End-of-Life Propellant Margin Budgeting: Trading Payload Mass & Mission Life for 5-Year Deorbit

Pillar: Constellation Scale | **Basis:** FCC § 25.283(e) & Spacecraft Systems Engineering | **Primary Source:** FCC / NASA ODPO | **As Of:** Active Nov 2026

Meeting the FCC 5-year post-mission disposal rule from mid-to-upper LEO shells requires reserving a dedicated end-of-life delta-v budget—forcing mission designers to trade revenue-generating station-keeping life and payload mass against guaranteed deorbit margin.

Documented Instrument & Engineering Record

• Why propellant gauging uncertainty matters: Bookkeeping (pressure-volume-temperature and thruster-on-time) errors accumulate over a 5–7 year mission; without a protected reserve floor, a satellite can run dry before its deorbit burn.

• Regulatory lock-in: Because 47 CFR § 25.283(e) defines EOM as the point when a propulsive spacecraft can no longer conduct collision-avoidance maneuvers, operators must initiate disposal *while* sufficient propellant remains.

• Altitude sensitivity: Deorbiting from 1,200 km requires substantially more delta-v than deorbiting from 500 km—making propellant mass fraction a decisive architectural driver.

• Passivation sequencing: After the final perigee-lowering burn, any remaining residual propellant must be vented/depleted to satisfy passivation rules.

Propellant Margin Tradeoffs by LEO Altitude Band

Altitude Band	Passive Decay Window	Propellant Reserve Strategy
< 500 km	Typically < 5 years	Small EOL margin; passive drag backs up thruster
500–650 km	Solar-cycle dependent (often >5 yrs)	Active deorbit burn required for guaranteed <=5 yrs
650–2,000 km	Decades to centuries	Large dedicated EOL delta-v + tank-gauging margin

Mission Designer, Compliance Lead & Founder Takeaways

• Finance and program leads must model the revenue impact of retiring a healthy satellite early to protect its EOL deorbit reserve.

• Electric propulsion (Hall/ion) offers high Isp for lower propellant mass, but requires months-long spiral-down times that must still fit inside the 5-year clock.

• Contracting an in-space servicer (such as Starfish Space's Otter) is a potential contingency if a spacecraft suffers a propulsion failure, not a substitute for initial ODMP propellant budgeting.

Cross-Cluster Links & Primary Sources

• **Amazon Leo (Redmond) Disposal Compliance:** https://bcesg.org/wa-space-orbital-amazon-leo-kuiper-compliance/

• **Solar-Cycle Drag Uncertainty (<500–600 km):** https://bcesg.org/wa-space-orbital-leo-drag-solar-cycle-limits/

• **FCC 5-Year Disposal Rule Mechanics:** https://bcesg.org/wa-space-orbital-fcc-5-year-rule-mechanics/

• **eCFR: 47 CFR § 25.283:** https://www.ecfr.gov/current/title-47/chapter-I/subchapter-B/part-25/subpart-D/section-25.283

• **NASA ODPO: Orbital Debris Mitigation:** https://orbitaldebris.jsc.nasa.gov/mitigation/

Provenance Note: Grounded in 47 CFR § 25.283(e) EOM trigger and NASA ODPO orbital lifetime mechanics as of 2026-11-16.