

New ECSS standard wrt high pressure vessels:  
what impact for industry and what recovery plan

**IAASS COPV Safety and integrity  
workshop  
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All the space you need



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## Introduction

- The new ECSS E32-02 standard will address to impact damage control in a near future
- As safety is a major concern, Industry fully agree with these new requirements
- Concerning the COPVs which are already off the shelve, no data exist to demonstrate the compliance against the new requirements of impact damage control.



a mitigation plan is needed

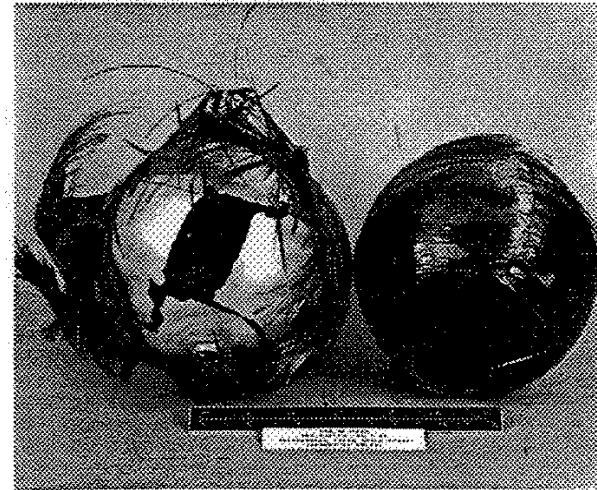
## Standards overview

- Up to now design and justification of COPVs were based on MIL-1522 dated 1972 updated in 1984 (MIL-1522A)
- No requirements about impact damage of the composite overwrap
- In 2006, AIAA S081 has been issued to take into account these aspects
- Same for ISO14623
- In 2008, ECSS E32-02 included a chapter 5.4 « damage control » at draft issue

## Standards overview (continued)

- To prepare US industry to comply with new standards, a joint research and technology effort among USAF, NASA and Aerospace Corporation was undertaken end of nineties.
- More than 100 COPVs have been tested; US manufacturers have an important data base about the behaviour of their own COPVs
- Despite of that, due to cost implementation, US COPV industry would still refer to USAF letter

Small Sphere Post-Impact Burst

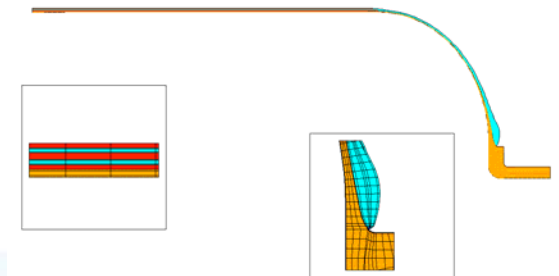


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# Review of the ASTRIUM space transportation COPVs

- ASTRIUM ST is involved in COPVs since 1982
- Up to now 800 COPVs have been produced
- More than 100 spacecrafts rely successfully on these COPVs
- Optimised design performed with FE models wrt internal pressure and environmental loads
- Safe life demonstrated by using Esacrack model
- ASTRIUM COPVs are not designed wrt impact damage tolerance as no numerical model exists

➡ Lack of justification to be covered by a test plan



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# Review of the ASTRIUM space transportation COPVs (continued)



70L xenon COPV  
Developed in 1998  
Carbon T800/Ti lined  
MEOP: 19MPa  
Safety factor: 1,5  
Designed safe life, LBB



89,5L Helium or Nitrogen COPV  
Qualified in 2004  
Carbon T800/Ti lined  
MEOP: 31MPa  
Safety factor: 1,5  
Designed safe life, LBB

Off the shelf COPVs

# A needed mitigation plan

- Risk assessment on manufacturer side:

- Non compliance with new standard requirement could lead to **rejection** of the product

⇒ product line endangered  
lost of competencies

- Risk assessment on prime satellite side

- european ITAR free products no more available

- To prevent such serious situation, Europe shall do the same effort than US

⇒ A mitigation plan is needed

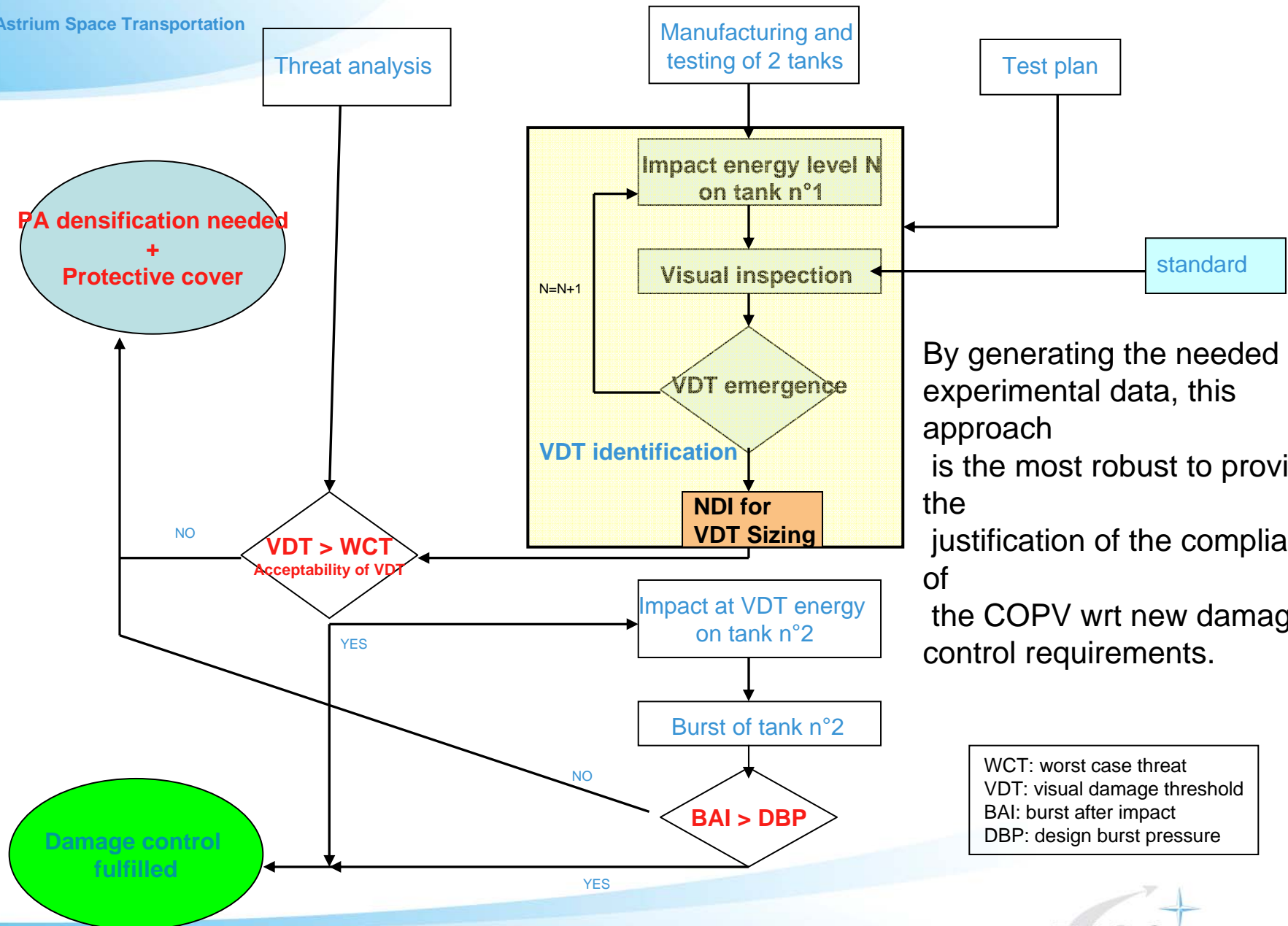
- To be funded by agencies as no ROI is possible (the european market is too weak)

# A needed mitigation plan ( continued)

- priority given to the characterisation of off the shelf COPVs based on a robust test approach
- secure futur COPVs by improving protective covers, indicators, NDI, and numerical models
- impact damage phenomenology:
  - because the impact damage depends on geometry, stiffness, damping of the overall structure, therefore:
  - different composite overwrap and different liner will lead to different behaviour of the composite shell,
  - identical composite overwraps will have different behaviour if impacted at full scale, sub-scale or coupon levels.

⇒ A robust justification must rely on tests at **full scale level**

- The main idea is to demonstrate that the margins are still kept when the VDT occurs.



By generating the needed experimental data, this approach is the most robust to provide the justification of the compliance of the COPV wrt new damage control requirements.

WCT: worst case threat  
 VDT: visual damage threshold  
 BAI: burst after impact  
 DBP: design burst pressure

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# Conclusions

- Safety is a key issue in particular for high pressure tanks. New standard ECSS 32-02 dedicated to this type of hardware will provide in a near future an answer through the new damage control requirements.
- Industry as well manufacturers and users fully agree to take into account these new requirements in the frame of future projects.
- For the off the shelf products, the mitigation plan which is proposed here should allow to reach this damage control objective through a robust approach,
- It will provide a consolidated data base that will allow to secure the development of the new hardware.