



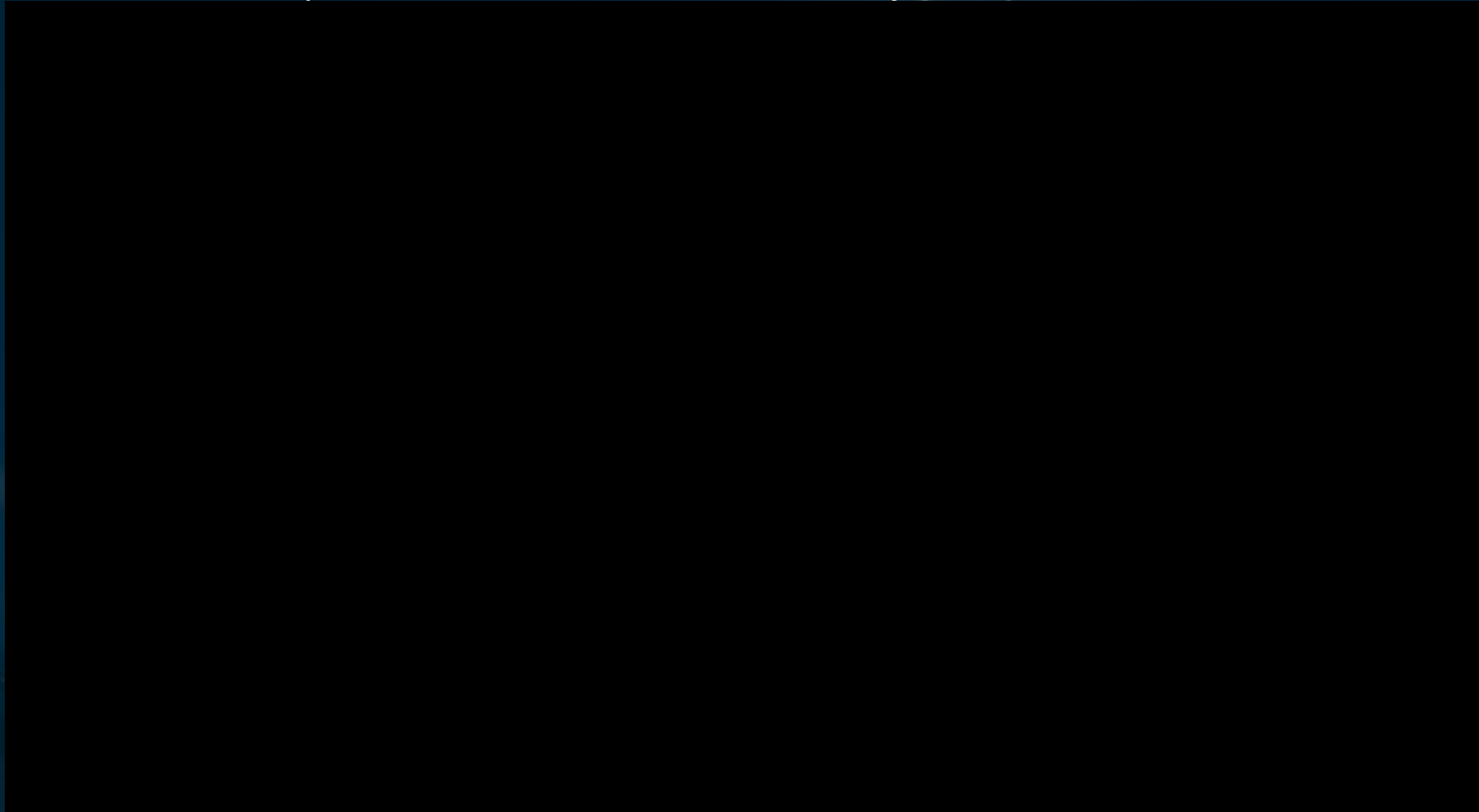
Ariane 6 Launch System Safety in operations

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European Space Agency (ESA) – Directorate of Space Transportation

Big Science Business Forum October 2022

RIGHT FIRST TIME approach

Right first time is a must. Test is the preferred verification method → tests shall be comprehensive and fully representative of the full operational domain of the Launch System.

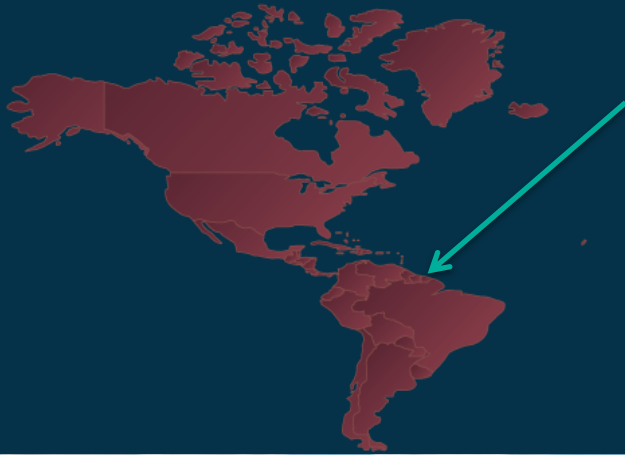


EUROPEAN SPACEPORT

European launchers lift off from the Centre Spatial Guyanais (CSG), Kourou, in French Guiana.

CSG is operated by the French space agency CNES and Arianespace, with the support of European industry.

ESA owns the launch infrastructure for the **Ariane 5, Vega & Vega C** launchers.



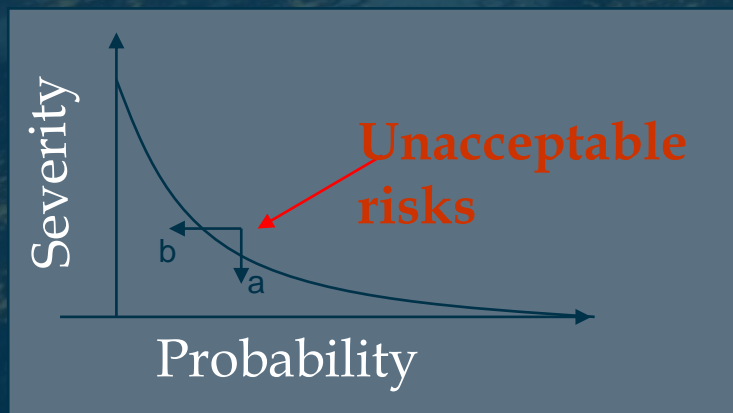
ARIANE 6 LAUNCHER CONFIGURATIONS



REGULATIONS

- French Space Operation Act (FSOA) : operating requirements of the French Guiana Space Center
- European and French regulations and decrees : Pyrotechnic safety regulations, environmental protection acts, directives to prevent major accidents for high-level industrial risk facilities (SEVESO III)

DESIGN-TO-RAMS

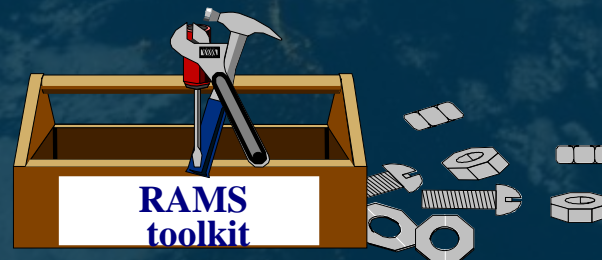


REDUCE A RISK



Mitigation logic:

- 1) Priority : detection and prevention
- 2) If not possible, corrective actions.



State of the Art :

- Design: system reliability (associated to detection) and optimized implementation
- Human: instructions, procedures, continuous training

→ All the FSOA is applicable to a Launch System

- **Operators + Facilities + Launch Vehicle + Safety Authorization**

→ What requires FSOA for any Launch System in Operations at CSG (since ESA/CNES Agreement in 2011) ?

- **Regulations for Exploitation of Installations (REI)** for ground operations & flight phases
- Complementary **Technical Regulation (RT)** for Third Party wrt launcher in flight & **ESA Space Debris Mitigation Policy (SDM)**

Safety requirements for the Operators

REI Part II – SAFETY RULES FOR ACCESS & CIRCULATION WITHIN GUIANA SPACE CENTER

- Article 7 - Interface with the safety regulations on facilities
- Article 8 - Access rules for people and vehicles
- Article 9 - Safety training
- Article 10 - Access control measures
- Article 11 - Traffic rules within the CSG perimeter
- Article 12 - Evacuation of a facility or area
- Article 13 - Access, traffic, time spent on and evacuation of the Salvation Islands
- Article 14 – Access and evacuation of the leisure area
- Article 15 - Transport of dangerous goods

→ What is the limitation on the number of permanent operators?

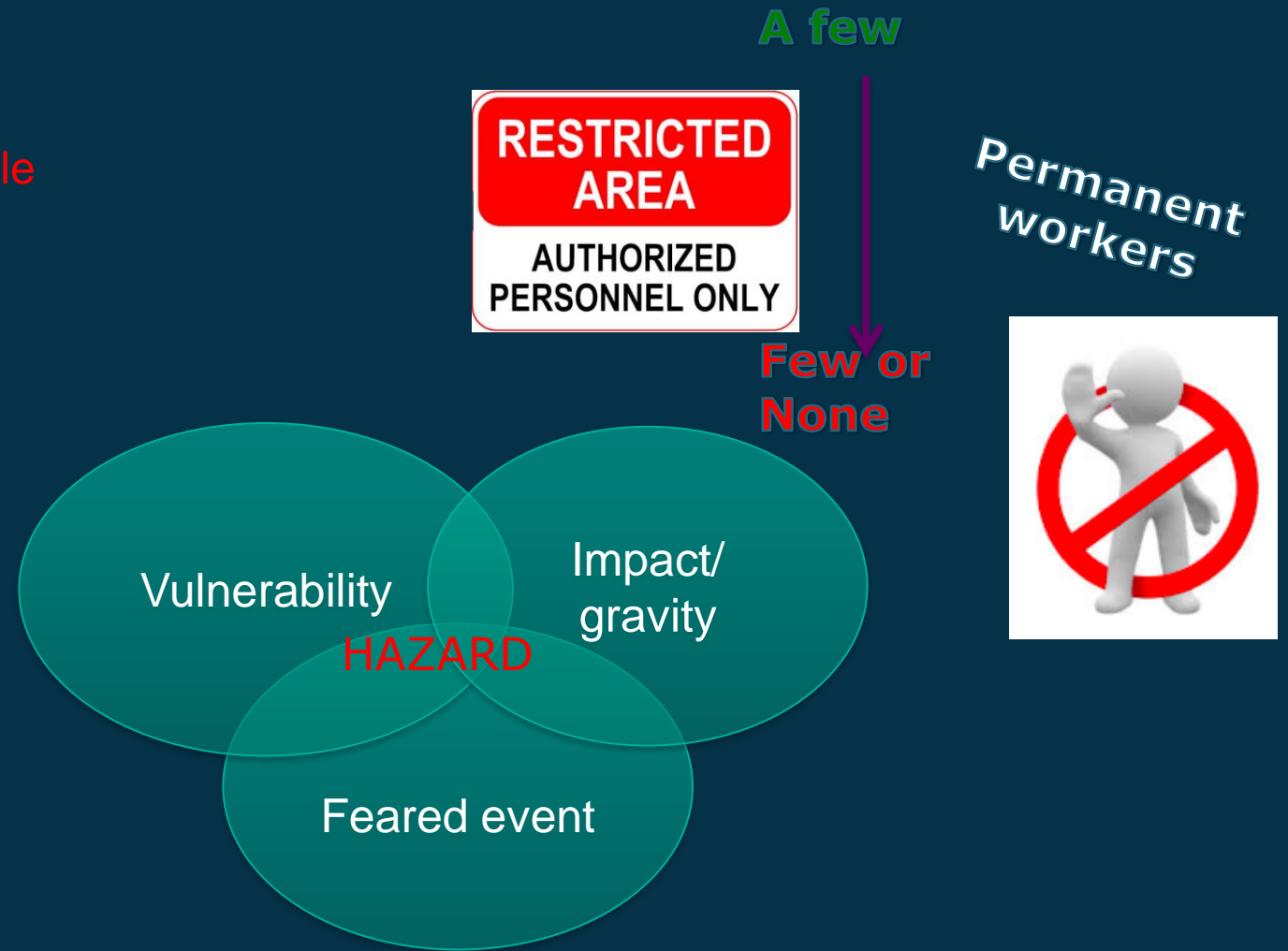
Safety requirements for the Operators

General consideration on the probability of a potential feared event linked to a hazardous system:

- = P1 in static condition → **Very Unlikely**
- > P1 in dynamic condition → Unlikely
- > P2 if energy delivered with control → **Probable**

Applicable to feared events of a :

- Pyrotechnical system
- Fluidic system
- Mechanical system
- Electrical system



Safety requirements for Buildings

REI Part III – SAFETY RULES FOR BUILDING / FACILITIES WITHIN GUIANA SPACE CENTER

- Article 16 - Facilities siting
- Article 17 - Provision of lands
- Article 18 – Exploitation of facilities
- Article 19 - Change of operator
- Article 20 - Cessation of activity



SAFETY REQUIREMENTS FOR BUILDINGS

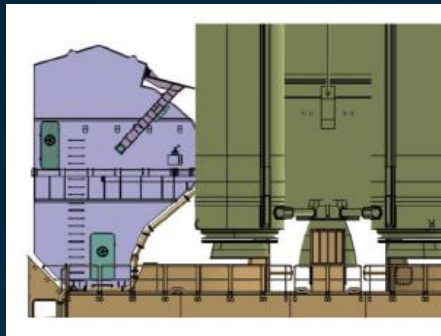
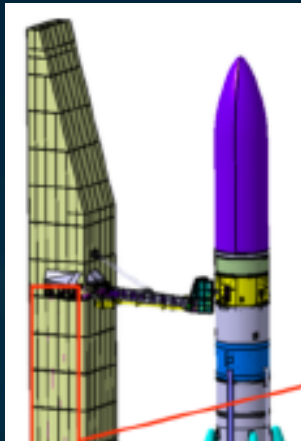


SAFETY OBJECTIVES ON COMBINED TESTS

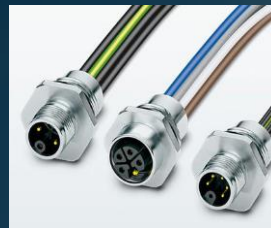
As the Combined Tests is the *Flight Model 0 (FM0) campaign*, by definition it will allow to de-risk the following launch campaigns thanks to the systematic and strict troubleshooting carried out during the Combined Tests.

Examples of Launch System hazards on ground : Cryogenic Connection System (CCS), explosive atmosphere (ATEX), Tanks pressure, Lightning risk, Ground Wind effect, Geyser effect,...

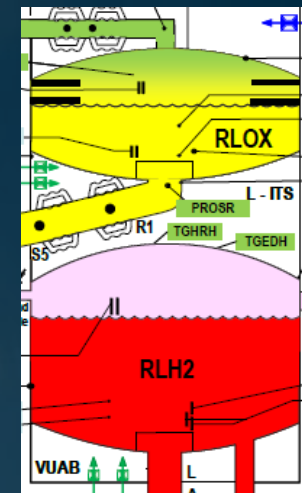
Cryo Connection System: untimely, no (or late) disconnection & leakage at lift-off



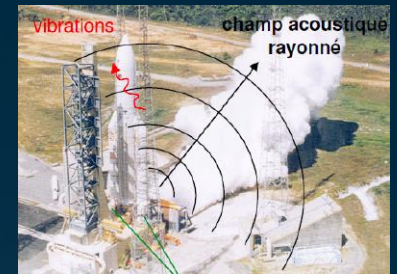
Fool-proof



ATEX

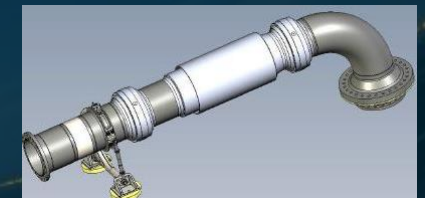


Loss of LLPM/ULPM tanks pressure



Acoustic environment

Geyser effect in oxygen feeding line



OPTO-PYRO control



Ground Wind



Lightning strike

SAFETY AT EACH STEP OF THE COMBINED TESTS



MITIGATE RISKS AT THE EARLIEST

With the goal of validating/verifying Launch System performances/requirements in advance to Combined Tests to
→ mitigate risks of Combined Tests major anomalies and secure Ariane 6 development schedule as such

EARLY COMBINED TESTS chosen on the *criticality* of the topic together with the availability and representativity of the test items needed. → *when Ariane 6 presents a particularity with regards to Ariane 5*

Main Early Combined Tests campaigns identified:



ECT Vulcain 2.1 ignition environment



ECT on Cryogenic Connection Systems (CCS) disconnection and retraction tests



ECT Central Core Deployment and ESRs mating in Launch Zone (CCDZ)

EARLY COMBINED TESTS CRYOGENIC CONNECTION



GOVERNANCE



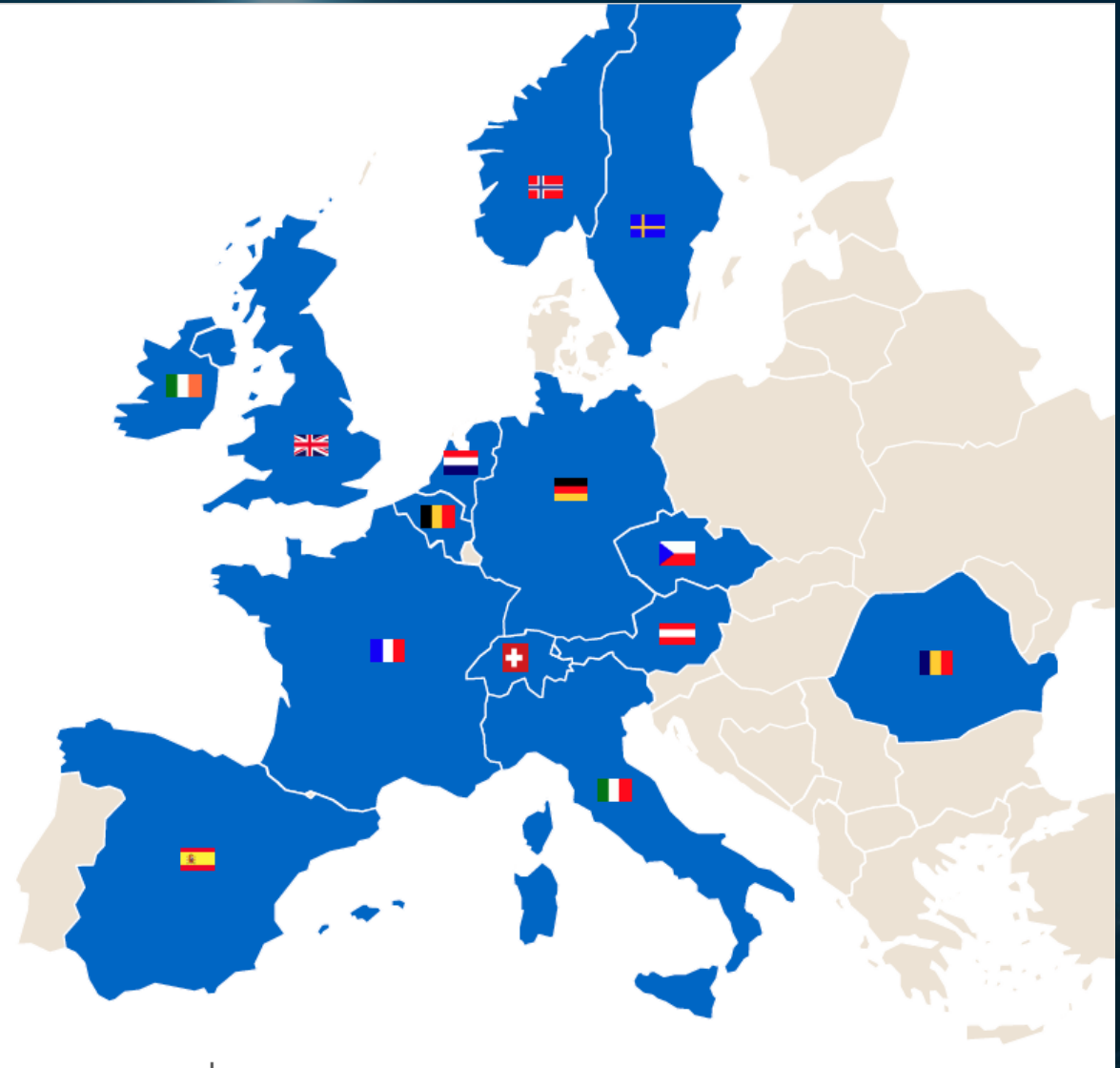
Launch System Architect
Procurement Entity



Launcher System
Design Authority



Launch Base
Design Authority



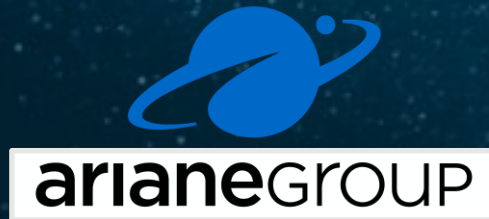
Thank you for your attention !



- Correspondence for questions : Aline.Decadi@esa.int
- Publication : Safety on ground operations on Ariane 6 Launch System, in Journal of Space Safety Engineering (Volume 9 - Sept 2022)
<https://www.sciencedirect.com/science/article/abs/pii/S2468896722000647>

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