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Rated By A Clark

Low Cost / Demisable Tank Project

14th October 2022

DEFENCE AND SPACE

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TESMP4 – Propulsion Products & Tanks

AIRBUS

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Introduction

- Since 2018, Airbus DS has been running an fully internally funded demisable tank (for satellites) development program.
  - Managed by the Propulsion Products & Tanks Group (tank architect is Graeme Yorwarth), based in Stevenage (UK).
    - See appendices for more details on the team's heritage and capability.
  - TRL6 achieved successfully in October 2021.

- **Commercial Objectives:**
  - Fully European.
  - Minimise replacement effort for existing tanks.
  - Reduce cost compared to current market products.
  - Maximise number of applications.

- **Key Technical Objectives:**
  - Demisable.
  - Flexible in size and mission application.
  - Reliable and repeatable manufacturing processes.
  - Meet latest industry requirements (ECSS).

- **Industrial Approach:**
  - Work with various SME's (both existing & outside current supply chain / space industry).
  - Materials and processes to be as generic as possible.
  - Sub-contract of all manufacture & test activities.

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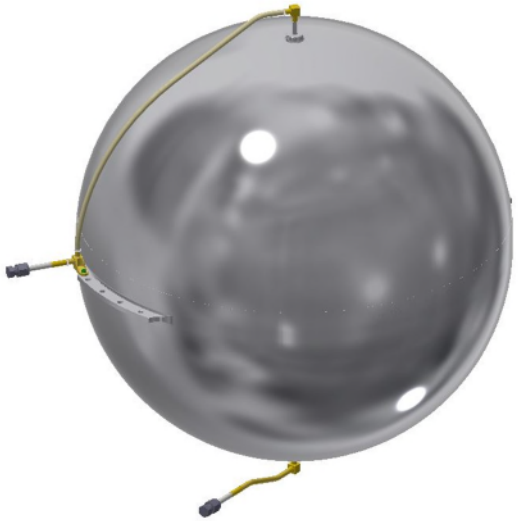
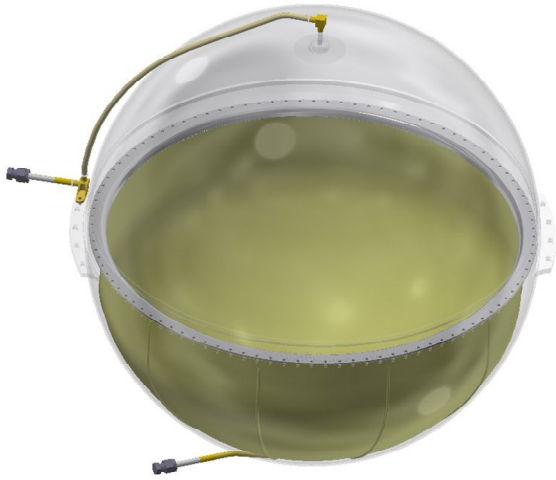
Demisable Tank Overview

Low Cost / Demisable Tank Data	
Material	Al6082 or Al 2219 (preferred)
Usable Volume	60L nominal but scalable
Interface	Equatorial (but polar / skirt possible)
Weight	6kg
Height	607mm
Diameter	521 mm
MEOP	24bar (proof 1.5, burst 2)
Diaphragm	Silicon Free





LOW COST

Existing Platform Applications

DEMISABILITY

Hydrazine Main System

Hydrazine Auxiliary System

Cold Gas System

Traditional Hydrazine Chemical System

Future Propulsion Systems (i.e. water)

07 September 2022

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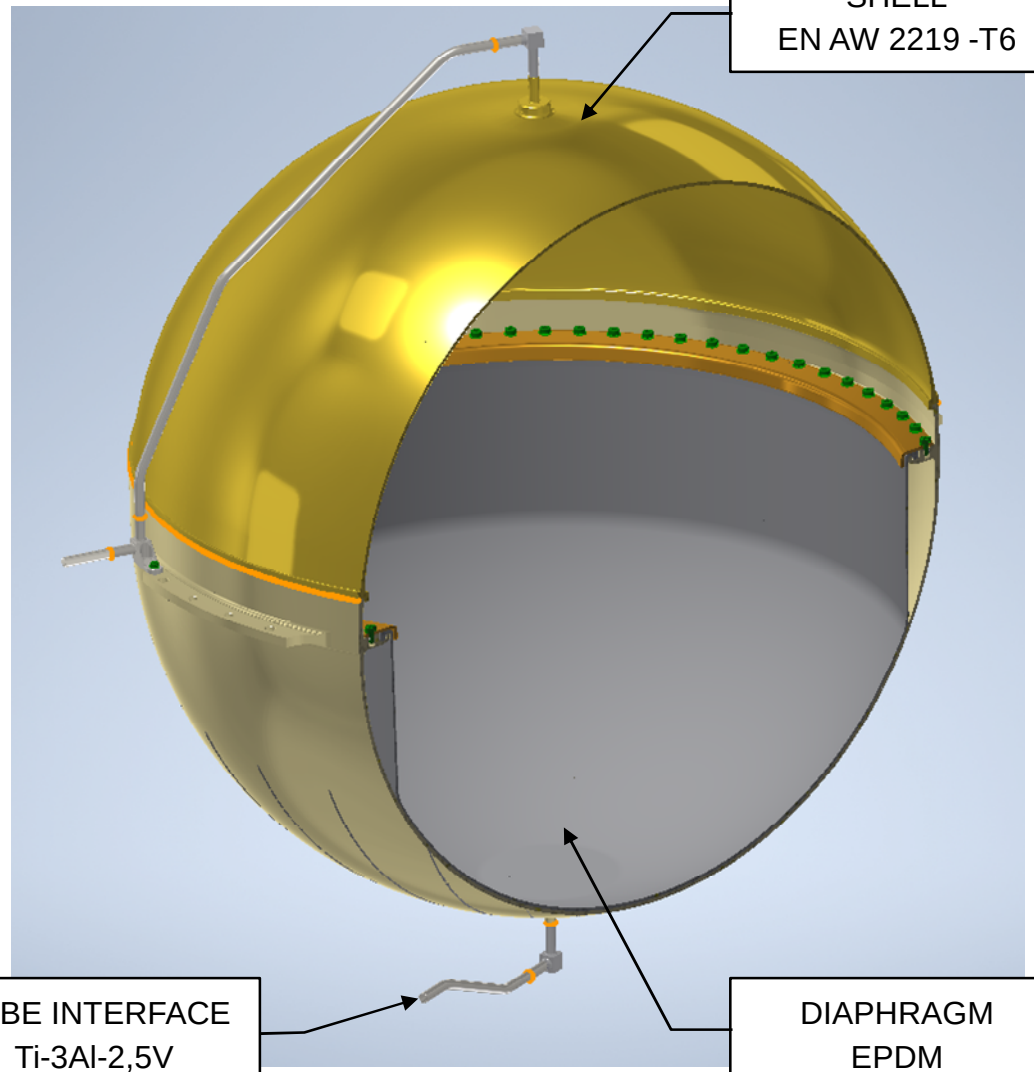
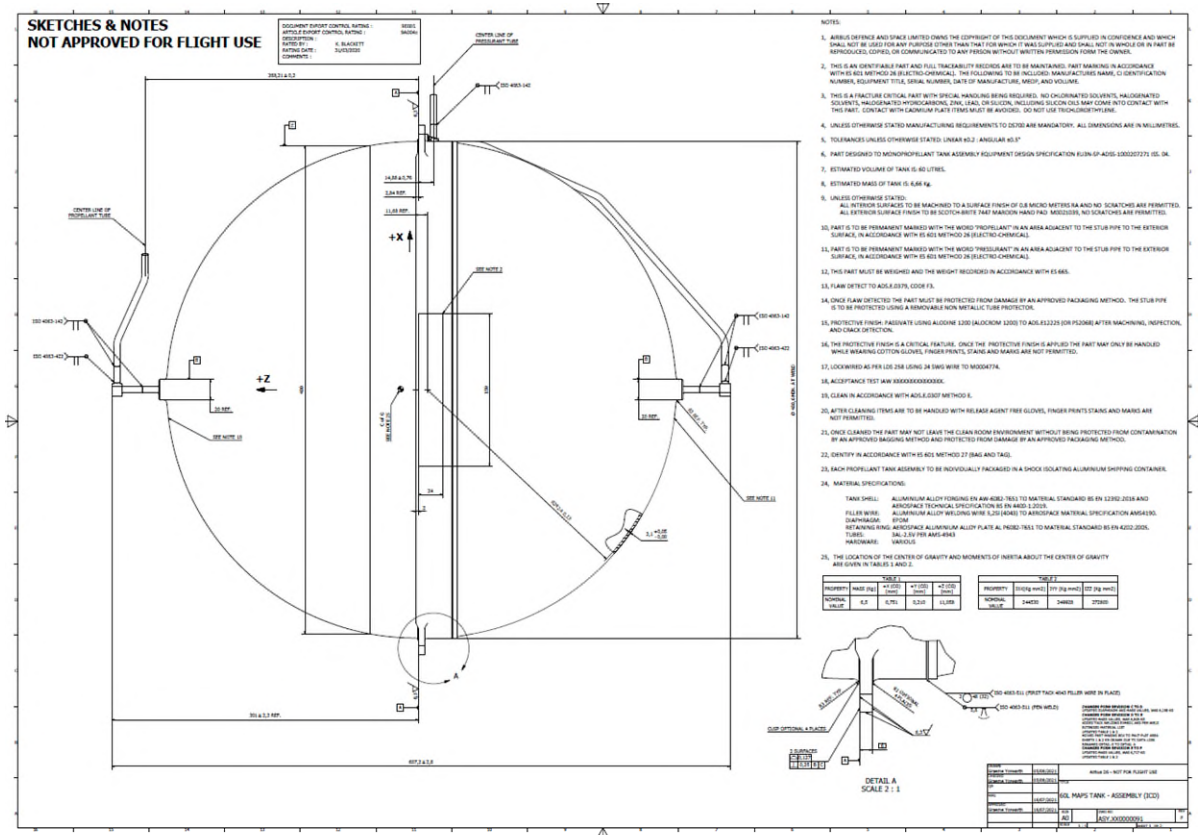
Design Overview



- Fully Demisable,
- Economical, scalable with minimum delta qualification.
- Identical Interfaces to existing products.



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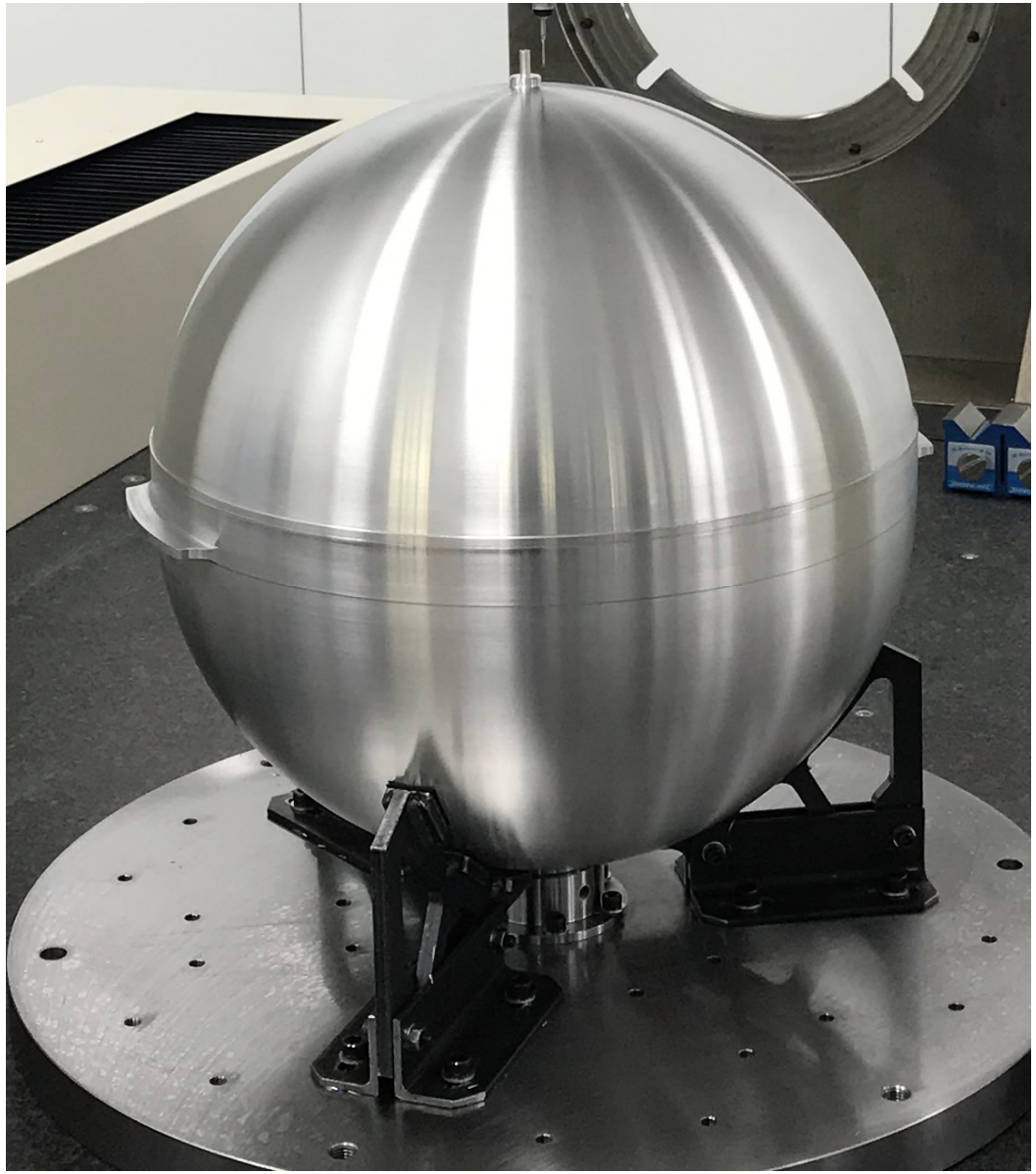
Development Model



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Principal Standards Compliance

- Airbus have 40+ years heritage in designing metallic pressure vessels successfully to these standards.
  - Demisability standards to be kept under review, especially as they mature (not available at project launch).

Design:

- Pressurised Hardware.
  - ECSS-E-ST-32-02C Rev.1
    - Under revision, Airbus on review committee.
  - AIAA-S-080A (complementary).
  - Airbus technical requirements
- Propulsion.
  - ECSS-E-ST-35C Rev.1.
- Demisability.
  - ESA cleanspace recommendations.
  - ESA-TECSYE-TN-018311.

Safety

- Fracture Control.
  - ECSS-E-ST-32-01C Rev.2
    - Airbus on review committee.
- Range Safety.
  - AFSPCMAN 91-710 VOL 3
  - CSG-NT-SBU-16687-CNES
  - JMR-002B
- Plus internal Airbus requirements and best practices.

Process

- Cleanliness.
  - ECSS-E-ST-35-06C.
- Materials & Process.
  - ECSS-Q-ST-70C Rev.1
- Quality.
  - ECSS-Q-ST-20C Rev.2.
  - Plus internal Airbus requirements and best practices.

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Main Technical Requirements

Requirement	Value	Origin
Hydrazine Compatible and Silica Free	EPDM	Internal Requirement
Mission Lifetime	16 years	Internal Requirement
Average Operating Temperature	40C	Internal Requirement
Daily Temp Cycling	50C to 55C	Internal Requirement
Qualification Temp Range	+2C to 60C	Internal Requirement
Storage Temp Range	-20C to 65C	Internal Requirement
External Leak Rate	1x10E-06 scc/sec	Internal Requirement
Internal Leak Rate (Diaphragm)	2.2x10E-02 scc/sec	Internal Requirement
Diaphragm Tensile Strength	> 10 MPa	MIL-R83412A
Diaphragm Elongation	> 210%	MIL-R83412A
Diaphragm Tear Strength	> 15kN/m	MIL-R83412A
Diaphragm Swell	~3%	MIL-R83412A

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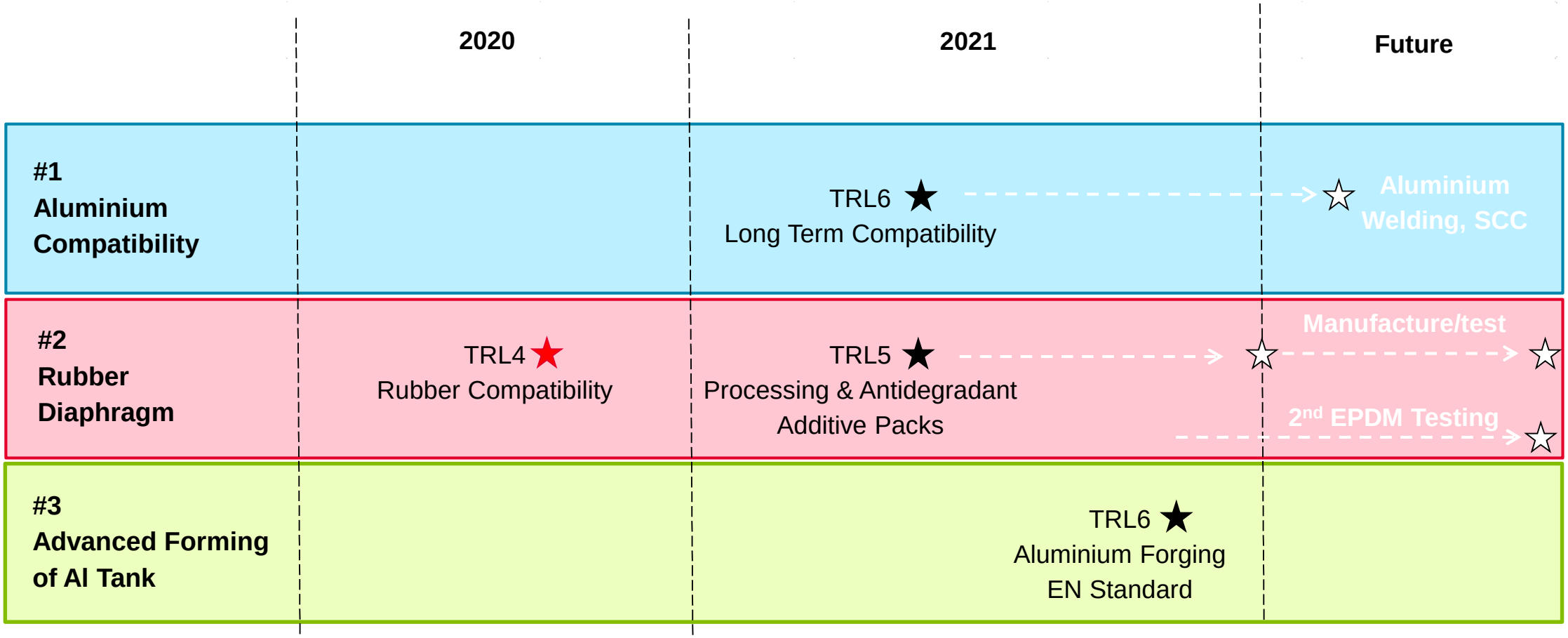
TRL6 Key Objectives Demonstrated



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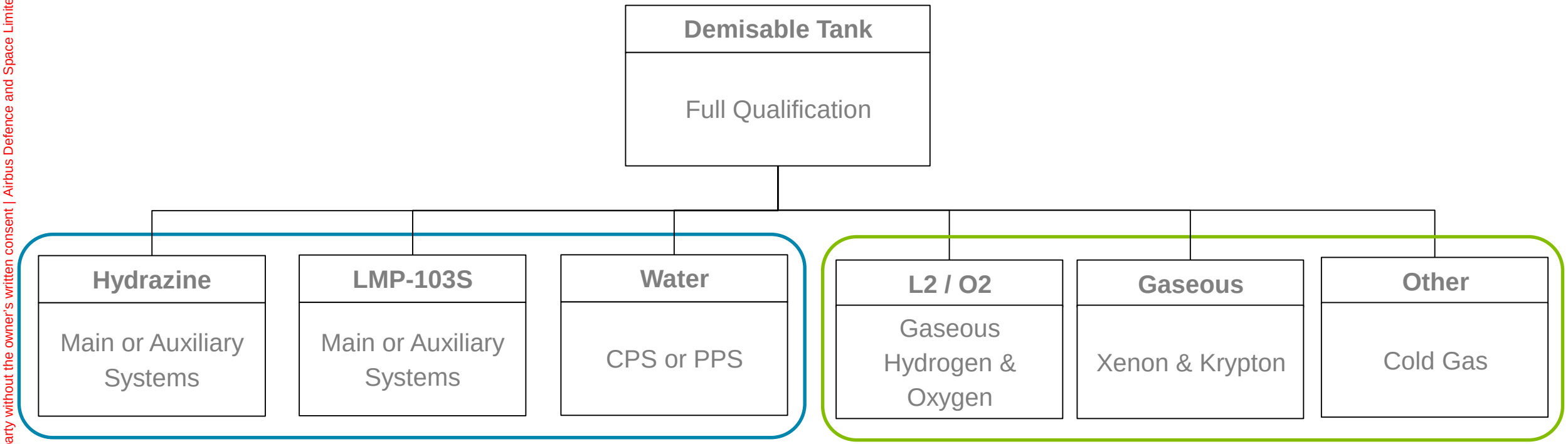
Tank Family & Applications



*With diaphragm material testing
+ SCC* testing
SCC = Stress Corrosion Cracking

*A simple PMD can be used as an alternative to a diaphragm

Chemical propulsion systems with diaphragm

Sizes other than that originally can be delta qualified with a minimal effort vs. a repeat full qualification.

Without diaphragm:

- **Hybrid chemical / electric.**
- **Very small electric (replace COPV).**
- **Very small cold gas (replace COPV).**

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Advantages

Technical

- Demisable shell material.
- Design can be scaled to different sizes with a minimum of delta qualification activities.
  - By diameter, so keeping spherical shape.
  - By height, so transforming to an allantoidal shape.
  - By diameter and height to approximately 300L
- For sizes < 20 litres and MEOP < 100 bar tank is a viable alternative to a COPV (mass wise).
- Qualification parameters to encompass all current and known future requirements
- A sponge or vane(s) for low flow rates can be inserted in place of the diaphragm if required.
- Compliance to ECSS standards.

Programmatic

- European only content and technology.
- Use of SME's for all manufacture & test activities.
  - Airbus acts only as final tank design authority.
    - Same strategy as for all our current tanks.
  - We are a successful heritage tank design authority (40+ years) and have flown on many ESA missions.
  - EPDM diaphragm proprietary to ADS – so ADS can licence multiple manufacturers if required.

  Note: suppliers, manufacturing and test house(s) to be selected.
- Use of Aluminium ensure supply chain robustness.
  - Much shorter lead-time vs. Titanium tank.
- Design authority fully under Airbus DS control, so no proprietary or commercial issues.

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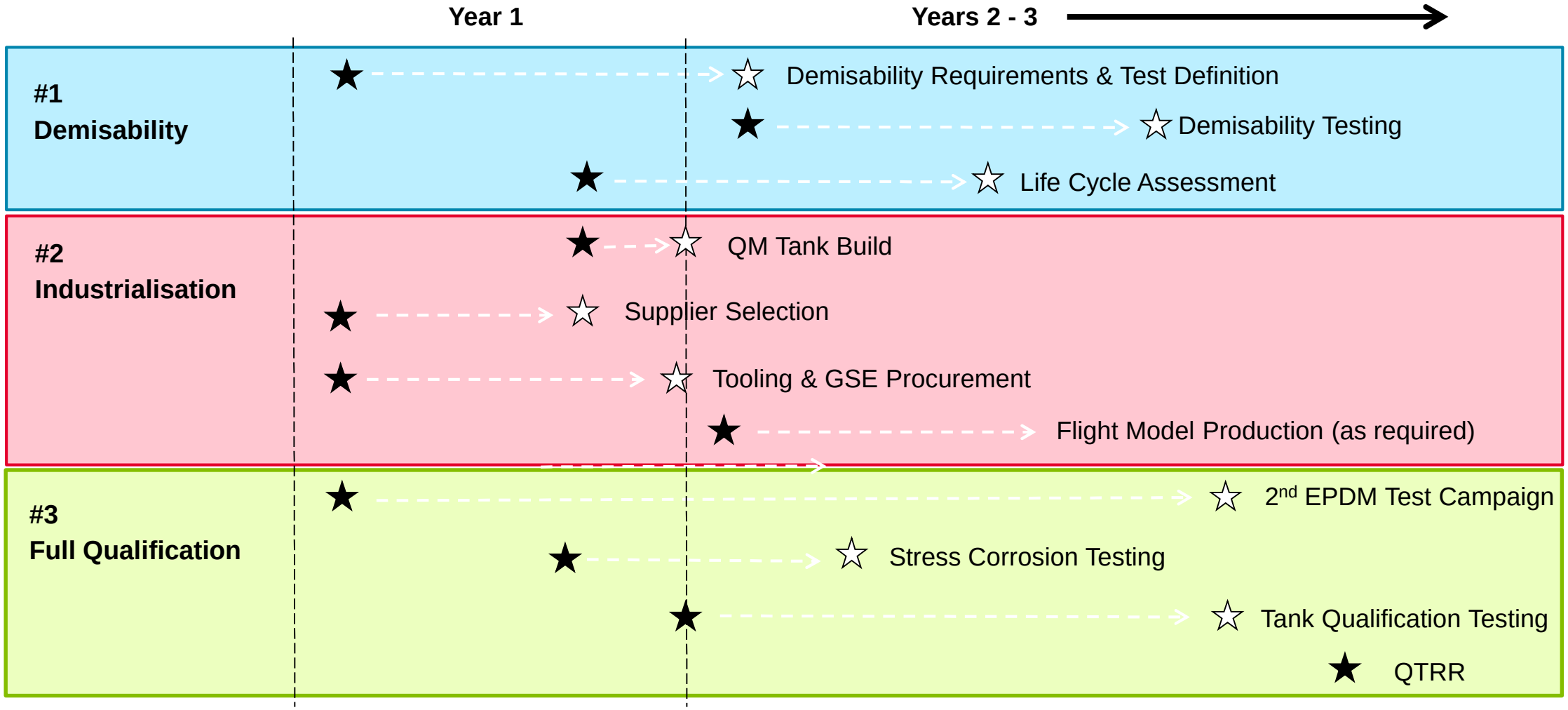
Development Logic Beyond TRL6



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Status

- **Currently Project Status:**
  - Full development plan to achieve TRL9 available.
  - Programmatic interest for such a tank.
    - Reduces reliance on Titanium raw materials along with lead-time reductions due to switching to Aluminium.
  - Flight models can be available within two to three years of project re-start (based on appropriate risk assessment).
    - Subject to final supply manufacturing / test chain validation and setup.
  - Risks for full qualification are considered low, the two main (new) aspects to demonstrate are:
    - Demonstrate demisability to the required level of robustness based on the latest industry data / findings.
    - Confirm suitability of EPDM diaphragm – this is the critical path item.

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APPENDICES

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TESMP4 – Propulsion Products & Tanks

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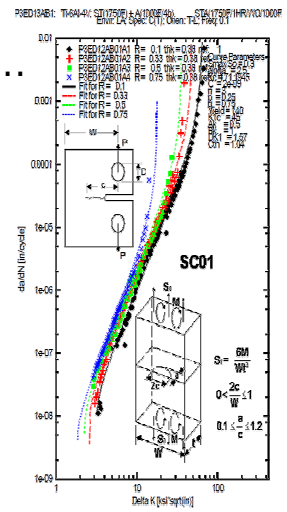
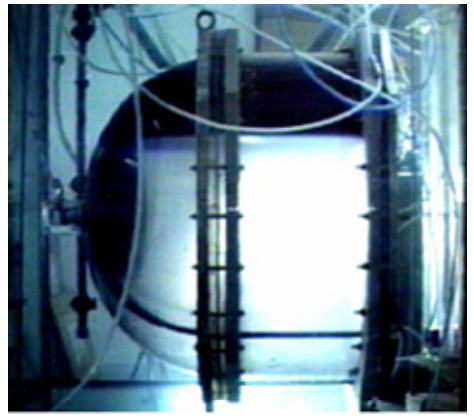
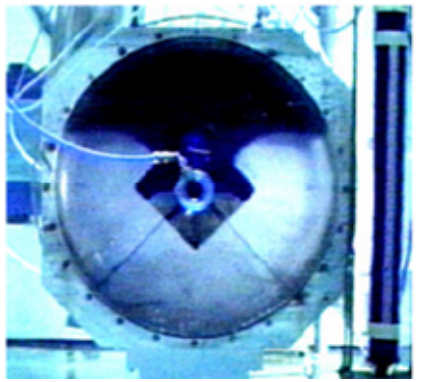
What is the ADS Propulsion Products & Tanks Group?

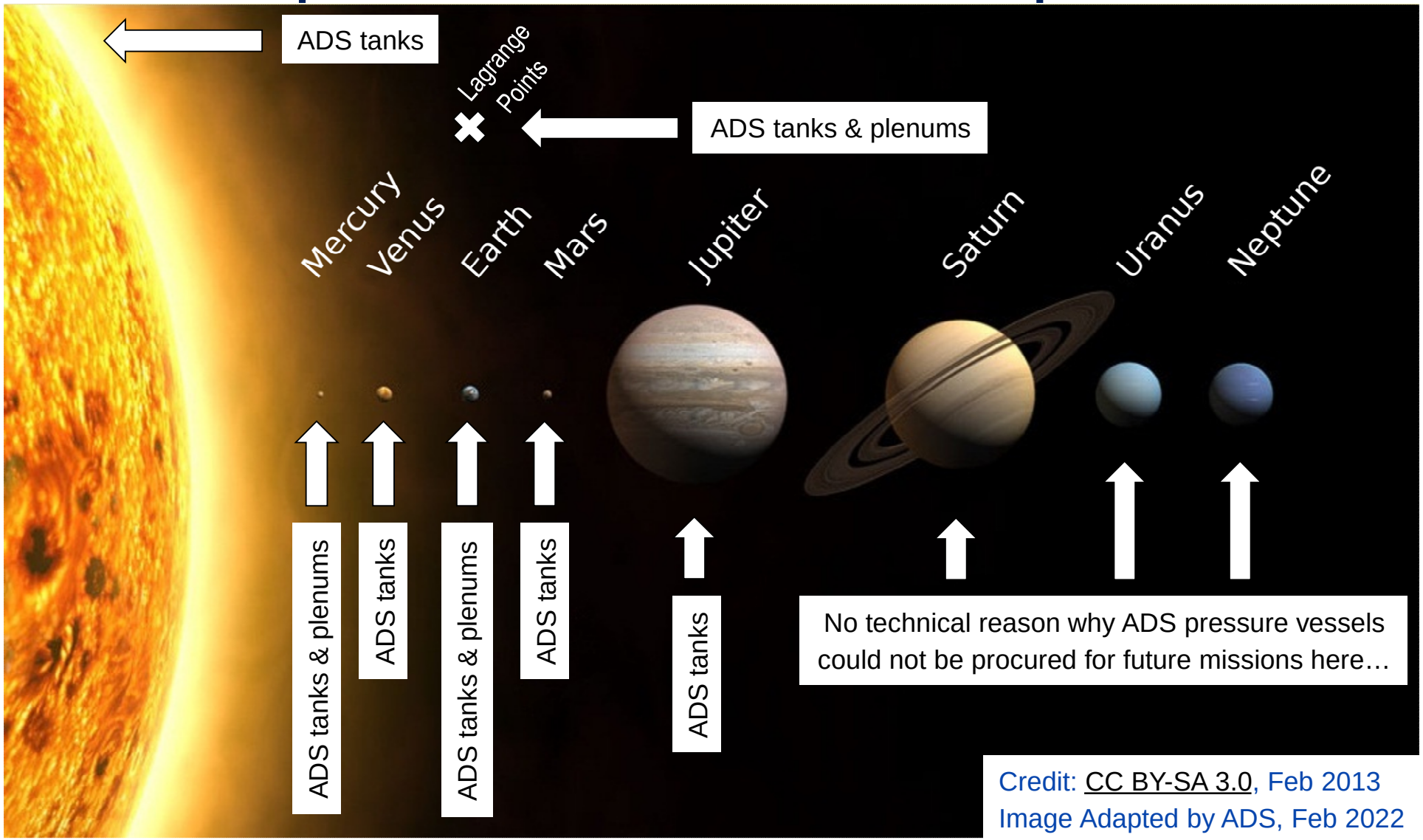
- Full Design Authority of (i.e. supplier of) Type I (Metallic) Pressure Vessels (Tanks & Plenums) [est. 1983]
  - Fully responsible for assuring that delivered pressure vessels are safe for use
  - Work with spacecraft architects to assure that delivered pressure vessels are appropriate for use
  - Working knowledge of US & European pressure vessel requirements for space applications (AIAA, ECSS, range safety, …)
  - Mechanical analysis (dynamics (inc. vibroacoustics), stress, fracture, &c.)
  - Functional analysis (sloshing, propellant management, &c.)
  - Functional testing (using our world-leading dedicated Neutral Buoyancy Test Bench)
  - Materials and processes test support (titanium, stainless steel, aluminium)
  - Pressure vessel drawings sign-off, manufacturing support & test support
  - Subcontracted manufacturing chains allow flexibility between America, Europe, …
  - In-flight propellant management support
  - >300 flight-standard pressure vessels (see overleaf)
    - Telecommunications, navigation, science, …
    - ~1→1630L volumes; 3→23bar max. operating pressures







What is the ADS Propulsion Products & Tanks Group?



Credit: CC BY-SA 3.0, Feb 2013
Image Adapted by ADS, Feb 2022

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