How we define our risk index

Satellites on orbit have many differences in design, components, shielding and operational procedures. Some may be more susceptible to the radiation environment than others, but this information is generally not available. To set a general level of risk is very difficult.

In the SPACECAST project the risk is set according to past experience when an anomaly occurred repeatedly on a telecommunications satellite at geostationary orbit. The anomaly was an unwanted phantom command caused by internal electrostatic discharge. A statistical analysis showed that the anomaly was caused by the accumulation of charge inside electronic components caused by high energy electrons > 2 MeV, and that it occurred when the electron fluence greater than 2 MeV exceeded 10^9 cm^{-2} sr^{-1} over a 2-day period [Wrenn and Smith, 1996; Wrenn et al., 2002].

Since SPACECAST calculates the daily electron fluence greater than 2 MeV, which includes the three hour forecast period, we set the risk level for geostationary orbit according to the following criteria:

- High fluence > 5 x 10^8 cm^{-2} sr^{-1}
- Medium fluence > 5 x 10^7 cm^{-2} sr^{-1}
- Low fluence < 5 x 10^7 cm^{-2} sr^{-1}

Internal charging requires time for the charge to accumulate to dangerous levels. Thus setting the risk after one day rather than 2 days provides some level of advanced warning and time to monitor the environment for the next 24 hours.

The risk levels are intended to provide a general guide for all satellites. However, the risk to specific satellite could, in principle, be scaled up or down according to the fluence at which anomalies occur. This service could be provided by a special arrangement.

The daily fluence is also a convenient quantity since it is used in engineering tools such as DICTAT to calculate the radiation dose to different types of material behind different thicknesses of Aluminium shielding.

Other studies have used different criteria, such as when the electron integral flux above 2 MeV exceeds 10^7 cm^{-2} sr^{-1} s^{-1} (medium) or 10^8 (High) cm^{-2} sr^{-1} s^{-1} [Wrenn, 2009]. However, since it takes time for the charge to accumulate inside a dielectric and then cause the anomaly, setting the risk according to the daily electron fluence is more appropriate.

References

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