OVERALL CONTROL ON SOLID ROCKET MOTOR HAZARD ZONE IN FRENCH GUIANA SPACE CENTER: EXAMPLE OF VEGA AN INNOVATIVE SOLUTION AT SYSTEM LEVEL

Myriam VERTUEUX(CNES)

Guiana Space Center,
BP 726, 97387 Kourou,
French Guiana

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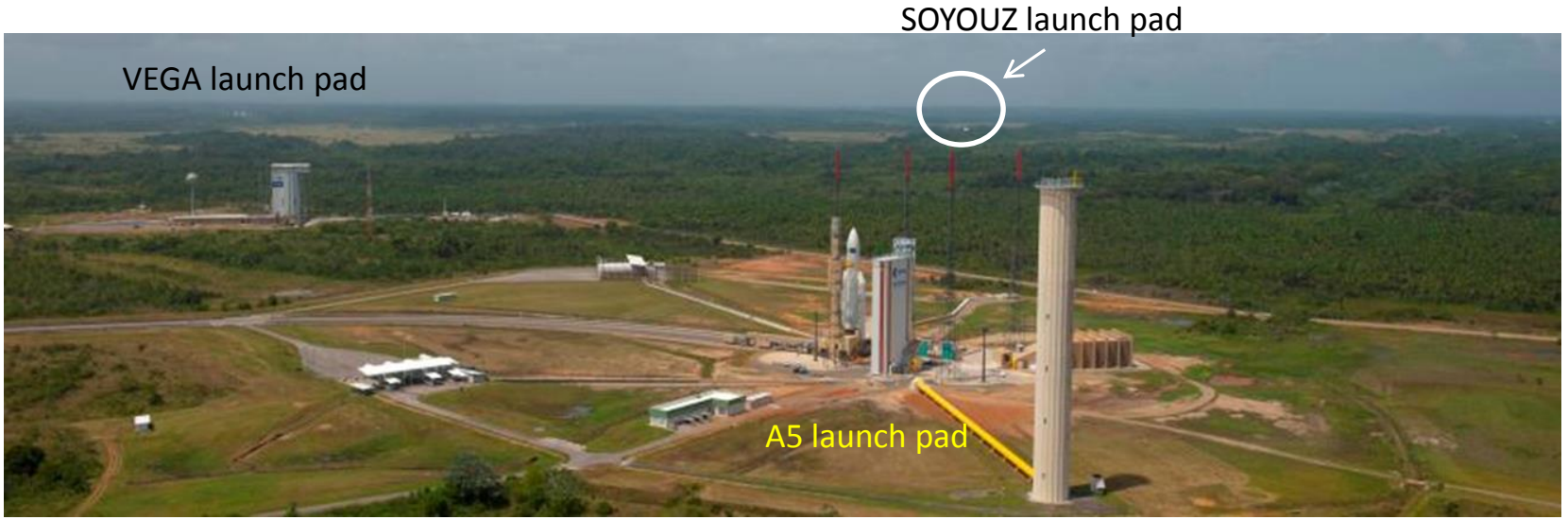
CONTEXT

The arrival of additional Space launch vehicles Soyouz and Vega in Guiana Space Center facilities faced a new ground range safety major question: The technical hazards assessment and management related to the preparation of these three launchers simultaneously with the same high level of safety.



The risk of self-propulsion of solid rocket motors brought by VEGA stages and the solutions to avoid the “domino effects” on neighboring facilities have been issued as one of the major concern in term of safety.

All Safety teams involved in the program (CSG and projects) had to find innovative solutions to handle this new risk.

These slides will present how thanks to preliminary analyses at system level, safety engineers found a good way to optimize on board and ground systems solutions.

SAFETY STRATEGY APPLIED EARLY FROM THE START OF VEGA PROGRAM

In order to avoid solid rocket motors inadvertent ignition and all the catastrophic consequences, a global risk reduction strategy has been applied:

A prevention strategy: all possible initiating events leading to inadvertent ignition are identified and treated in a Hazard analysis in order to reduce their occurring probability to an acceptable level.

Mitigation strategy: in the worst case that the ignition of the solid rocket motor occurs, corrective measures are implemented to avoid uncontrolled flight of the pyrotechnic stages of VEGA and to reduce the consequences.

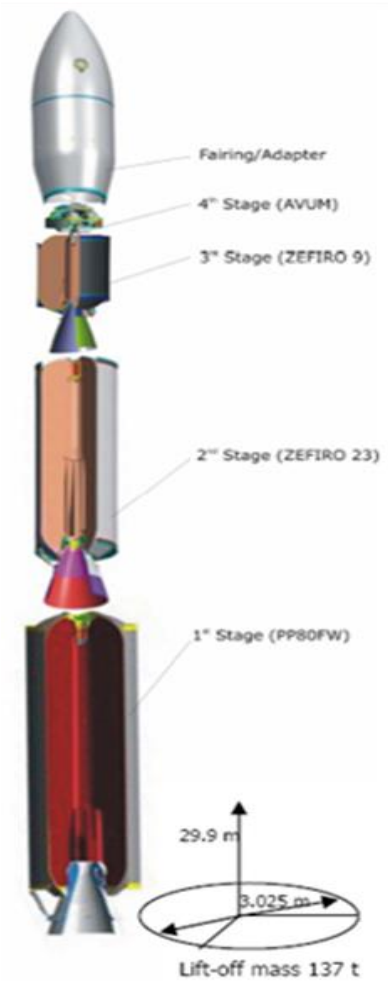
MECHANISM LEADING TO SELF-PROPULSION

GENERAL PRESENTATION OF VEGA LAUNCHER and MAIN ACTIVITIES IN CSG

The operational deployment of each pyrotechnic stages of VEGA in CSG includes various activities:

- Storage
- Transportation
- Integration of pyrotechnic stages
- Pyrotechnic tests/control

activities



HAZARD ANALYSIS

3 following conditions:

- The aggression of the ignition chain or solid propellant loading channel of each of the three Solid rockets motors.
- The takeoff strength of the specimen (and attached supports) is superior to the gravity
- The aggression doesn't damage the structure of the specimen (no pneumatic explosion of the specimen)

The initiating causes could be:

a-A mechanical aggression (during transport, drop of an object over the SRM, …)

b-An electrical aggression (lighting strike, electrostatic discharge, …)

c-A human error

d-An inadvertent firing command

e-thermal energy aggression (fire in the facility, …)

f-Others

VEGA LAUNCH PAD

Mobile gantry

Lightning protection

VEGA ANTI-FLIGHT SOLUTIONS

Safety studies and working groups conclusions showed that one of the best solution to reduce the risk during all phases of activities was to find a compromize on the installation of non flight devices on onboard systems and ground systems.

Protective solutions well-adapted for each phase of preparation of the VEGA stage have been implemented :

Solid rocket motor main igniters of P80, Z23 and Z9 in transport and storage configurations are fitted by a protective on board device called safety snap ring.

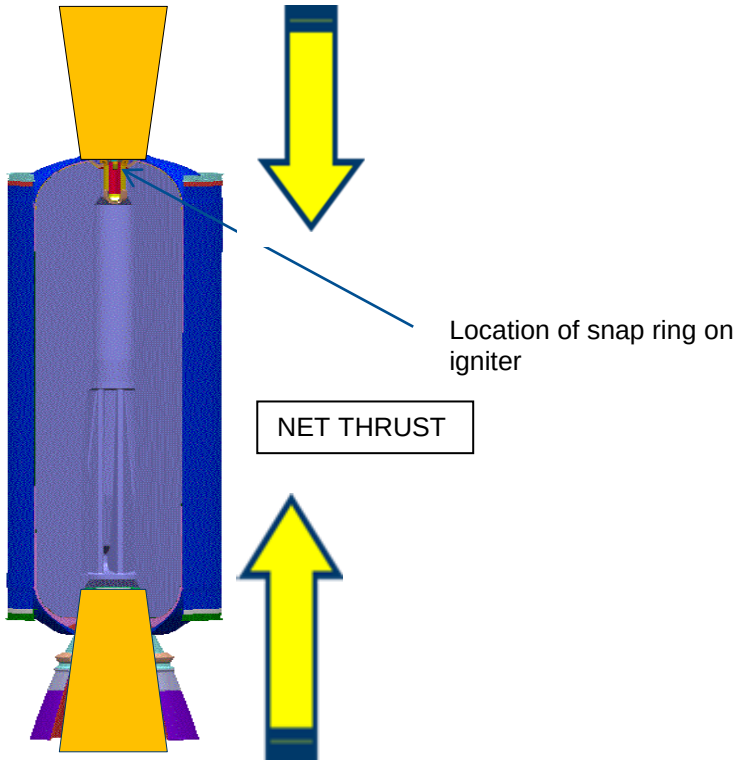
During integration phases in launch area, the P80, Z23 and Z9 are protected by two means:

- a reinforced structure of the roof of the mobile gantry
- P80 is equipped with 4 anti-flight knives fixed to the structure of the mobile gantry

AN ON BOARD DEVICE: SAFETY SNAP RING

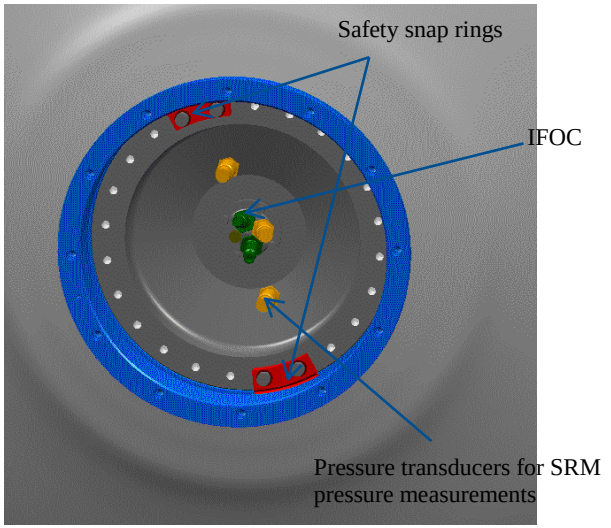
The concept is based on the principle to bring weak the snap-ring used as mechanical connection between the motor case (polar boss side) and the igniter adapter ring. This is obtained reducing both the snap-ring cross section and the angular extension of the ring.

The device built with an aluminum alloy is designed to break at a well-defined range of pressure (from 15 to 30 bar that is to say from 150 to 300 milliseconds after the ignition), and having the scope of creating a new port area for combustion gas outflow. **The basic effects are to induce a low pressure functioning of the motor and to create an opposite thrust force, anti-flight oriented.**



The controlled rupture of the igniter to case connection and the consequence of opening of a new hole in the upper part of the motor will generate a thrust contrary to the nominal nozzle thrust

The safety snap-ring is installed after the igniter integration, and is removed just before the upper stage integration in mobile gantry. For P80, it is installed during igniter integration in BIP facility and for the zefiros stages (Z23 and Z9), it is installed in Italy.
It is replaced by the flight snap ring easily mounted without losing the exact positioning of the igniter.



As a conclusion, the idea to use for all transport, handling, tilting and lifting operations ground snap-ring for igniter to case mechanical connection designed to rupture at a well-defined motor pressure permits short, safe and simple operations. The concept is not costly, easy to install and proved reliability demonstrated by tests.

GROUND ANTI-SELF-PROPULSION SYSTEMS

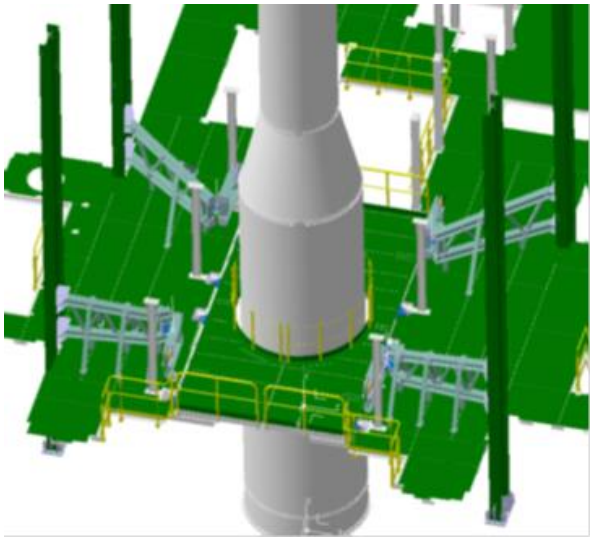
P80 knives

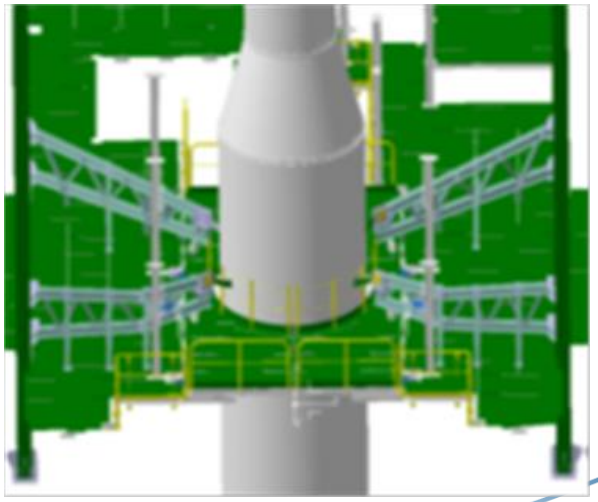
The concept is based on 4 structures composed by steel framework connected on the vertical main pylons and framework of mobile gantry and supporting 4 knives.

The system is a passive mode that is activated by the elevation of the P80 motor in the catastrophic event of ignition inside the mobile gantry.

The anti-lift-off system guarantees the P80 SRM case destruction (destroying its ability to sustain internal pressure) by the penetration of at least 2 knives in radial opposition

The system is not costly and is simply used: the different parts are handled by hand, in order to simplify the positioning. The removal of the system before flight is done just before the mobile gantry removal, a few hours before launch.





EXAMPLE OF KNIFE

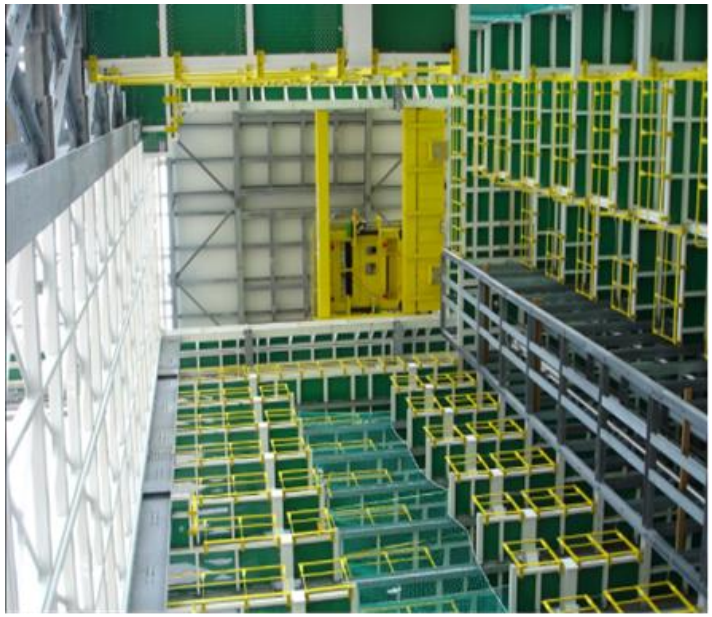
GROUND ANTI-SELF-PROPULSION SYSTEMS

Mobile gantry roof

The structure supporting the roof located straight above the launcher have the capability to destroy Zephiro stages in the event of vertical takeoff

The framework is designed to oppose any potential event of self-propulsion of the launch vehicle motors. The device consists of steel beams installed on the roofing of the gantry

The device constitutes a mesh of a size lower than 2 meters. P80, Z23 and Z9 specific datas (mass, axial stiffness, thrust, ..) have been taken into account for beams net dimensioning



CONCLUSION

Safety is a major component of space programs, Each program has the same objectives and the same constraints

Safety strategic decisions had to be defined right from the start of the program and before the structuring choices are made regarding:

- the safety of persons and property, the protection of public health and the environment
- The harmlessness of the activities and of the facilities with respect to each other in the event of a major accident on one of the facilities by the application of the location rules for the facilities, roadways, and critical networks (electrical, water, etc)

It is fundamental to have in mind that **only a preliminary analysis at system level, can lead to an optimization of solutions coming from ground facilities and on board systems.** The case of VEGA is a very good example of ground and on board teams cooperation. This hand by hand work lead, at the end, to find low development cost solutions to handle the risk of the self-propulsion but with also, a good level of reliability, simplicity of design and use in operations**.**

THANKS FOR ATTENTION: QUESTIONS ?