



# The Soyuz Launch Escape System: An Overview

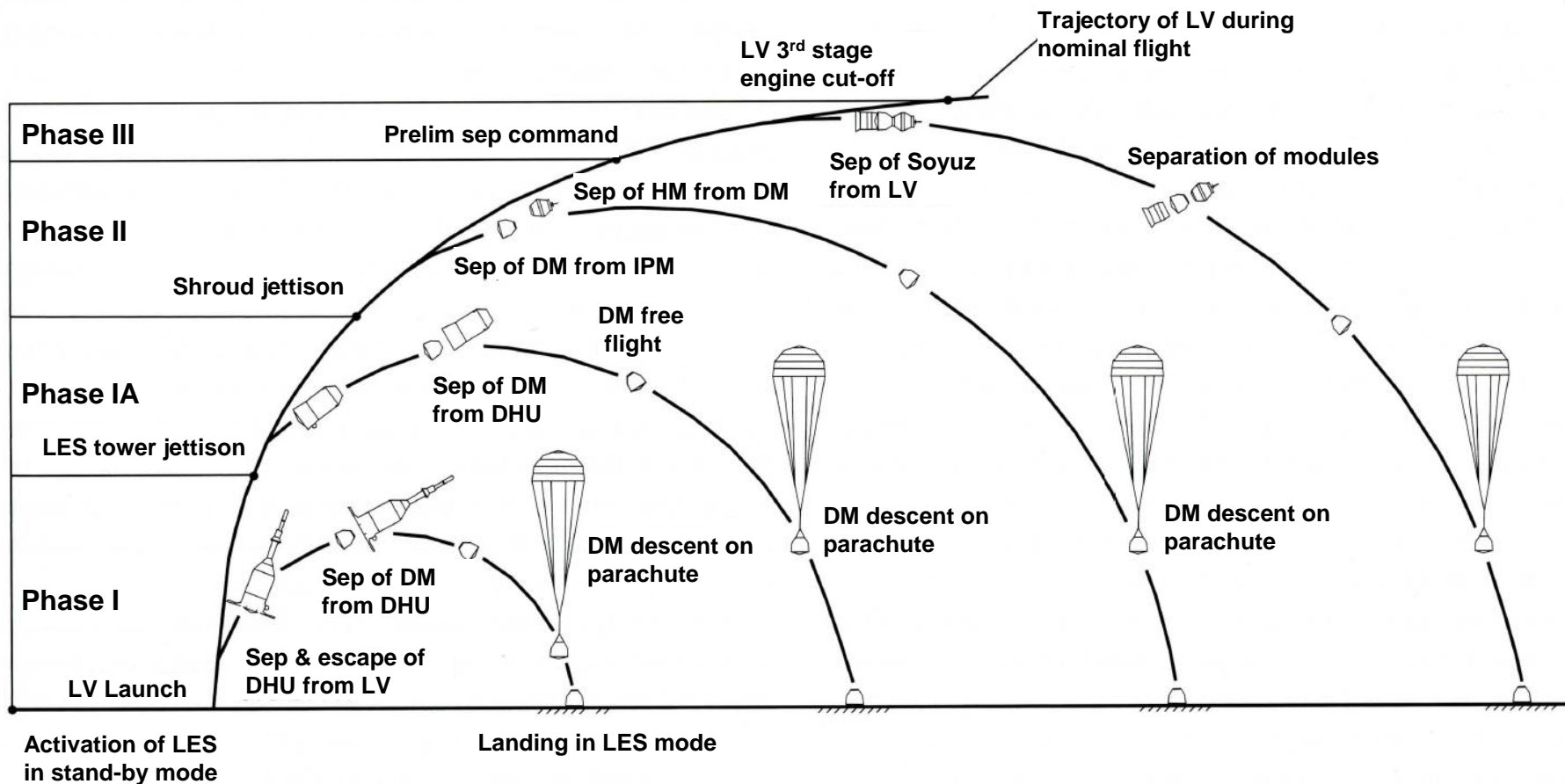
Photo: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

# Soyuz Launch Escape System

- ❑ Piloted versions of the Soyuz-FG launch vehicle (LV) include a «Система Аварийного Спасения» or [CAC], literally “System for Emergency Rescue,” but more commonly translated into English as “Launch Escape System” (LES)
- ❑ The LES is designed to safely separate the part of the spacecraft with crewmembers (the descent module) from a launch vehicle in the event of an emergency during any phase of ascent, starting at LES activation (about 40 minutes prior to launch) until safe insertion of the spacecraft into orbit (8 minutes and 48 seconds after lift-off).
  - The LES makes use of pyrotechnic devices, springs, and/or solid rocket motors to separate the spacecraft elements - descent module (DM), habitation module (HM), and Instrumentation/Propulsion Module (IPM) - from each other and/or from the faulty LV
  - After separation, the existing Soyuz entry and landing systems (parachutes and soft landing thrusters) are used to safely land the DM
  - There are no phases of the launch where a safe abort is unavailable
  - The LES is fully automatic after activation and requires no crew involvement. Prior to launch and during powered flight, it can be automatically triggered by an LV fault, or manually activated from the launch control center

# Soyuz Launch Escape System (cont.)

- ❑ The launch profile is divided into four phases as a function of altitude and speed of the LV; LES response varies according to the phase of flight (see next slide)
  - Phase I is from prior to launch until 114 seconds; during this phase powerful solid rocket motors in the LES Tower are required to pull the spacecraft away from the LV and to a safe altitude, four stabilizer panels deploy to provide aerodynamic stability; then 4 auxiliary thrusters pull the shroud and HM away and to the side, allowing the DM to descend and parachutes to deploy
  - Phase IA is from the jettison of the LES tower until jettison of the shroud. During this phase, the 4 auxiliary thrusters are sufficient to separate the spacecraft from the LV and pull the shroud and HM away, allowing the DM to descend
  - Phase II is after shroud jettison; at this point the spacecraft is high enough and moving fast enough that separation springs are sufficient to take the DM and HM away from the LV
  - Phase III is a very brief period just prior to 3rd stage engine cut-off, where the entire spacecraft (DM, HM and IPM) can separate from the LV in a nominal manner, and separation of modules occurs as it would at nominal end of mission



## Operation of the Launch Escape System during launch vehicle ascent

### Abbreviations:

LV = Launch Vehicle

LES = Launch Escape System

DHU = Detachable Head Unit (Soyuz DM & HM encapsulated in shroud)

DM = Descent Module

HM = Habitation Module

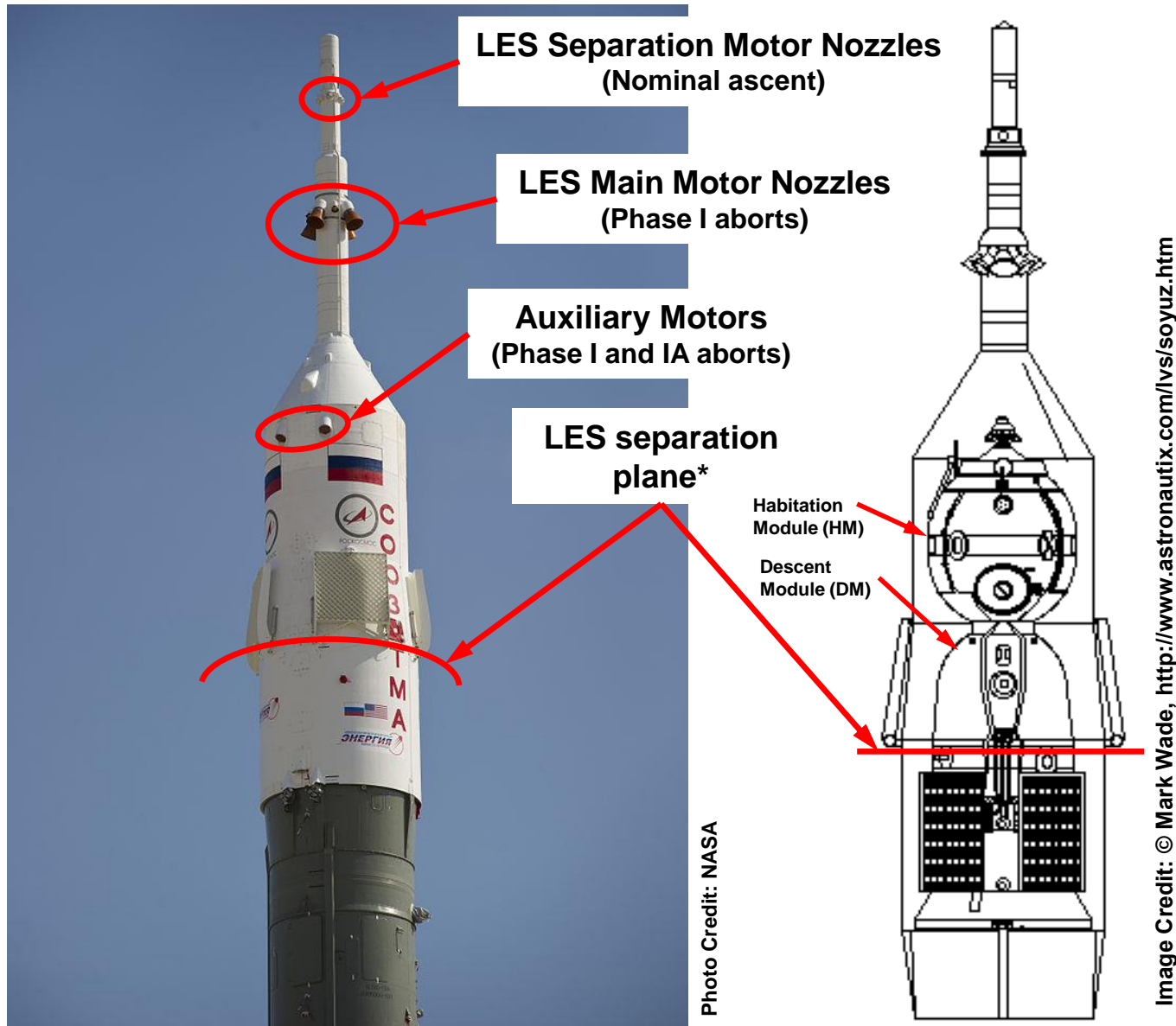
IPM = Instrumentation/Propulsion Module

### Source:

Sevastianov, N. N., & et al (Eds.). (2007). *Space "Energy" of Korolev: on the 50th anniversary of the beginning of the space era.* (pp. 117-118) Moscow: "ШАНС+". (Original is in the Russian language)

# Soyuz Launch Escape System History

- ❑ Versions of the LES operated during un-manned test flights (failures) of the Soviet N-1 moon rocket and Proton rocket with the L-1 lunar probe
- ❑ On April 5, 1975, failure of the 2<sup>nd</sup> stage to separate after 3<sup>rd</sup> stage ignition triggered a Phase II abort at liftoff +295 sec.
  - Crewmembers experience sustained high g-loads during re-entry, but landed safely in the Altai
  - Referred to as “The April 5 Anomaly,” “Soyuz 18-1” or “Soyuz 18a”
- ❑ On September 26, 1983, Fuel spilled at the base of the launch pad and ignited about 2 minutes before launch. The Launch Director issued the emergency signal, which triggered activation of the LES in a pad abort 2 sec before launch
  - Crewmembers briefly experienced high g-loads during LES operation, and landed safely about 1 km from the launch pad
  - Both subsequently flew again, both in Soyuz and on the Space Shuttle
  - Referred to as “Soyuz T-10-1” or “Soyuz T-10a”
  - For video of this incident (Russian language only), see:  
<http://www.youtube.com/watch?v=UyFF4cpMVag>
- ❑ Another excellent video (Russian language only) describing how the LES works, and especially the process for manual activation, see:  
<http://www.youtube.com/watch?v=-CwqsB0CV-0#>
- ❑ A third, final video (again, Russian only) showing both the T-10-1 event (beginning at 2:45) and development tests for launch escape systems, which will give you a great idea how the system would work during a Phase I abort (beginning at 3:45) in the following video:  
<http://www.youtube.com/watch?v=jcANi-4j0Ik#>



\*for Phase I and IA aborts



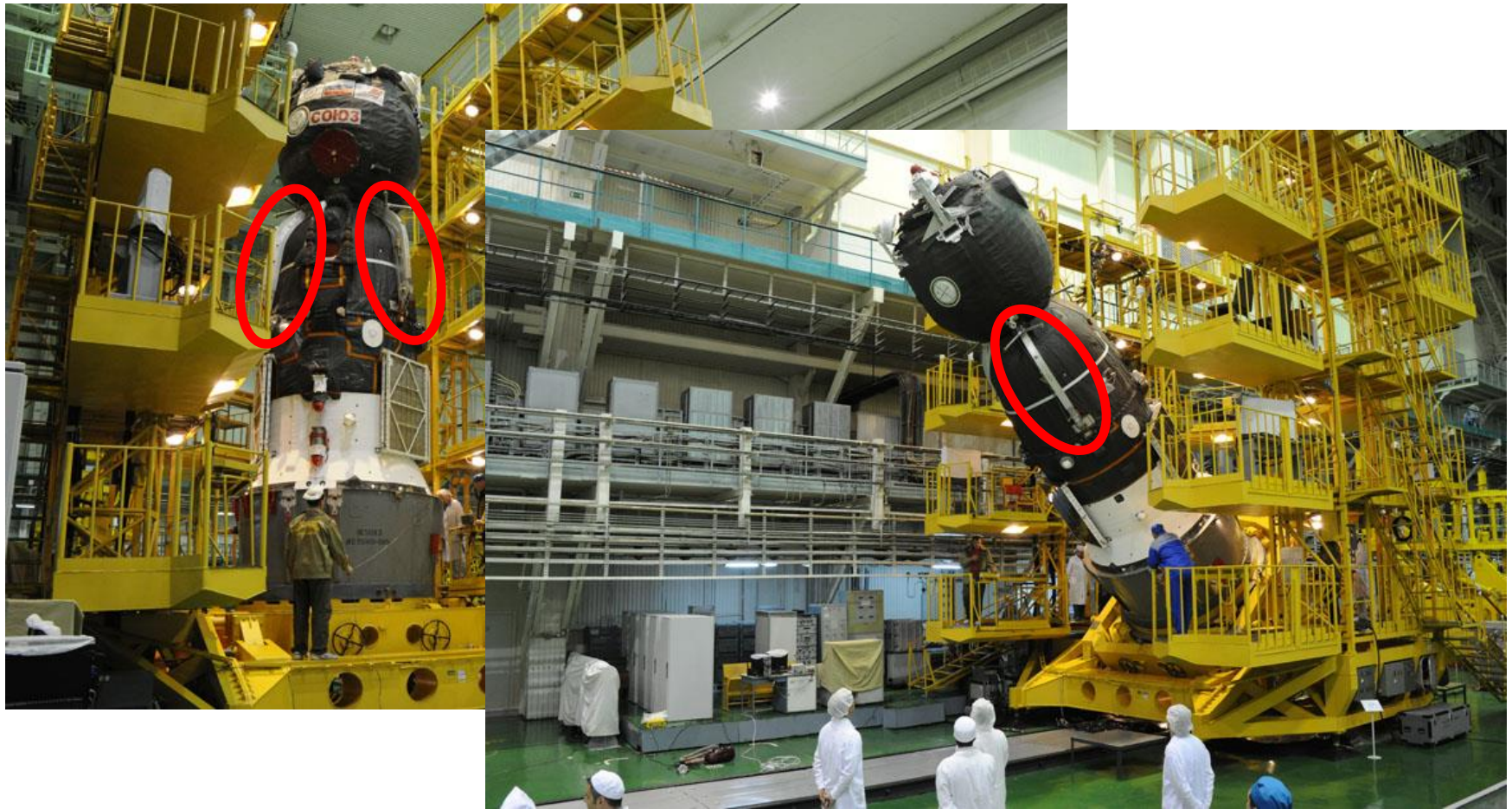


Photo: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

**Soyuz spacecraft being rotated for installation of nose fairing (shroud) –  
note load-bearing cradles (highlighted) that will be the structural  
interface of the spacecraft with the shroud**





Photo: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

## Final close-outs; load-bearing cradle highlighted





Photo: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

**Installation of nose fairing (shroud) – close-up of the load-bearing cradle.  
Cradles are jettisoned with the shroud during a nominal ascent.**



Photo: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

**“Encapsulated” Spacecraft transported for integration with LV  
LES Stabilizer Panels highlighted**





Photo: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

**“Encapsulated” Spacecraft ready for 3<sup>rd</sup> stage integration; LES Stabilizer panels clearly visible; and 1 of 4 Shroud LES nozzles highlighted**



Photo: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

**Integration of Spacecraft with 3<sup>rd</sup> Stage**  
**2 of 4 Shroud LES rocket nozzles are visible**





Photos: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

## Installation of LES Tower



Photos: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

## Completed 3<sup>rd</sup> stage with spacecraft and LES





Photos: RSC-Energia , <http://www.energia.ru/ru/archive/photo.html>

## Completed LV ready for roll-out

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A photograph showing a Soyuz rocket being mated to the International Space Station (ISS) by the Russian Service Module (RSM) crane. The rocket is positioned vertically, and the RSM crane is extended from the station's structure. The scene is set against a clear blue sky. The text "End of Presenation" is overlaid on the image.

**End of Presenation**