Satellite Breakups

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Publication 62530, *History of On-Orbit Satellite Fragmentations, 13th edition*). The Tsyklon third stages, with a dry mass of about 1360 kg, used hypergolic propellants, namely nitrogen tetroxide and unsymmetrical dimethylhydrazine. A mixture or over-pressurization of these propellants could lead to a tank rupture.

On 10 June, a 17-year-old ullage motor from a Russian Proton launch vehicle broke-up in an elliptical orbit of 655 km by 18,410 km with an inclination of 65.1°. This is the 34th identified breakup of a motor of this type, which also employs hypergolic propellants. More than 70 debris were detected after the event, but due to the nature of the eccentric orbit the official cataloging process will take time. This ullage motor was flown before Russian officials were aware of the breakup potential of the component and could implement mitigation measures.

A much less severe debris-generating event apparently occurred on 14 February 2006, when a single fragment separated from the fifth oldest man-made object in Earth orbit, the Vanguard 3 spacecraft (International Designator 1959-007A, U.S. Satellite Number 20). Unlike Vanguards 1 and 2, which are also still in orbit about the Earth, Vanguard 3 remains attached to the small third stage of its launch vehicle. The combined mass of the spacecraft and stage is only 45 kg. The new piece of debris was cataloged in April 2006 (International Designator 1959-007B, U.S. Satellite Number 29005) in an orbit very similar to that of Vanguard 3, *i.e.*, approximately 500 km by 3300 km with an inclination of 33.4°. The principal candidate causes for the release are (1) deterioration of the surface materials of Vanguard 3 or its orbital stage and (2) impact of the assembly by a very small meteoroid or orbital debris. ♦

ISS Large Area Debris Collector (LAD-C) Update

The Preliminary Design Review (PDR) for LAD-C was held in Houston, Texas on 31 May 2006. The U.S. Department of Defense Space Test Program (DoD STP) organized and hosted the PDR. Participants included LAD-C team members from the U.S. Naval Research Laboratory (NRL), STP, and the NASA Orbital Debris Program Office, as well as engineers supporting International Space Station (ISS) and Extra Vehicular Activity (EVA) Offices.

A total of 10 presentations were given during the PDR. They covered project, science, and instrument overview, mechanical design, material control, electronic design, software flow and data acquisition, thermal control, test plans, and EVA issues. At the conclusion of this successful PDR, issues and action items were summarized, and assigned to various members for follow-up in regular biweekly teleconferences.

LAD-C will benefit orbital debris, cosmic dust, and satellite safety communities. Major contributing organizational members of LAD-C and their responsibilities are: NRL (lead, management, acoustics, engineering), NASA Orbital Debris Program Office (science planning and operations), JAXA/ISAS and Chiba University (aerogel, calibration), ESA Space Debris Office (system software, calibration), UC Berkeley (calibration), University of Kent at Canterbury (calibration). The DoD STP office is in charge of flight preparations, including system integration and safety. The responsibility of post-flight analysis and modeling will be shared by all team members. The current schedule for LAD-C is: Safety Review on 16 August 2006, Critical Design Review (CDR) in November 2006, and system delivery in September 2007. The deployment is tentatively scheduled for 2008, with retrieval in 2009. ♦

PROJECT REVIEWS

STS-114 Micrometeoroid/Orbital Debris (MMOD) Post-Flight Assessment

J. HYDE, R. BERNHARD, & E. CHRISTIANSEN

NASA Johnson Space Center (JSC) personnel assisted Kennedy Space Center (KSC) inspection teams in the identification of 41 micrometeoroid/orbital debris (MMOD) impact sites on the OV-103 vehicle (Discovery) during STS-114 post-flight inspections. There were 14 MMOD impacts reported on the crew module windows (Figure 1). The largest impact feature, a 6.6 mm x 5.8 mm crater on window #4, was caused by a particle with an estimated diameter of 0.22 mm (Figure 2). This impact was among the largest ever recorded on a crew module window. The window was removed and replaced. Scanning Electron Microscope/Energy Dispersive X-ray (SEM/EDX) analysis of dental mold samples from the impact site to determine particle origin was inconclusive, possibly due to contamination picked up on

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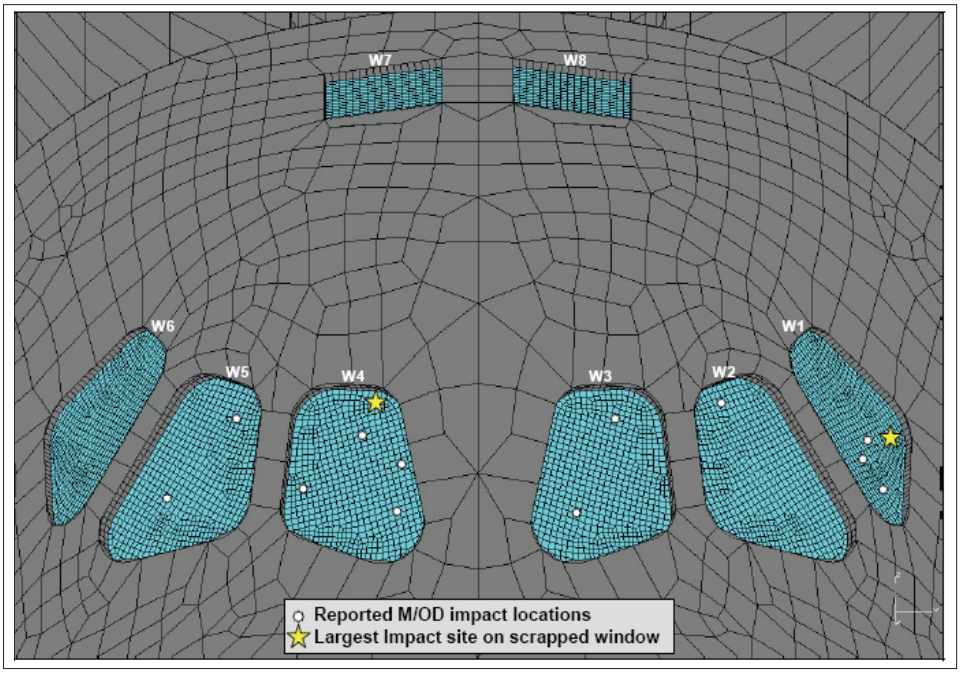

Figure 1. STS-114 crew module window impact map.

STS-114

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the ferry flight from Edwards Air Force Base to KSC.

The radiators on the inside of the payload bay doors sustained 19 impacts (Figure 3) with one of the impacts causing a face sheet perforation. The 0.61 mm diameter hole was produced by a particle with an estimated diameter of 0.4 mm, which approaches the 0.5-mm critical particle diameter of the wing leading edge reinforced carbon-carbon (RCC) panel high-temperature regions (Zone 3, Figure 4) that was established during Return to Flight testing of the RCC panels.

An inspection of the payload bay door exterior insulation (FRSI) revealed a 5.8 mm x 4.5 mm defect that was caused by an MMOD particle with unknown composition, as the sample obtained was contaminated.

Figure 5 provides a summary of the exterior surface survey that was conducted following the STS-114 mission. Two windows were removed and replaced due to hypervelocity impact. Nineteen impacts were recorded on the payload bay door radiators, with one face sheet penetration. Three impact sites were identified on the FRSI. There were four hypervelocity impact sites detected on the wing leading edge RCC panels. One impact was detected on the top cover of the TPS sample box (TSB) payload that was mounted on a carrier in the aft portion of the payload bay. ♦

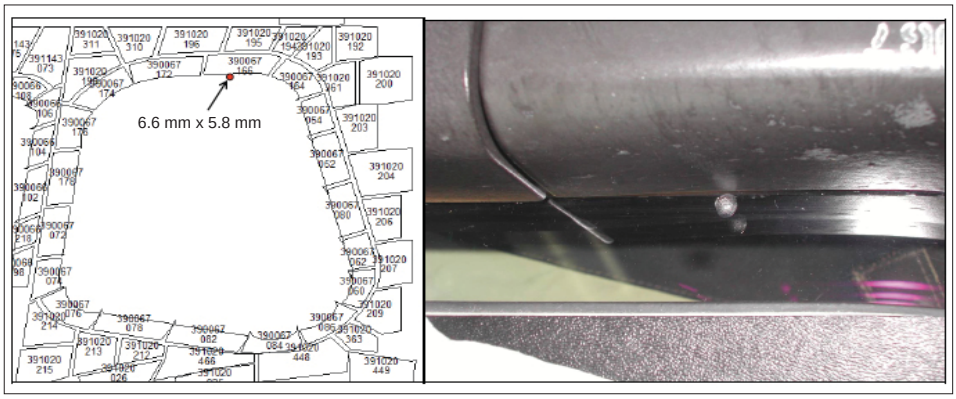

Figure 2. Hypervelocity impact on window #4.

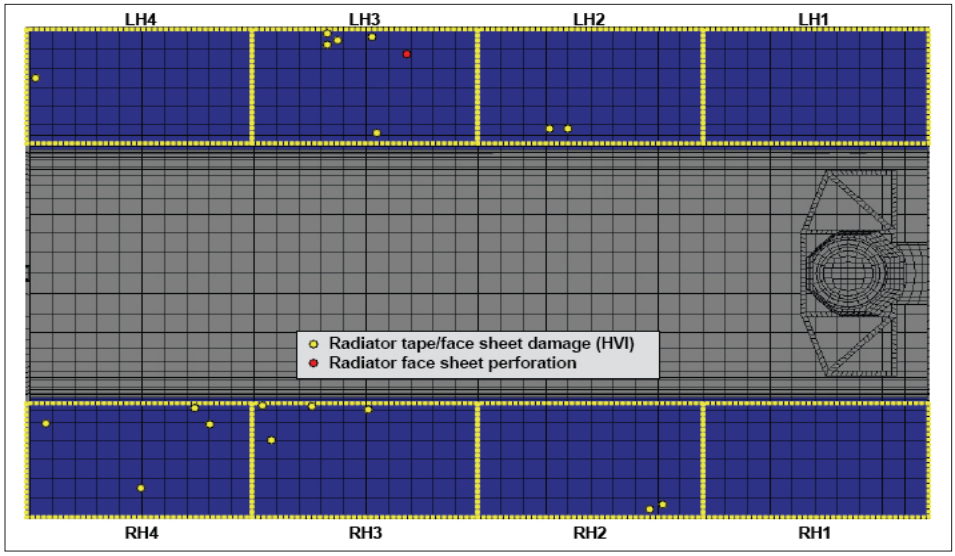

Figure 3. STS-114 payload bay door radiator impact map.

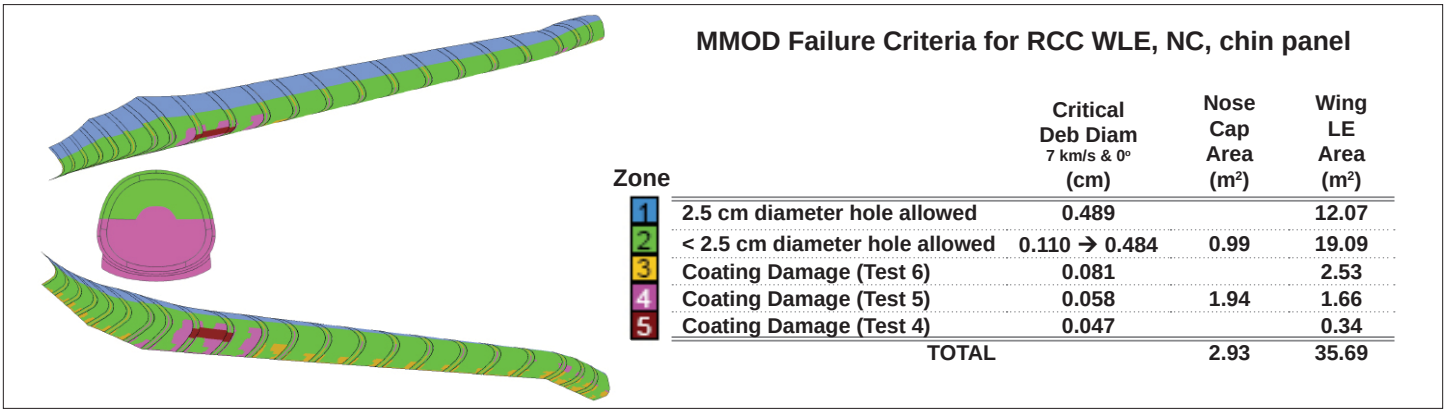

Figure 4. RCC failure criteria and critical particle size.

Region	Debris	Meteoroid	Unknown	TOTAL	Max. Diameter (mm) Crater	Projectile
Windows	0	1	13	14	6.6	0.2
Radiators	2	2	15	19	3.2	0.5
FRSI	1	0	2	3	5.8	1.3
RCC	0	0	4	4	1.8	0.2
TSB cover	1	0	0	1	0.5	0.1
	4	3	34	41		

Figure 5. STS-114 impact damage summary.