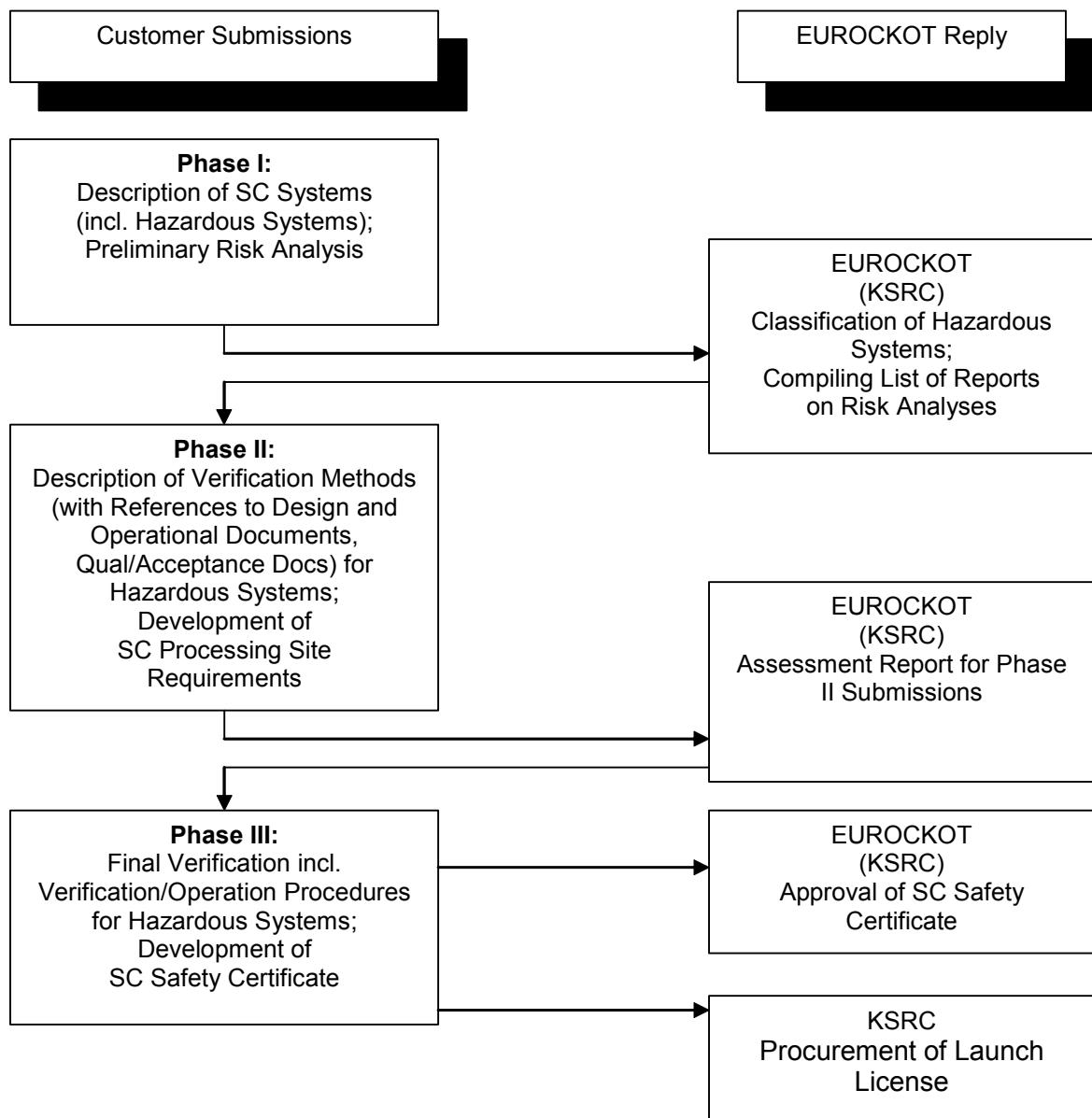
It should be noted that the phased safety submission procedure described in the following sections is a generic description for a spacecraft under development. For existing spacecraft designs, the safety submission process can be streamlined.

#### 9.2.1 Phase I Safety Submission

The spacecraft designer or Customer prepares a file containing all planning documents for hazardous systems. The file shall contain a description of the hazardous systems and a reply to a hazardous items check list supplied by EUROCKOT. A detailed check list of potential hazardous items can be found in the EUROCKOT Safety Handbook EHB-0004.

The document shall cover all safety-related activities such as component choice, safety and warning devices, risk analysis for catastrophic events and in general all data enabling the risk level to be evaluated.

EUROCKOT will study this submission, classify the hazardous systems described and declare any special requirements imposed by the Flight/Ground Safety departments. EUROCKOT will compile a list of potential sources of hazards in accordance with the list provided in EHB-0004. Based on this list, EUROCKOT will compile a list of reports on SC/GSE hazard analyses.



**Figure 9-1 Safety submissions and assessment.**

### 9.2.2 Phase II Safety Submission

The spacecraft designer or Customer shall submit the hazardous systems manufacturing, qualification and acceptance documentation as soon as it becomes available. It must satisfy the requirements laid down by EUROCKOT at the end of phase I. This documentation states the requirements for spacecraft integration facility equipment and operations to be used during the launch campaign and all other documents required by EUROCKOT during phase I and phase II submissions. It also defines the policy for checking and operating all systems classified as hazardous.

EUROCKOT checks that the documentation supplied in phase II complies with the requirements specified in phase I, states its intentions concerning verification of systems classified as hazardous and defines the draft procedure to be applied during spacecraft activities.

Phase II hazard analysis reports established by the Customer shall describe with sufficient degree of detail:

- Hazard prevention measures
- Methods of verification of hazard prevention measures with references to drawings, manuals, etc.
- National or agency safety standards with which the spacecraft complies

### 9.2.3 Phase III Safety Submission

The final safety submission must result in a statement accompanied by a data package encompassing the complete results arising from phases I and II including

EUROCKOT's replies to the submissions. In addition, the spacecraft designer or Customer shall submit the final verification plan and operations procedures for systems described as hazardous.

## 9.3 Safety Submission Contents and Requirements

A detailed description of the format, contents and requirements for the safety submissions is given in the EUROCKOT Safety Handbook EHB-0004. As a minimum, the format and data described below must be presented at the safety review of phase III, but no later than six months prior to launch. The final statement shall take into account the responses from EUROCKOT to the safety submissions made in phases I and II.

### 9.3.1 Release of Safety Statements

The safety statement (safety certificate) is the official document from the spacecraft designer or Customer and is signed by responsible officers of the spacecraft designer or Customer, e. g. by the Project Manager/Chief Designer of Spacecraft, Department Manager.

### 9.3.2 Final Date for Submission

The final safety statement shall be submitted to EUROCKOT not later than five months before the spacecraft launch.

### 9.3.3 Applicability

A safety statement shall be presented for the following phases of operation:

- Operations with spacecraft and ground support equipment at the technical complex and launch complex
- Flight of the spacecraft as a part of the launch vehicle from moment of launch up to the spacecraft separation from the third stage.

#### **9.3.4 Identification of Statements**

Each safety statement is prepared in separate lists and must include the following information:

- Safety statement name and its designation number
- Name of the company which presented this statement
- Name and post of the person who is responsible for it
- Date of submission

The format of this safety statement is contained within annex 2 of the EUROCKOT Safety Handbook EHB0004.

#### **9.3.5 Spacecraft Safety Data Package Contents**

The data package which confirms the operational safety of the spacecraft and its support equipment shall be attached to the safety statement. The package of data on safety concerning the spacecraft operation shall include data as described in Sections 9.3.6 and 9.3.7.

#### **9.3.6 Hazardous Systems**

Please refer to the EUROCKOT Safety Handbook EHB-0004 for a more detailed list and description of hazardous systems.

#### **9.3.7 Guidelines for Safety Analyses**

Analyses must be undertaken concerning the safety of the spacecraft and the support equipment during the following phases of operation:

- Operations with the spacecraft and support equipment at the technical complex and launch complex
- During the flight of the spacecraft as a part of the launch vehicle, beginning with the moment of launch up to spacecraft separation from the upper stage.

##### **9.3.7.1 Overall Assessment of Risk and Severity**

The results of the safety analyses of the spacecraft and the support equipment and operations at the technical and launch complex are used to assess the overall safety of pre-launch operations.

The results of the safety analyses on the spacecraft during flight up to separation from the launch vehicle third stage are used to assess the overall safety of the flight phase of *Rockot/Breeze-KM*.

The safety of such phases is determined by the severity of the hazard impact classified with a severity of either catastrophic or critical.

- Catastrophic severity is defined as the total loss of the launch vehicle and/or spacecraft, ground facilities and/or support equipment, and/or severe injury or loss of life to service personnel and/or severe damage to the environment and population.

- Critical severity is defined as a partial launch failure, aborted launch because of the launch vehicle and/or, the spacecraft and/or support equipment failure and non-fatal injury to service personnel.
- Inhibits. Safety inhibits of spacecraft and support equipment, concerning inadvertent operation of systems:
  - Inadvertent operation leading to a catastrophic failure must be inhibited by at least three independent mechanical or electrical inhibits.
  - Inadvertent operation leading to a critical failure must be inhibited by at least two independent mechanical or electrical inhibits.

In flight:

- Catastrophic severity is defined as the loss of the launch vehicle and/or the spacecraft.
- Critical severity is defined as an incomplete achievement of the mission goal, i. e. reduced mission effectiveness.

#### 9.3.7.2 Probability of Hazards

The potential threat of a hazard must be evaluated qualitatively by classification of the probabilities of such events occurring into categories ranging from "High" to "Remote".

#### 9.3.7.3 Prevention of Hazards

In the safety analyses of the spacecraft and support equipment, measures concerning prevention of hazards via the spacecraft design, technology and operational barriers must be shown.

The requirements for spacecraft safety must include the following:

- Design characteristics. Safety of spacecraft and support equipment via design measures and material characteristics such as:
  - Strength coefficients
  - Sealings/couplings structure and quality of umbilical connectors
  - Design and layout of the cable network insulation

#### 9.3.7.4 Reference Documents

In the results of the analysis of the spacecraft or support equipment, there should be references to design and operational documentation, to procedures on equipment and system level, to existing statistics for previous spacecraft/equipment, or to verification by similarity. In analyses of emergency cases in which the spacecraft or equipment endangers the launch or technical complex or the launch vehicle during flight, any documents used as references in the assessment must be mentioned. In the event of any of the above mentioned documents having classified status and being unable to be released, a non-classified version of the document should be provided.

### 9.4 Non-compliance with Safety Requirements / Waivers

EUROCKOT and KSRC shall identify the non-compliances, if any, of the spacecraft and its GSE with the safety provisions of EHB-0004 as early as possible. The Customer shall document any non-compliance in form of a report on spacecraft non-compliance with the safety provisions of EHB-0004 and submit this report to EUROCKOT and to KSRC safety experts

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for review and provision of their recommendations. These recommendations shall be taken into account and implemented prior to spacecraft safety certification. The non-compliance reports shall demonstrate that a particular provision or provisions in EHB-0004 cannot be complied with and yet the respective operational and/or managerial measures introduced in connection with the non-compliance or non-compliances under review will minimize the risk of the associated hazards. Each report shall be signed by the spacecraft designer's executives whose positions are higher than those of the signatories to the hazard reports.

The spacecraft safety statement shall be signed at a higher managerial level if the spacecraft fails to comply with one or more provisions in EHB-0004.

## 9.5 Summary

It must be shown as a result of the safety submissions described above that the spacecraft and its support equipment have been subjected to analyses and tests which confirm their compatibility with the *Rockot/Breeze-KM* launch system for all phases from launch preparation, through the launch and ascent phase and up to spacecraft separation. The final safety submission (phase III) shall be presented to EUROCKOT not later than five months prior to launch for approval.

It should be noted that EUROCKOT will work actively with and assist the spacecraft contractor or Customer to help them meet the safety regulations. For this purpose, EUROCKOT will interact with the Customer very early on in the mission integration process (phase I submission) to ensure that no surprises occur at a late date.