French Process for debris Mitigation Compliance Verification

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“The French Space Operation Act (LOS: Loi relative aux Operations Spatiales) defines the frame used by the French government to authorize and supervise the space operations under his responsibility”

Why a law : to be compliant with UN treaties

The French Space Operation Act has been published in order France to be compliant with its international commitment through the 5 UNO international treaties, in particular :

- the Outer Space Treaty (1967),
  - art VI : obligation to authorize and supervise non governemental national space activities
  - art. VIII : define authorization regime to control registered space object.
- the Liability Convention (1972)
  - Liability without fault to establish for damage on land or in airspace,
  - Liability with fault in extra-atmospheric space
- the Registration Convention (1975)

"French Space Operation Act was published on June 3, 2008"

French Space Operation Act

Space Operations Law
(+ L.331 Code of Research modification with regard to CNES missions)
Law 2008-518 June 3, 2008

Liability regime

Decree relating to authorizations delivery 2009-643 June 9, 2009

Décret relating to space data

Decree modifying decree n°24-510 of 28 june 1984

Licensing Process

Ministerial Order « Technical requirements for space operations» March 31,2011 (modified on 12 October 2017)

Ministerial order for space data

CNES order : «CSG Police regulation »

Technical Regulation

TR

REI

- *Flight authorization granted by Ministry in charge of space,*
- *Technical conformity, in flight control and regulation writing delegated to CNES*

FSOA – Liability regime

Who should apply ?

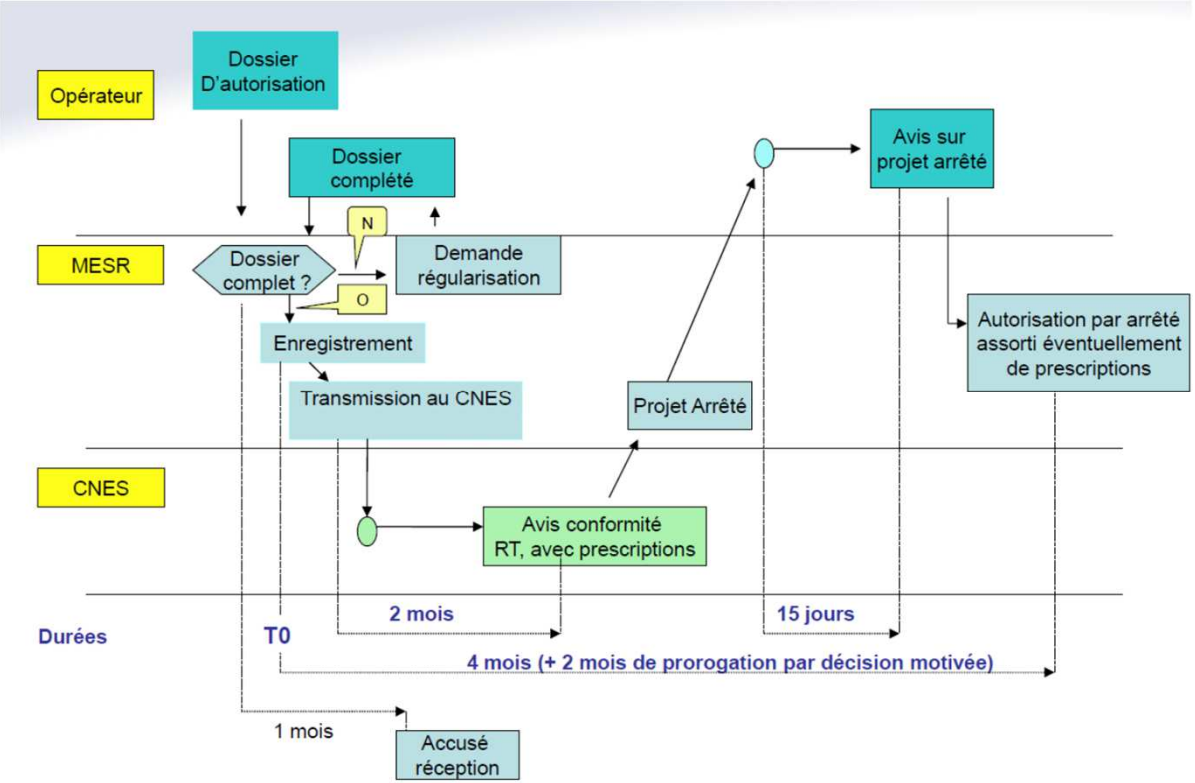
- Any operator, whatever its nationality, who intends to launch or return a space object from/to French territory
- Any French operator who intend to launch a space object from foreign territory
- any physical person having French nationality or juridical person whose headquarter is located in France, whether it is an operator or not, intending to be procured the launching of a space object,
- any French operator intending to control or transfer such an object during its mission in outer space.

Nota : FSOA only applicable to private operator. CNES operations compliant with Technical Regulation, authorization and supervision are under CNES President responsibility

Which request ?

- *Flight authorisation*: authorization to fly for a space object (launcher or satellite)
- *Generic license* : allow fast flight authorization process for a family of space object
- *Preliminary conformity certificate* : conformity status wrt Technical reglementation during space object development

Decree defines procedure to obtain a license



In order to obtain flight autorisation operator must provide

- an administrative request to **Ministry** in charge of space
- a technical data package to **CNES** containing :
  - Complete description of mission, operation, design
  - Management and quality plan
  - Hazard report
  - Environmental Impact Study

Flight authorization application process

Application process is a formal and legal process.

- The **Operator** issue an **authorisation demand** (DDA) for a dedicated Launcher or satellite Mission. A set of technical document are required, especially an **Hazard Report** and an **Environmental Impact study**
- The operator is **legally responsible** for **demonstrating the compliance** with the FSOA regulations
- CNES perform technical **conformity control** and may write **prescriptions** if conformity is not reached
- CNES delivers **conformity notice** signed by CNES President to Ministry in charge of Space
- The Minister issue a **decree** based on CNES Conformity Notice that gives authorization to perform the launch or in-orbit control subject of the demand. Generally, the decree is issued few weeks before the launch.
- CNES perfom pre-flight and in flight control in order to check authorization terms are respected, especially presciptions
- CNES perform in flight safety check and may destroy the launcher or recommand end of life for satellite

Preliminary conformity certificate process

Preliminary conformity certificate is a formal and legal process only between CNES and the applicant

- For each **milestones** during launcher or satellite **development** (SRR, PDR, CDR,…), operators or manufacturers can issue a Preliminary Conformity Certificate demand to CNES.
- The demander provide all relevant technical documentation necessary to demonstrate its compliancy wrt FSOA, in particular an hazard report and an Environment Impact Study)
- CNES prepares perform the technical conformity and the **Preliminary Conformity Certificate** that is signed by the CNES president and sent to the demander.
- The Preliminary Conformity Certificate **does not supersedes an authorisation** to launch or to control that remains mandatory

Nota :

- in this process, Ministry in charge of space is not in the loop
- Preliminary conformity certificate is not mandatory but highly recommanded for innovating development

Technical Regulation - Area and principles

Technical Regulation (TR) divided in two parts:

- launch of space objects with return of space objects
- in orbit control

Main risks to master when enforcing the law

- Debris production in space
- Population and public health injuries, properties and environment damages when returning on the earth

The Technical Regulation requirements :

- are coherent with the international guidelines concerning population risks and space debris
  - IADC Space Debris mitigation Guidelines (2002, rev 1 2007)
  - Space Debris mitigation guidelines of COPUOS (2010)
  - International Standards Organization (ISO 24113, ECSS)
- have to be considered in the design,
- have to be fulfilled during the operations.

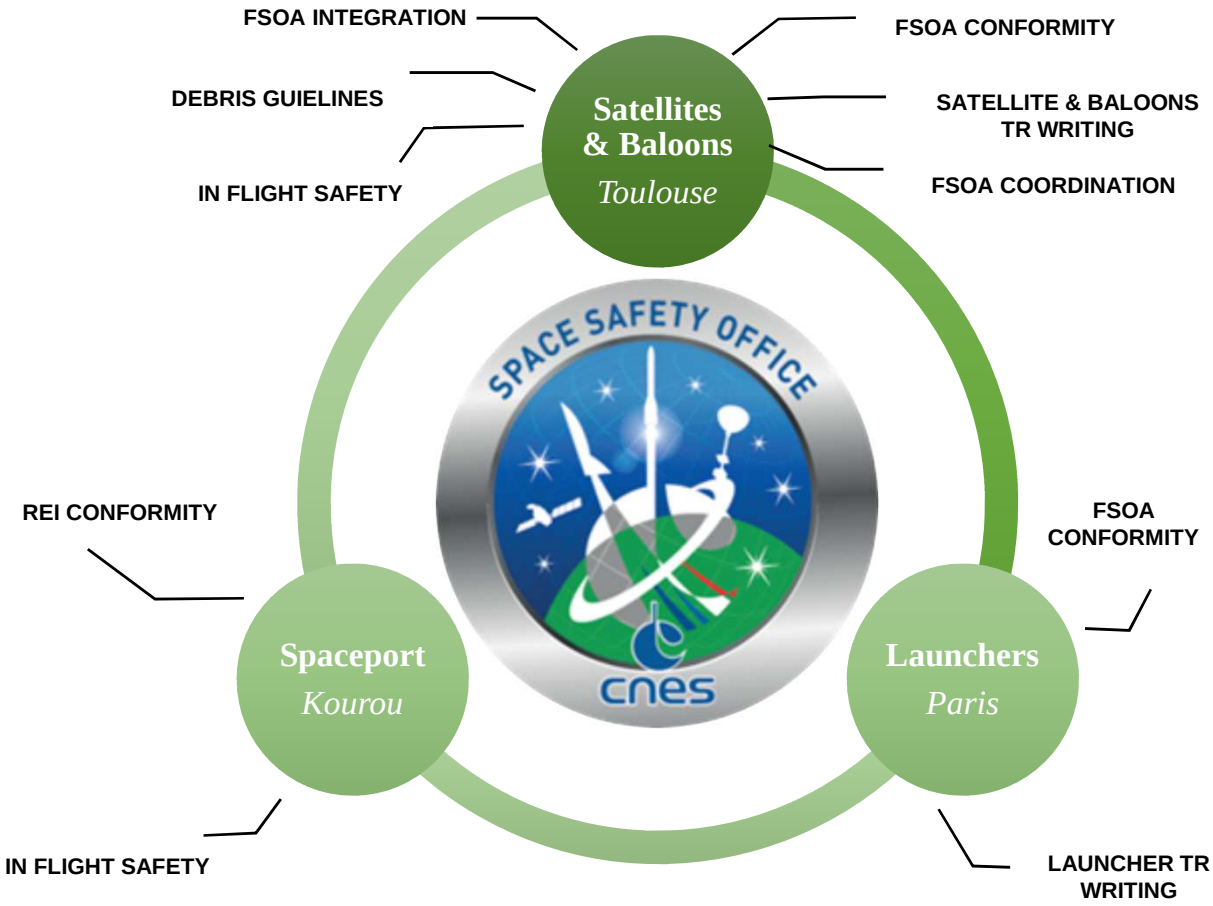
CNES organisation : 3 Space Safety Offices

« Space Safety Offices are in charge of Spaceflight Safety and Space Sustainability »

Drivers :

- Space debris mitigation
- Space traffic regulation
- Population, health and environment protection

Nota : CNES baloons authorization are not in the frame of FSOA but supervised directly by CNES by delegation from French Aeronautics Navigation Agency (DGAC)



LOS implementation

Guide of Good Practices (RNC-LOS-GR-CNF-8-CNES)

- A guide of good practices characterize practices in force, that help to demonstrate compliance with the technical regulation
- Conformity with all or part of the requirements of these technical regulation is assumed to be acquired if the operator can demonstrate compliance with the relevant recommendations of this guide

Softwares

- **STELA** to verify compliance with protected regions clearance after End of Life
- **DEBRISK** to define parts of the vehicle that could reach the ground
- **ELECTRA** to assess the population risk

FSOA : AN EFFICIENT TOOL FOR SPACE SUSTAINIBILITY

EUTELSAT
GLOBALSTAR
AIRBUS GEO
CSUM
CSUT
AIRBUS
TAS
CNES
...

Satellites

4
Preliminary conformity

22
on-going submission

3
Mission extension

65
satellites flying under FSOA license

50
submission between 2010 & 2018

4
End of Life

6
New licenses

VEGA
SOYUZ
ARIANE 5

Launchers

11
Launch authorisations

UPCOMING : Need of new space traffic rules

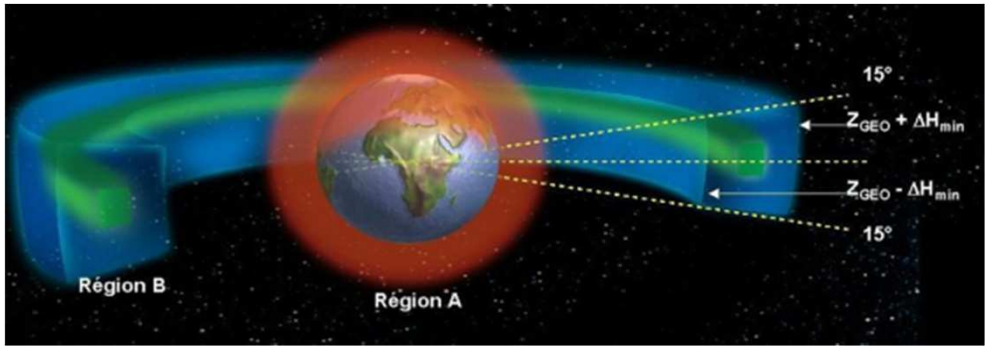
"2019 paradigm is not anymore 2008 paradigm"

international guidelines, best practices, national regulatory acts to be updated

ANNEXE : Technical Regulation Main Requirements

Limitation of space debris

- Region A: Protection of low earth orbit (0 – 2000 km) through limitation of the presence in the protected region to 25 years through
  - Atmospheric reentry (controlled or uncontrolled),
  - Maneuvers to a stable orbit whose perigee remains outside protected regions for at least 100 years



- Region B: Protection of the geostationary earth orbit through maneuvers to an orbit which will not interfere with the protected region, within 100 years : graveyard orbit

ANNEXE : Technical Regulation Main Requirements 2/3

Limitation of space debris

- No production of debris during the nominal operations
- Limitation of accidental collision risks with manned vehicles and geostationary satellites
- Probability of accidental break-up, up to end of life $<10^{-3}$
- During the disposal phase, obligation to deplete or make safe stored energy (electrical, fluidic, …) to avoid debris production and to permanently deactivate energy production means
- Probability to successfully perform disposal manoeuvers >0,85 and to have the adequate energy resources for the disposal >0,99

ANNEXE :Technical Regulation Main Requirements 3/3

Nuclear safety when carrying radioactive material

Planetary protection

Population safety: probability of at least one victim lower or equal to 10^{-4} through

- Uncontrolled atmospheric re-entry with destruction of the vehicle. The design must be driven by architecture and material selection to limit ground impacting fragments number and energy

- Controlled atmospheric re-entry when risk is too high (satellites with heat resistant materials) with a high level of probability to impact predefined uninhabited zone (usually south Pacific)