Use of Cold Gas Energy for Tactical Missile In-Flight Release

Philippe GUITAUT
Technical Manager
ALKAN
Rue du 8 mai 1945
94460 VALENTON - FRANCE

guitaut@alkan.fr

ABSTRACT

The RAFALE is the first aircraft equipped with an Ejector Release Unit (ERU) using a cold gas energy source.

In addition to its unmatched operational advantages, this equipment provides a major improvement of the ejection characteristics which, in the case of tactical missile separation, are mandatory for the pilot and aircraft security.

It is proposed to explain the advantages of such an ERU and to emphasize the recorded improvements compared to any pyrotechnic ERU.

1.0 SELECTION OF A COLD GAS ERU FOR THE RAFALE

The RAFALE is the first aircraft equipped with a cold gas ERU.

The export JAS 39 GRIPEN has now joined the group of the most modern aircraft fitted with the latest technology for weapon delivery.

In both cases, the choice was dictated by the willpower of the aircraft manufacturers and the users to equip these aircraft with units meeting today operational requirements and, in particular, able to release sophisticated stand off missiles, such as the APACHE (MBDA) in optimal conditions for the pilot and aircraft security.

In that respect, heating of the gas storage container has been implemented to guarantee the required minimum ejection velocity. Results and means of implementation will be set forth within this presentation

The design of this "Cold Gas Ejector Release Unit" (SDE) was engaged in 1991. Its full development has been completed recently and this unit is now in serial production.

The SDE has been now been fielded for 4 years in the French Navy.

Paper presented at the RTO AVT Symposium on "Functional and Mechanical Integration of Weapons and Land and Air Vehicles", held in Williamsburg, VA, USA, 7-9 June 2004, and published in RTO-MP-AVT-108.

2.0 ADVANTAGES OF COLD GAS EJECTION COMPARED TO PYROTECHNIC EJECTION

2.1 Operational plan

The use of a cold gas energy source provides the users with a significant time saving,

- No debris after combustion ⇨ no cleaning of the ejection sub assembly,
- Use of conventional materials (metal and composites) since the ejection sub assembly is not subjected to "pyrotechnic" corrosion,
- No scheduled maintenance ⇨ No ERU removal from pylon,
- Fast exchange of gas bottle compared with the re-conditioning with two cartridges of a pyrotechnic Ejector Release Unit).
- Possible use of an airborne air compressor for in-flight pressure replenishment.

But it is in the improvement of ejection performance and in the adaptation flexibility of its ejection characteristics that the cold gas energy finds all its justification.

2.2 Technical performance

The energy production intended to eject the missile with pistons is completely different depending on whether the opening of a gas storage container or pyrotechnic cartridges are used.

If we compare the Energy = f (Time) curves, it shows:

- For a pyrotechnic ejection: a steep energy spike at the beginning followed by a quick pressure drop.
- For a pneumatic ejection: an energy which bends in a more rectangular shape.

This results in improved ejection characteristics with regard to a pyrotechnic Ejector Release Unit.

So, for a given reaction, the ejection velocity of a cold gas ERU is higher to what is recorded with an ERU with pyrotechnic cartridges or, for the same velocity, a lower reaction is achieved with a cold gas ERU.

The curve in figure 1 illustrates the improvements recorded in a comparative study between the Ejector Release Unit of the MIRAGE 2000 and the RAFALE Ejector Release Unit system.

It can be noticed that for a mass of 1300 kg (APACHE missile) the improvement of speed is about 1 m/s.

The curve in figure 2 shows what would be the reactions obtained for both types of ERUs (pneumatic and pyrotechnic) for the same ejection velocity.

2.3 Flexibility of the available energy :

The cold gas energy is stored in a bottle inflated on the ground at a pressure of 350 bars. This pressure can be adjusted to the type of store to be ejected, and in particular reduced, if limitation of the reaction is required. This possibility is impossible when pyrotechnic cartridges are used; their energy being fixed.

In the same way, either by the use of an airborne compressor or by a heating incorporated into the bottle, pressure can be regulated providing a constant pressure, independent of the outside temperature, to achieve repetitive ejection characteristics whatever the flight conditions (altitude).

A thorough study on that topic will be presented.

3.0 CONCLUSION

The cold gas energy affords missile ejection rack a lot of operational advantages and provides unmatched ejection characteristics which today reliability and safety require.

The achieved development of the ERUs for RAFALE and GRIPEN gives henceforth users and aircraft manufacturers equipment adapted to the modern tactical missions requirements.

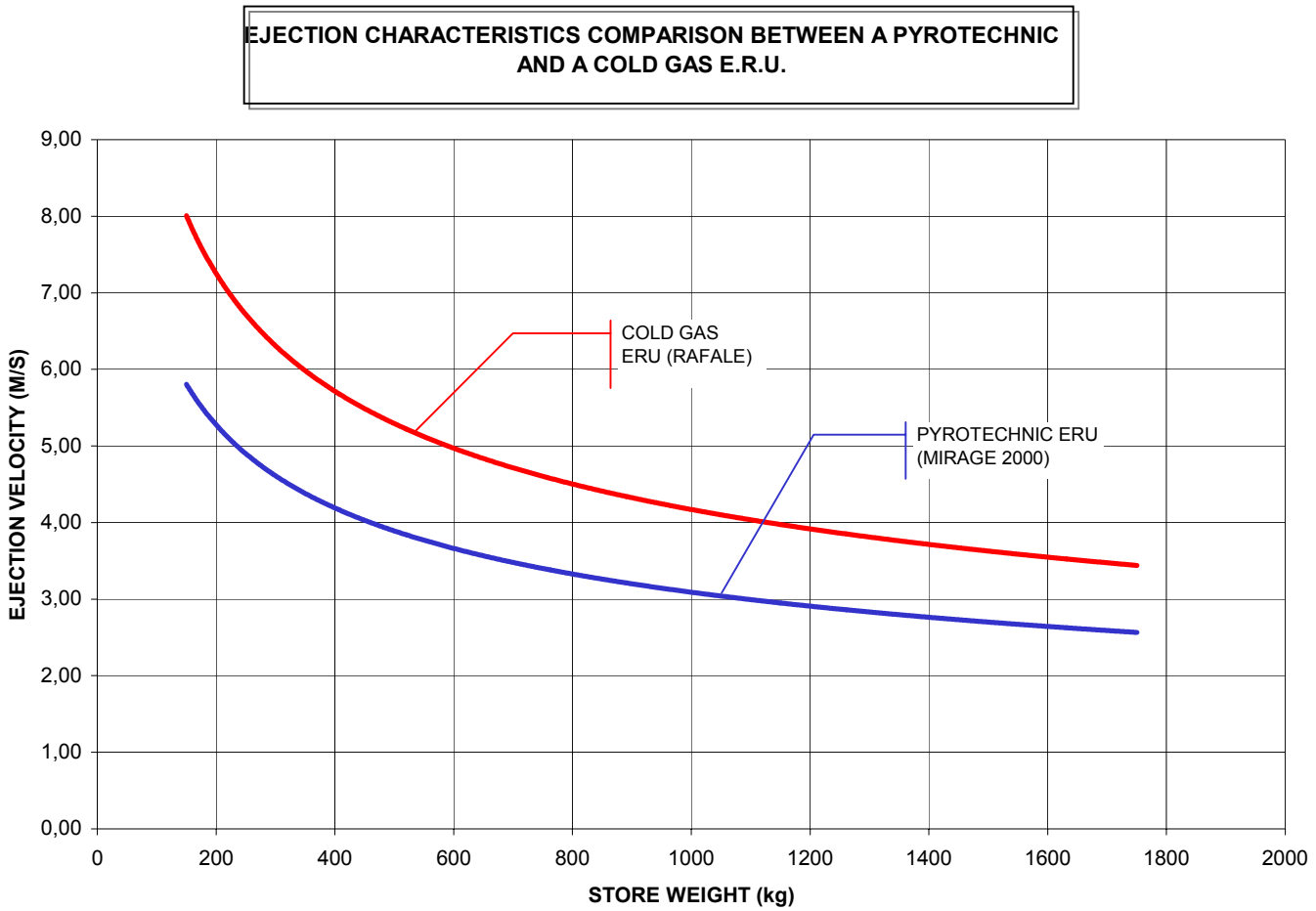

EJECTION CHARACTERISTICS COMPARISON BETWEEN A PYROTECHNIC AND A COLD GAS E.R.U.
EJECTION VELOCITY (M/S)
9,00
8,00
7,00
6,00
5,00
4,00
3,00
2,00
1,00
0,00
0
200
400
600
800
1000
1200
1400
1600
1800
2000
STORE WEIGHT (kg)
COLD GAS ERU (RAFALE)
PYROTECHNIC ERU (MIRAGE 2000)

Figure 1

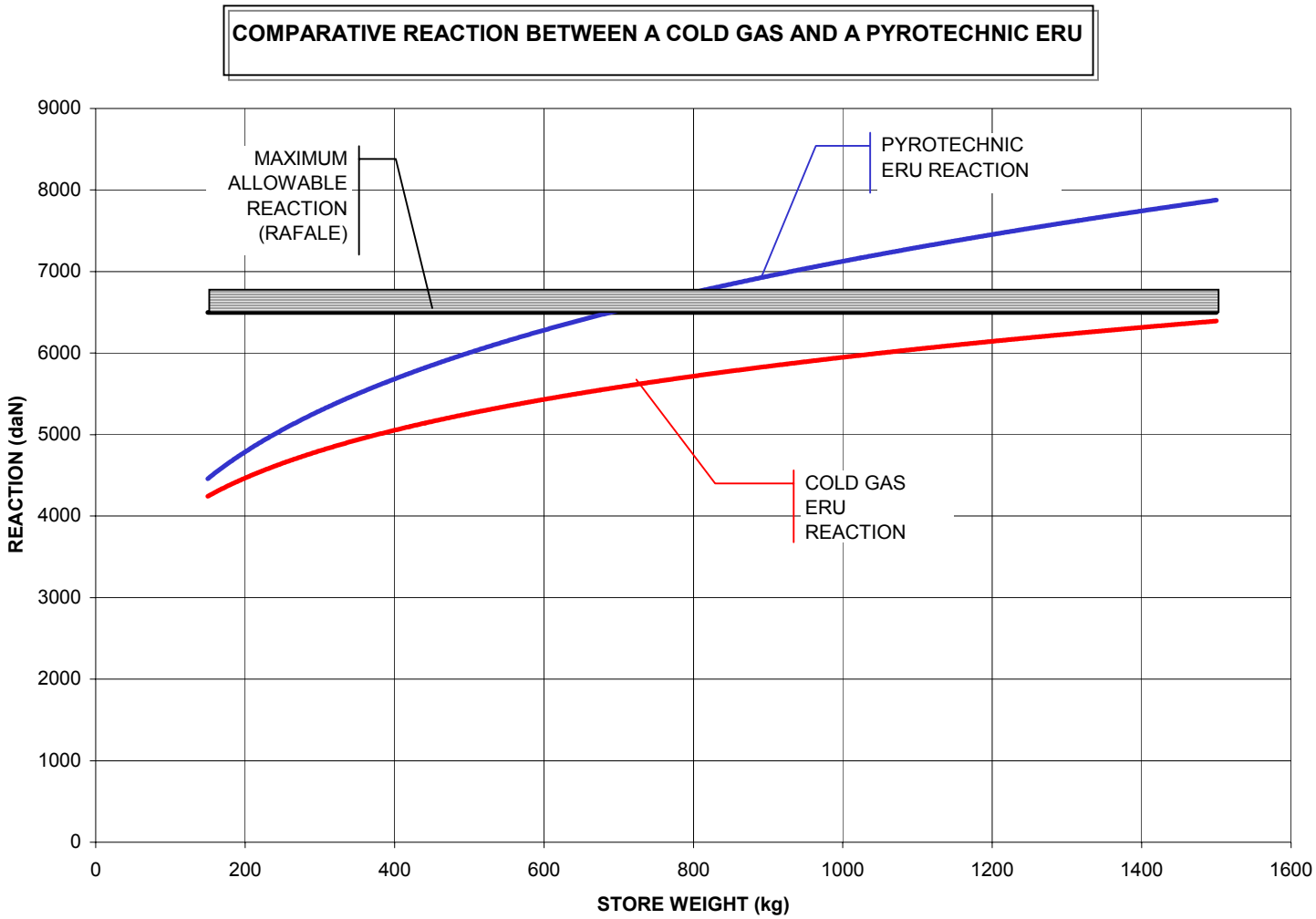
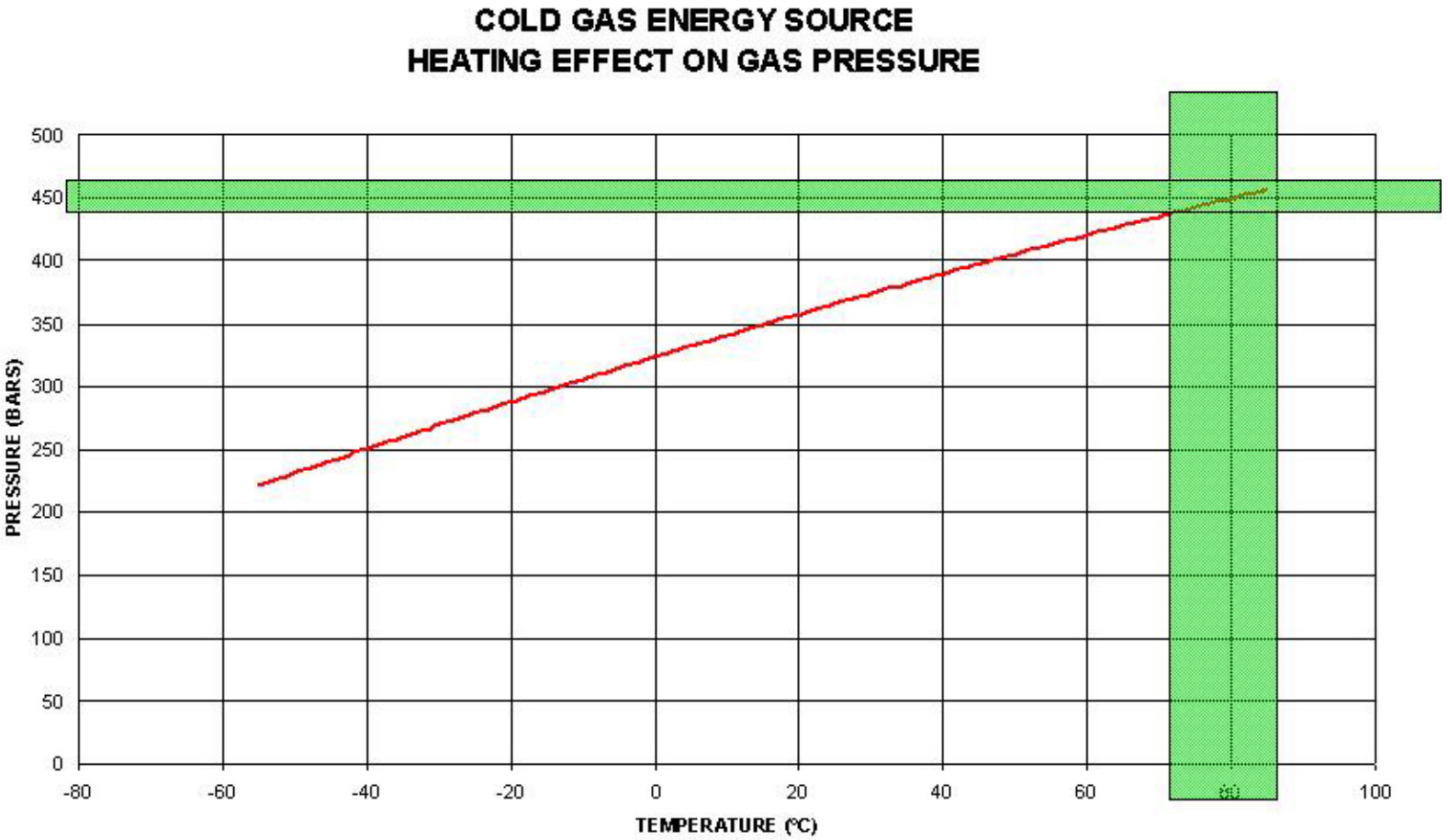

COMPARATIVE REACTION BETWEEN A COLD GAS AND A PYROTECHNIC ERU
MAXIMUM ALLOWABLE REACTION (RAFALE)
PYROTECHNIC ERU REACTION
COLD GAS ERU REACTION
REACTION (daN)
STORE WEIGHT (kg)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
200
400
600
800
1000
1200
1400
1600

Figure 2

Figure 3


COLD GAS ENERGY SOURCE
HEATING EFFECT ON GAS PRESSURE
PRESSURE (BARS)
500
450
400
350
300
250
200
150
100
50
0
-80
-60
-40
-20
0
20
40
60
100
TEMPERATURE (°C)

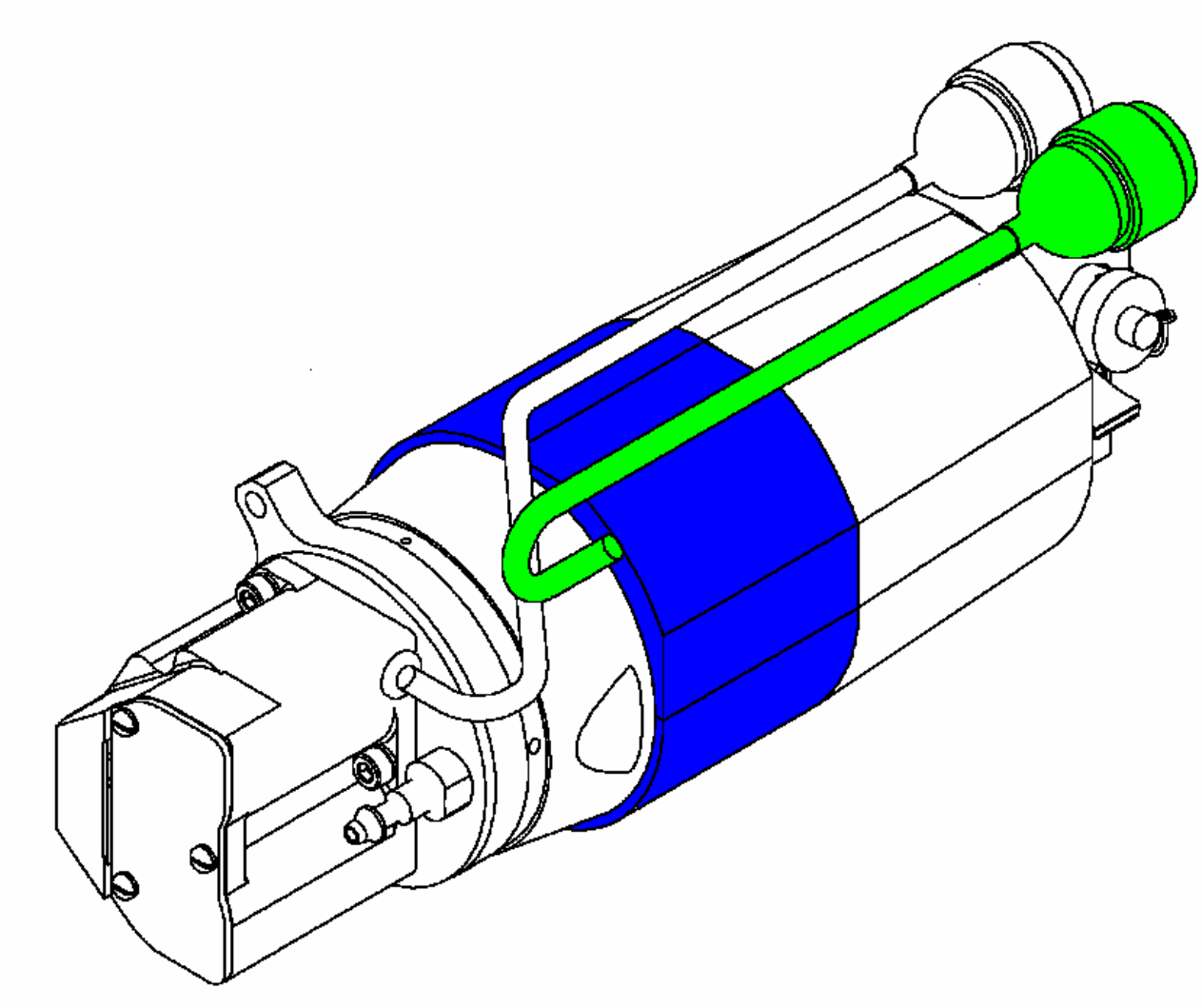


Figure 4

DISCUSSION EDITING

Paper No. 4: USE OF THE COLD GAS ENERGY FOR TACTICAL MISSILE IN-FLIGHT RELEASE

Authors: Philippe Guitaut, ALKAN, France

Speaker: s.a.

Discussor: Philippe Planas

Question: 1. How about the operational cost/ Procurement cost of cold gas systems?

2. What do you think about designing the internal piston chamber shape so that the ejection ^ thrust profile looks like between pyro and cold gas technologies.

Speaker's Reply: 1. Comparison of cold gas bottle + GSE (replenishments) with "special" cartridges (for minimum ejection characteristics)

Maintenance operations an initial investment (cartridges must be available as if a conflict could break out tomorrow) has determined that cold gas solution was the most economical.

2. Attempts have been made to design a pyrotechnic generator which could replace cold gas energy.

Regardless of the recurring cost of this generator the RAFALE specifications have not been met, so far, with pyrotechnic solutions.

The minimum ejection velocity (SCALP ejection) and the maximum reaction force (65000 N) to achieve throughout the temperature range are still incompatible with classic pyrotechnical components.