

The Failure of a Small Satellite and the Loss of a Space Science Mission

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Abstract

On March 4, 1999, the Wide-Field Infrared Explorer (WIRE) was launched from Vandenberg Air Force Base on a Pegasus XL launch vehicle into a 540 km orbit with a planned mission duration of four months. WIRE was designed to conduct a deep infrared, extra galactic science survey 500 times more sensitive than the Infrared Astronomy Satellite (IRAS) Faint Source Catalog. The instrument consists of a cryogenically cooled, 30-centimeter telescope and all associated electronics designed to detect faint astronomical sources in two infrared wavelength bands. The WIRE launch was nominal. Shortly after launch, ground commands were transmitted to perform a planned secondary venting of the secondary hydrogen tank. The next pass showed that the spacecraft was tumbling at increasing rate, ultimately spinning up to 60 rpm. Within 36 hours of launch, the instrument's 4-month supply of cryogen was completely exhausted. The WIRE scientific mission was declared lost on March 8, 1999.

The root cause of the WIRE mission loss is a digital logic design error in the instrument pyro electronics box, which inadvertently caused the cover to be ejected. The transient performance of components was not adequately considered in the box design resulting in the inadvertent pyrotechnic device firing during the initial pyro electronics box power-up. The results from the investigation into the failure mechanism will be discussed; that is, how did the mission fail.

An equally important question is why did the mission fail. Spacecraft systems go through a variety of analyses, simulations, tests, and reviews. These will be discussed showing why the error resulted in a mishap on-orbit.

A review of launcher and spacecraft performance and failures in the Industry over the last decade will be reviewed. Trends will be presented and discussed.