Assessing the Survivability of Satellites during Reentry

Nicholas L. Johnson, *Johnson Space Center*

Out of the more than 29,000 human-made objects cataloged in Earth's orbit since the launch of Sputnik 1 in 1957, approximately 18,000 have fallen back to Earth in an uncontrolled manner. Whereas the majority of these objects completely burn up during reentry and most of the surviving debris falls into the oceans, some potentially hazardous debris does impact Earth in a manner that might pose a risk of human casualty. As an example, in January 2005, a 50-kg (110-lb.) casing of a solid rocket motor landed near Bangkok, Thailand.

NASA Safety Standard 1740.14 requires that each NASA reentering spacecraft and launch vehicle orbital stage be assessed for debris that might survive reentry and pose a human casualty risk anywhere in the world. The high-fidelity Object Reentry Survival Analysis Tool (ORSAT) is employed by the Orbital Debris Program Office to evaluate these risks. Various versions of this state-of-the-art code have been used during the past 10 years to perform over 20 different satellite reentry analyses. In 2006, ORSAT 6.0 – a major upgrade of ORSAT – was completed and accepted for use in all NASA space programs.

The ORSAT model uses integrated trajectory, atmospheric, aerodynamic, aerothermodynamic, and thermal/ablation models to perform a complete component analysis of the reentering object to determine survivability and subsequent human casualty risk. New features of the code include: improvements of the trajectory and the gravitational models; incorporation of additional atmospheric models; two-dimensional heating rate and temperature variation around spheres, cylinders, cones, and flat plates; drag coefficients for cones; and general program improvements. Additional new capabilities include gas cap radiation effects at very high entry velocities, recession for nonmetallic insulation materials, calculation of structural failure of solar array hinges, tank bursting, an expanded materials property database, and trajectory mapping on a world map.

Solid rocket motor casing found near Bangkok in January 2005.