Effects of Operating Parameters on MMOD Risk
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Presentation Overview

• Effects on MMOD Risk:
  – Altitude
    • Debris
    • Meteoroid
  – Inclination
  – Year of Flight
  – Spacecraft Orientation
  – Mission Duration
Effect of Altitude on MMOD Risk: Debris

- Debris flux varies significantly with altitude
- Generally peaks in the 800-1000 km altitude range
Effect of Altitude on MMOD Risk: Meteoroid

- Meteoroid flux is relatively insensitive to altitude
- Increases about 6% between 400km and 1500km

![Meteoroid Risk versus Altitude Graph](image)
Effect of Inclination on MMOD Risk

• Debris risk increases with inclination and levels out/decreases between 80-110 degrees.

Debris Risk versus Inclination
(2mm diameter debris, year = 2021, alt 824 km, inc = 28.5 to 110 degrees)
Effect of Year of Flight on MMOD Risk

- Debris flux varies each year
- Smaller debris particles affected more than large

![Debris Risk versus Year chart](chart.png)

Debris Risk versus Year
(1, 2, 5mm diameter debris, year = 2020-2035, inc = 98.2 deg, alt 824 km)
Effect of Orientation on MMOD Risk

- Orientation can have large effect on risk
- Applies to debris and meteoroids

Source: Ref: TM-2009-214785, Section 2.11.5, p25. (1m diameter by 1.5m long cylinder, year 2010, duration 1 year, 400km altitude, 0.13 cm Al 6061-T6 bumper, 10 cm standoff, 0.32 cm Al 2219-T87 rear wall, ORDEM 2k, 91 Meteoroids)
Effect of Mission Duration on MMOD Risk

- Debris (and meteoroid) risks increase linearly with exposure duration.
Summary

• **Effects on MMOD Risk:**
  
  – **Altitude**
    • Debris flux varies considerably with altitude
    • Can be significantly higher than at lower altitudes
    • Meteoroid flux is relatively insensitive to increasing altitude
  
  – **Inclination**
    • Debris risk generally increases with inclination
    • Decreases and increases between 80-110 degrees
  
  – **Year of Flight**
    • Debris risk generally decreases from 2020-2024
    • Increases from 2024-2030/2031, then decreases
  
  – **Spacecraft Orientation**
    • Some orientation have lower risk than others
  
  – **Mission Duration**
    • Debris and meteoroid risks increase linearly with exposure duration