Assessment of Design for Demise Approaches for Reaction Wheels

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Agenda

- Program Description
- Modification Options
- Demisability test results
- Simulation results (work ongoing)
Program Overview

- The program is funded by ESA in the frame of a TRP contract.

- The object of this study is to further investigate the break-up processes of a reaction wheel during re-entry, with the ultimate goal of having a fully demisable reaction wheel at the release altitude of 78km.

- The ball bearing unit (BBU) was already identified as a key element (demising late) during the demise process in previous studies.

- Potential design changes are analyzed with regards to the optimization of demisability.

- With the BBU being the key piece of technology in a reaction wheel, any design changes are carefully considered against heritage requirements.
Modification Options

- Baseline wheels (from study:
- RSI 68 with steel rotating mass and RCD ball-bearing unit (BBU)
- RSI 68 (Al) with rotating mass made from Aluminum

Options to improve demisability of BBU
- Modify BBU threaded rings to trigger break-up earlier
- Glued connections to trigger break-up at lower temperature
- Further Ideas
Baseline (RSI 68 Nms - Stainless steel)

- Input conditions extracted along the CleanSat reference trajectory
  - Total of 225 cases in an altitude range between 58 and 98 km
    - 25 attitude variation cases for each main release altitudes (60, 69, 78, 87, 96)
    - 10 attitude variation cases at +/- 2 km from the each main release altitude
Baseline (RSI 68 Nms - Stainless steel)
Comparison between Baseline and Al68 (RSI 68 Nms)
Surviving parts from Baseline model
BBU - Release triggers

- Added temperature dependent release triggers inside the BBU to assist in its break-up.
- Triggers added at:
  - Threaded ring (at 900K releasing the shaft)
  - Rotor (at 490 K releasing the rotor rings)
BBU - Release triggers

Real-time Animation
[flight direction to the right; view from zenith to nadir]
BBU - Release triggers

Slow-Motion Animation
[flight direction to the right; view from zenith to nadir]

„Assessment of Design for Demise Approaches for Reaction Wheels“
ESA Contract No. 4000122741
Comparison of most-probable casualty area
Conclusion and Status as per October 2018

Simulation results show:

- **RSI 68 (Al)** (Aluminum rotating mass with no further modifications)
  - is demisable at and above release height of 87 km in 2/3 of the cases.
- **RSI 68 (Steel rotating mass, with minor modifications of BBU)**
  - is demisable at and above release height of 87 km

Next steps to further decrease the demise altitude

- Simulation with smaller, but faster spinning wheel type: RSI 45 (Al)
- Use of thermite to increase the thermal energy within the BBU
- Combination of various modifications

The demise altitude has already been lowered to 87km and more options are available to improve the Demisability even further.
Rockwell Collins Germany Existing Productline

- Rockwell Collins Space qualified Aluminum rotating masses:

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