



**ariane**GROUP

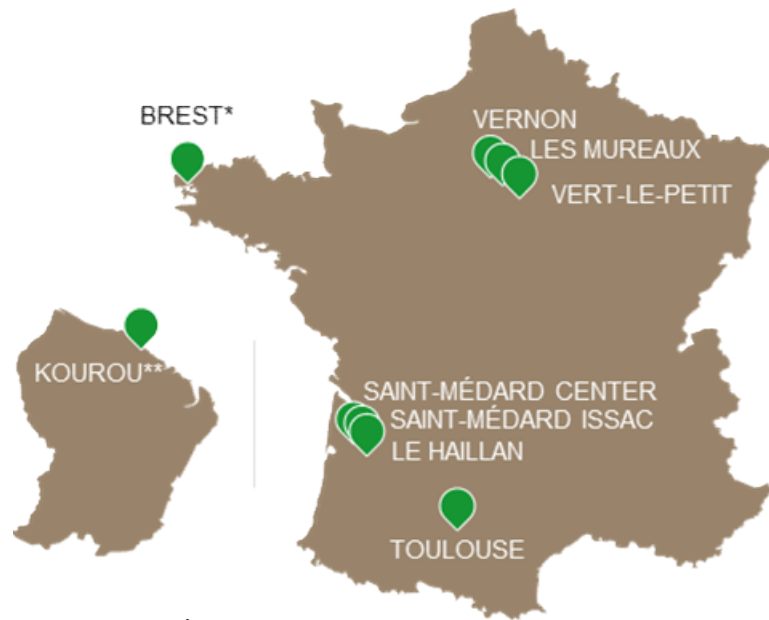
# **EQUIPMENT FOR SATELLITE END-OF-LIFE MANAGEMENT AND DEORBIT**

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**CLEAN SPACE INDUSTRY DAYS, NOORDWIJK**



# ARIANEGROUP - LOCATIONS

## FRANCE



## GERMANY



Center for  
Orbital  
propulsion

\* Secondment to the French Navy site on Île Longue  
\*\* Locations on the Guiana Space Center (CSG)

# ArianeGroup Lampoldshausen

## Overview – Development of the Site

- 1963 – Initial set-up of test stands by the Bölkow-Entwicklungen KG to test thruster and propulsion devices in cooperation with the DLR
- 1968 – First applications for the satellite business
- 2009/2013 – Investment in a new multi functional building. More than 2300 m<sup>2</sup> shop floor space is covering production, logistic and support departments for the manufacturing of propulsion components
- 2014 – Inauguration of a Integration Hall for Complete Propulsion Subsystems. Today more than 250 employees dedicated for propulsion are working in Lampoldshausen. ArianeGroup is continuously and systematically investing in the build up of required infrastructure and engineering tools at Lampoldshausen site

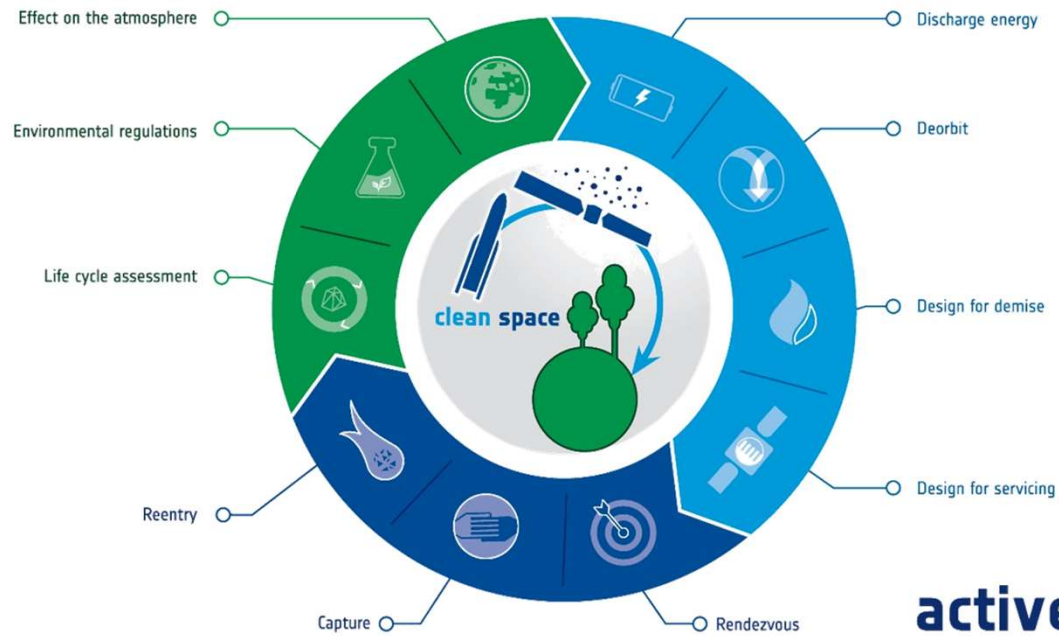


# ecodesign

→ REDUCING IMPACTS

# cleansat

→ SPACE DEBRIS REDUCTION



# active debris removal

→ IN-ORBIT SERVICING

# ecodesign

→ REDUCING IMPACTS

Effect on the atmosphere

Environmental regulations

Life cycle assessment

Reentry

Capture

Rendezvous

# cleansat

→ SPACE DEBRIS REDUCTION

Discharge energy

Deorbit

Design for demise

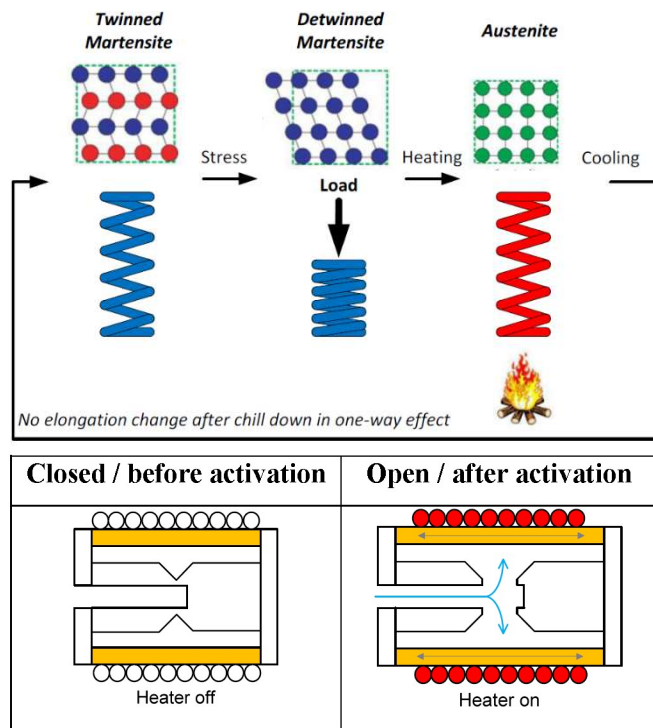
Design for servicing

# active debris removal

→ IN-ORBIT SERVICING



# CLEANSAT – DISCHARGE ENERGY – SMA VALVE



## Pyrovalves have several drawbacks:

- Explosive substance (pyrotechnic device with life limitations)

## SMAVs have

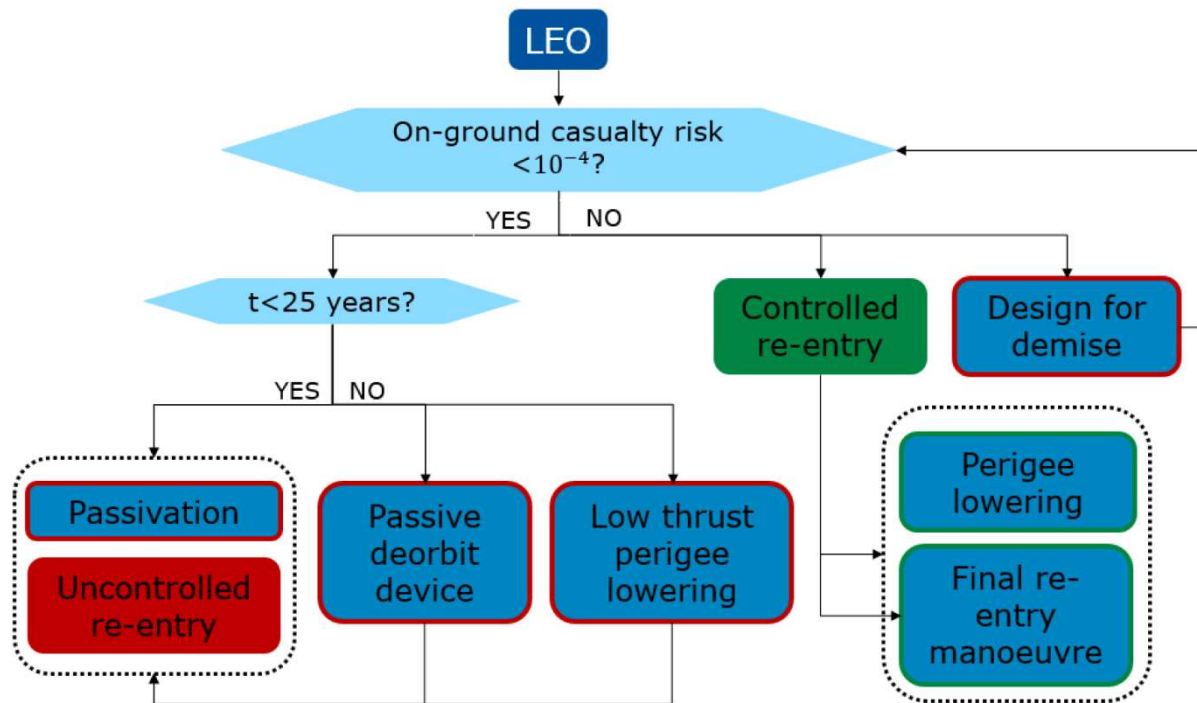
- no lifetime limitations
- A simplified electrical activation
- lower self-induced shock loads
- no legal and safety constraints,
- not subject to REACH or other regulations.

# SMA VALVE – A QUALIFIED PRODUCT IN ORBIT





# CLEANSAT – DEORBIT



# CLEANSAT – ACTIVE DEORBIT

## Typical Deorbit Requirements for an active deorbit

<https://www.eoportal.org/satellite-missions/metop-sg#metop-sg#metop-sg#metop-second-generation-program>



### Example METOP SG spacecraft

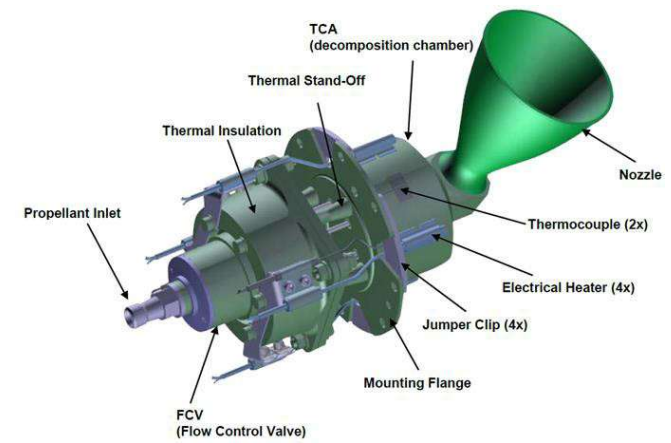
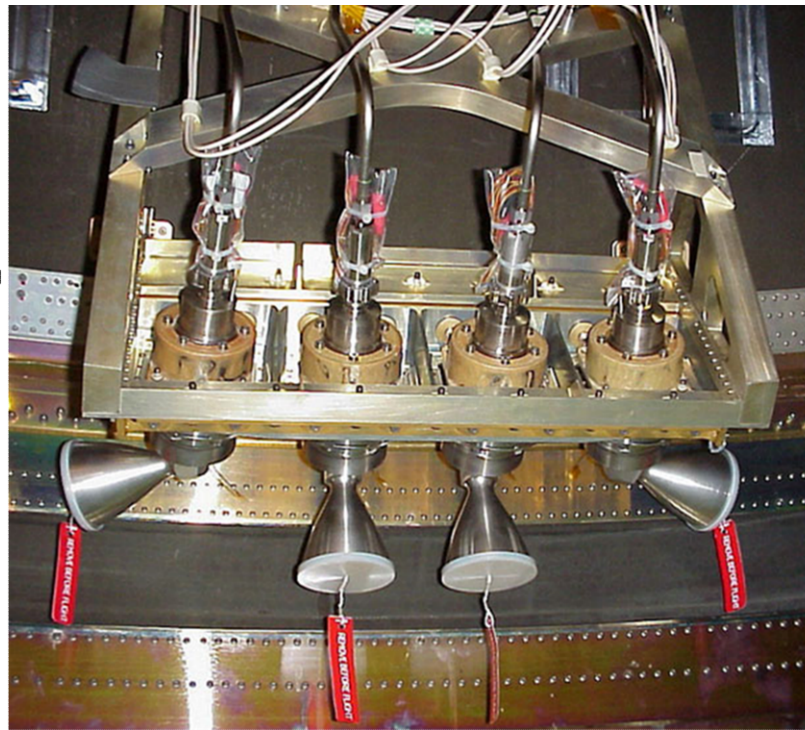
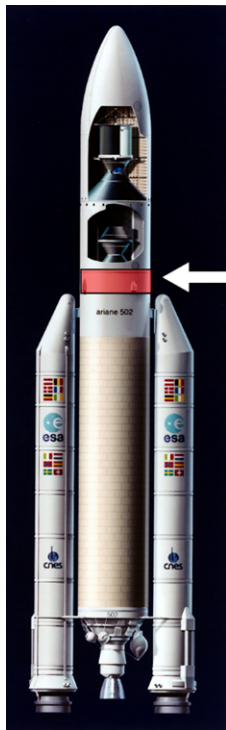
- launch mass between 4.2 and 4.4 tons
- Deorbit  $\Delta v = 222$  m/s (equivalent to  $\approx 68\%$  of the total Hydrazine propellant)

### European Needs (CleanSat Study):

Design Point	Case 1 min. 150N @ 5,5 bar	Case 2 150N @ 18 bar regulated	Case 3 200N average
Operation mode	Blow down	Regulated	Blow down
Operating pressure	24 - 5,5 bar	18 bar	14 - 5,5 bar
Design Pressure	24 - 5,5 bar	24 - 5,5 bar	24 - 5,5 bar
Design point @ 24 bar	500 N	194 N	434 N

# CLEANSAT – ACTIVE DEORBIT

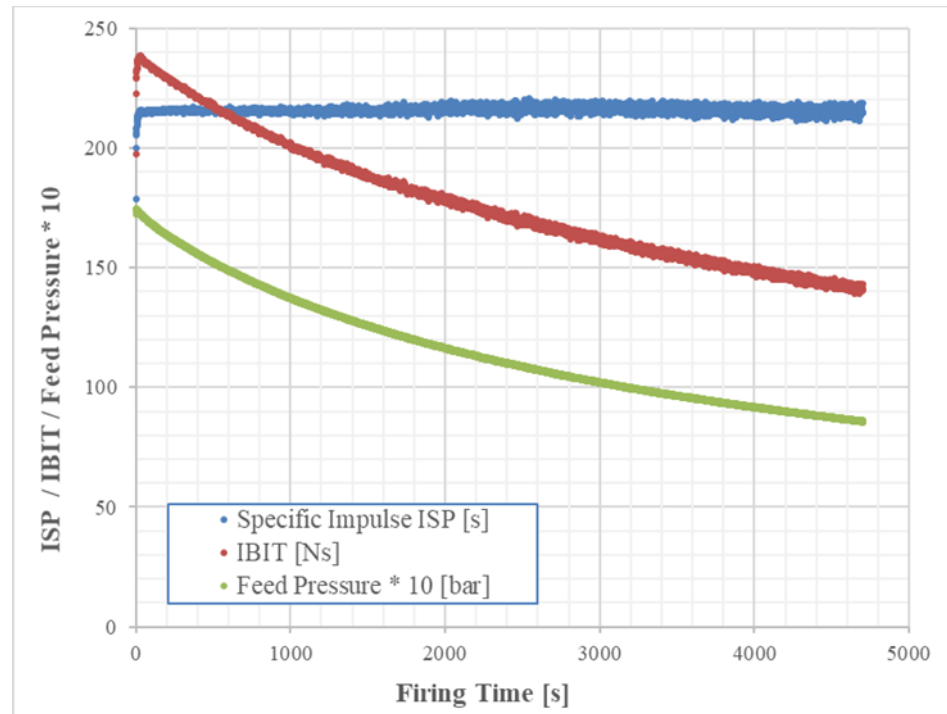
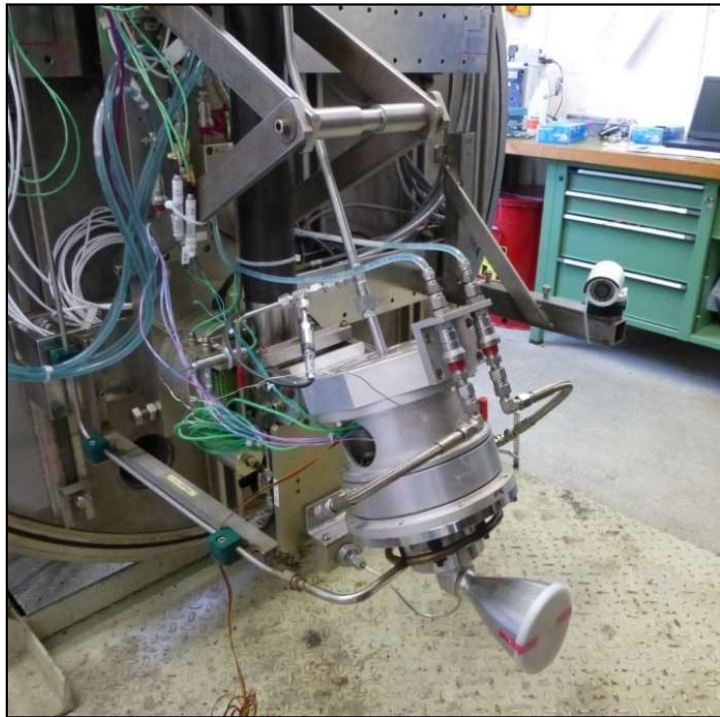
The Ariane 5 Roll Control Thruster was qualified as deorbit Engine



<b>Supply pressure range</b>	<b>5.5 bar - 34 bar</b>
Thrust range	120 N - 540 N
SSF specific impulse range	212s – 230s
Shortest ON-time	16ms
IBIT @ Ton=100ms, 26bar	< 55Ns
Total propellant throughput	app. 880kg

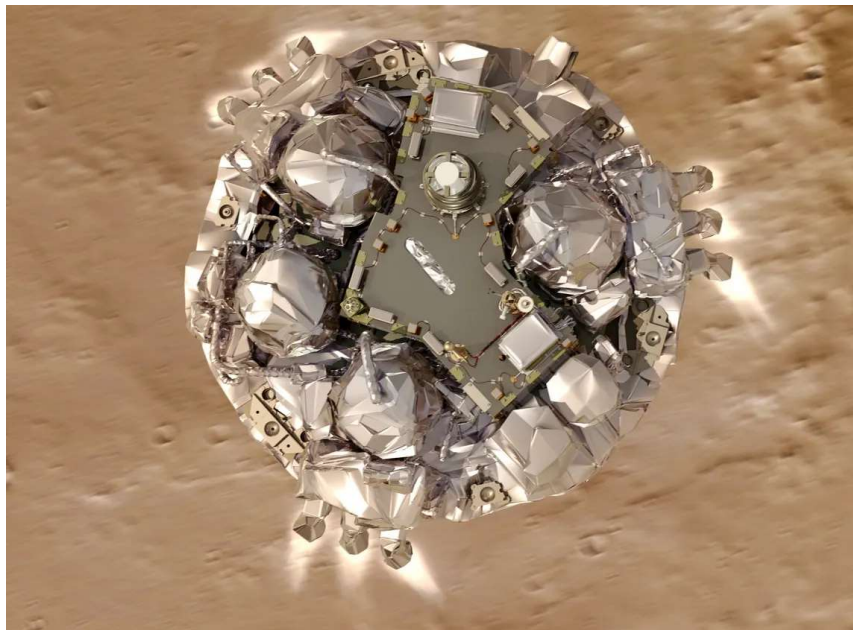
# CLEANSAT – ACTIVE DEORBIT

The Ariane 5 Roll Control Thruster was qualified as deorbit Engine



# EXPLORATION

The Ariane 5 Roll Control Thruster is used for various exploration missions



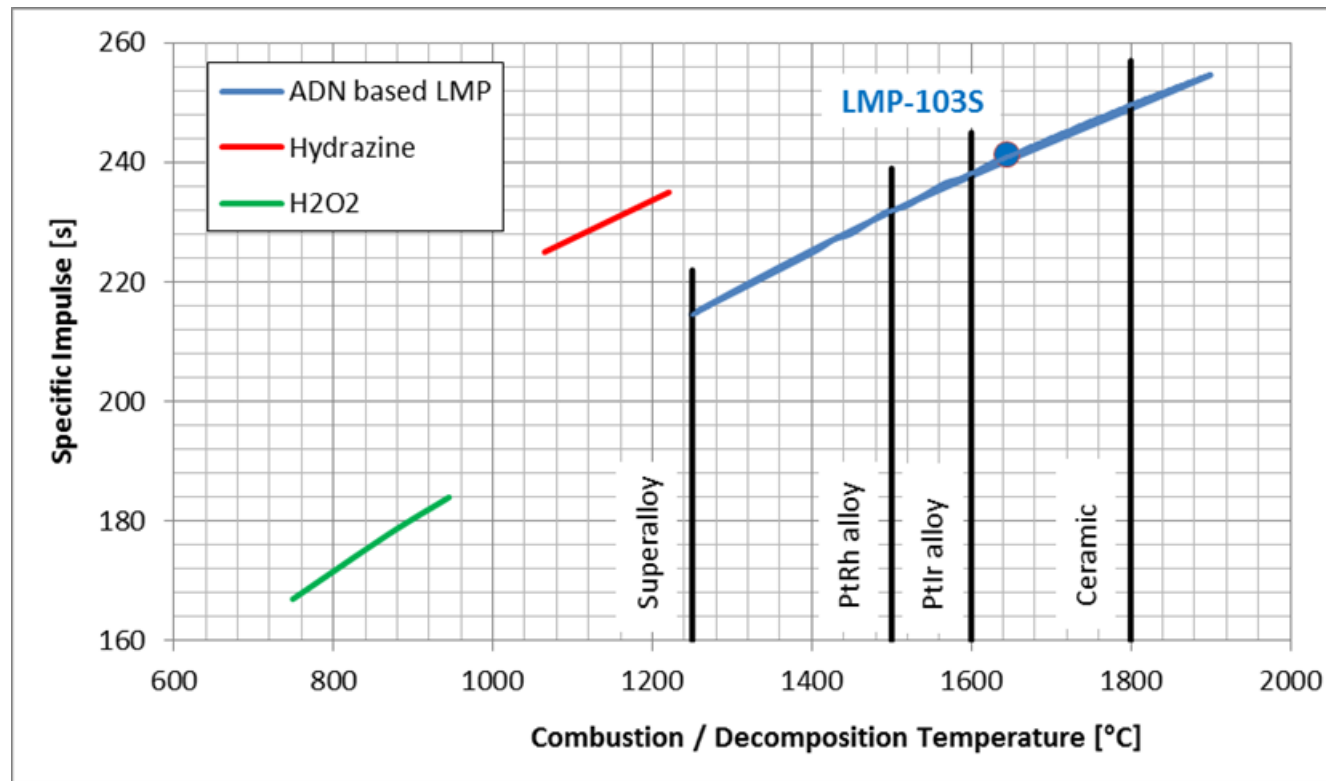
Exomars 2016



ESA Space Rider - Reusable Transport System

# CLEANSAT – ACTIVE DEORBIT

## Green Options as Hydrazine alternative



## CLEANSAT – DESIGN FOR DEMISE



Titanium tanks are the only confirmed re-entry debris [5].

Project started with a literature study to search for Al based tank materials

Material	Temp	Media				Test period	Ref	Source
	Fahrenheit - F	NTO [ 2 ]	MMH [ 4 ]	UDMH [ 3 ]	N <sub>2</sub> H <sub>4</sub> * [ 1 ]			
AL1100	N <sub>2</sub> H <sub>4</sub> : <75, 100, 165, 275 MMH: 275 NTO: <80, 40->110, 275	2-A	1-A		1-A	N <sub>2</sub> H <sub>4</sub> : 4 weeks@<100F, 48 weeks@165F, 64hrs&8hrs @AAT MMH:300hrs,600hrs,120days,1yr@275F NTO: 1 yr @60F, 2 months, 300 & 600 hrs @275F	[ 9 ] [ 10 ]	[ 18 ] [ 19 ] [ 21 ] [ 23 ]
AL2014	N <sub>2</sub> H <sub>4</sub> : <75, 100, 165, 275 MMH: 275 NTO: <80, 40->110, 275	2-A	1-A		1-A	N <sub>2</sub> H <sub>4</sub> : 4 weeks@<100F, 48 weeks@165F MMH: 6hrs, 24 weeks @275F NTO: 2months, 1 yr @60F; 21 months@AAT,1month@158F, 300 & 600 hrs @275F	[ 9 ]	[ 18 ] [ 19 ] [ 20 ] [ 21 ] [ 23 ]
AL2017					1-A		[ 9 ]	[ 25 ]
AL2021		3-A			2-A		[ 9 ]	[ 19 ] [ 20 ]
AL2024	N <sub>2</sub> H <sub>4</sub> :<75 MMH: 248	2-A	1-A		1-A	N <sub>2</sub> H <sub>4</sub> : - MMH:6hrs,24weeks@248F	[ 9 ]	[ 18 ] [ 19 ]
AL2219	NTO: 130 N <sub>2</sub> H <sub>4</sub> : 160, 298, 338 MMH: 275 NTO: <60,40->110, 275,AAT, 40*** UDMH: 40***	1-B 2-A	1-A	1-A 1-B	1-B 2-B	NTO: 21 months@AAT,1month@158, N <sub>2</sub> H <sub>4</sub> : 4days, 46days, 84days@160F (max compatibility 8yrs) MMH:300hrs,600hrs,120days,1yr@275F NTO: 45 days @ AAT, 1 yr @60F, 300 & 600 hrs @275F and 33days@40C UDMH: 33days@40C	[ 5 ] [ 6 ] [ 7 ] [ 9 ] [ 10 ] [ 11 ] [ 12 ]	[ 8 ] [ 14 ] [ 15 ] [ 16 ] [ 17 ] [ 18 ] [ 19 ] [ 20 ] [ 21 ]
AL3003	N <sub>2</sub> H <sub>4</sub> : <75 NTO: 130	1-A			1-A		[ 9 ]	[ 18 ] [ 19 ]
AL4043	NTO: <80				1-A		[ 9 ]	[ 19 ]
AL5052	N <sub>2</sub> H <sub>4</sub> : <75 NTO: 130	1-A			1-A		[ 9 ]	[ 18 ] [ 19 ]
AL5086	NTO: 130						[ 9 ]	[ 19 ]
AL5456	NTO: 40->110				1-A	NTO: 1 yr @60F	[ 9 ]	[ 19 ]
AL6061	N <sub>2</sub> H <sub>4</sub> : AAT, 120, 275 MMH : 275 NTO : 130, 40->110, AAT,60, 158,275	2-A	1-A		1-A / 3A	N <sub>2</sub> H <sub>4</sub> : 5 months@120F, 1mont@ AAT; 64hrs@275F, 8hrs @ AAT MMH: 300hrs, 600hrs,120days, 1 yr@275F NTO: 21 months@ AAT,1month@158, 1 yr @60F, 300 & 600 hrs @275F	[ 9 ] [ 11 ]	[ 22 ] [ 18 ] [ 19 ] [ 23 ] [ 24 ]
AL715					1-A		[ 9 ]	[ 18 ] [ 19 ]
AL7075	NTO: AAT, 60, 130, 40->110, 158	2-A				NTO: 21 months@ AAT,1month@158, 1 yr @60F	[ 9 ]	[ 19 ]
AL356-T6**	N <sub>2</sub> H <sub>4</sub> : <75 NTO: <100				2-A	NTO: 1 yr @60F	[ 9 ]	[ 18 ] [ 19 ] [ 22 ]





The new ArianeGroup DT-180 propellant membrane tank is fabricated from Al2219, a commonly used aluminium alloy that has excellent strength and toughness, making it suitable for use in a wide range of applications.

# Thanks for your attention

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