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Methodology and Results of High Enthalpy Wind Tunnel and Static Demisability Tests for Existing Spacecraft Structural Joining Technologies

Mark Fittock[a]*, James Beck[b], Alan Flinton[c], Alison Gibbings[d], Ali Gülhan[e], Volker Liedtke[f], Tobias Lips[g], James Merrifield[h], Jan-Christian Meyer[i], Gerrit Proffe[j], Martin Sauerbrey[k], Thorn Schleutker[l], Tiago Soares[m]

[a] *Predevelopment, Space System Studies & Proposals, OHB System AG, Universitätsallee 27, Bremen, Germany 28359*, mark.fittock@ohb.de
[b] *Belstead Research Limited, 387 Sandyhurst Lane, Ashford, TN25 4PF, UK*, james.beck@belstead.com
[c] *Fluid Gravity Engineering Ltd, The Old Coach House, 1 West Street, Emsworth, Hants, PO10 7DX, UK,* alan.flinton@fluidgravity.co.uk
[d] *Predevelopment, Space System Studies & Proposals, OHB System AG, Universitätsallee 27, Bremen, Germany 28359*, alison.gibbings@ohb.de
[e] *Supersonic and Hypersonic Technology Department, German Aerospace Center DLR, Cologne, Germany*, ali.guelhan @dlr.de
[f] *Aerospace & Advanced Composites GmbH, Viktor-Kaplan-Straße 2, building F, 2700 Wiener Neustadt, Austria,* volker.liedtke@aac-research.at
[g] *HTG – Hyperschall Technologie Göttingen GmbH, Am Handweisergraben 13, Bovenden, Germany 37120,* t.lips@htg-gmbh.com
[h] *Fluid Gravity Engineering Ltd, The Old Coach House, 1 West Street, Emsworth, Hants, PO10 7DX, UK,* jim.merrifield@fluidgravity.co.uk
[i] *Space Engineering, UNSW Canberra, Northcott Drive, Canberra, ACT, Australia 2600*, jan-christian.meyer@unsw.edu.au
[j] *Formerly of Predevelopment, Space System Studies & Proposals, OHB System AG, Universitätsallee 27, Bremen, Germany 28359*, gerrit.proffe@outlook.com
[k] *INVENT GmbH, Christian-Pommer-Straße 34, Braunschweig, Germany 38112*, martin.sauerbrey@invent-gmbh.de
[l] *Supersonic and Hypersonic Technology Department, German Aerospace Center DLR, Cologne, Germany*, thorn.schleutker@dlr.de
[m] *Space Systems and Concurrent Engineering, European Space Agency ESTEC, Keplerlaan 1, Noordwijk, State, The Netherlands NL-2200 AG*, tiago.soares@esa.int

* Corresponding Author

Abstract

The recently introduced discipline of design-for-demise (D4D) is looking for technical solutions on different levels to promote the atmospheric demise of spacecraft and respective components in order to reduce the casualty risk on ground. Previously performed studies revealed that opening the outer satellite structure during re-entry as early as possible helps to improve the overall demise. Therefore, technologies to open and/or release external structural elements and spacecraft modules are needed. In order to get a better understanding of the behavior during re-entry of current structural joining technologies, tests have been performed in high enthalpy wind tunnel and static heat chambers. These were setup to be representative of a number of joining configurations utilized within satellite designs. Samples representing a broad range of options were prepared and tested in both chambers. An overview of test procedures and findings are presented here along with early conclusions and future activities. The samples exhibited a broad range of phenomena and it was seen that a number of different failure scenarios are possible dependent upon joining technology used along with heat flux profile and mechanical loads applied, among other influencing factors. The results from these tests will feed into the development of new demisable joining technologies for bread-boarding development and assist in designing similar tests in the near-future. These on-ground activities will help to raise the current understanding of satellite demise and the role that joining technologies play, therefore leading to more informed decisions regarding the ways to increase satellites' break-up altitude in the future reducing the on-ground casualty risk.

Keywords: Design, Demise, Joining, Re-entry, Break-up, Testing