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Exploration of Near Earth Asteroids (06)
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CONCEPTUAL DESIGN OF A PLANETARY DEFENSE TECHNOLOGY DEMONSTRATION MISSION

Abstract

Given the past occurrences of asteroids and comets colliding with the Earth, it is necessary to study how to mitigate the threat of a near-Earth object (NEO) on an Earth-impacting course. When the warning time is short, the use of nuclear explosive devices (NEDs) may be required to generate a sufficient impulsive velocity change or to deliver sufficient disruption energy. For such a scenario with a short warning time, an innovative, versatile hypervelocity nuclear interceptor (HNI) spacecraft would need to be launched to intercept the target NEO at a closing velocity of more than 10 km/s. With the current nuclear triggering systems limited to surviving impact speeds of less than 300 m/s, flight testing demonstrations of the HNI spacecraft will be required to conduct verification and validation of the key technologies. The flight demonstration mission concepts studied in this paper fall into three different budget classifications: \$250M, \$500M, and \$1B. This paper presents conceptual mission design for three different mission costs to demonstrate a multipurpose HNI spacecraft carrying NEDs. Each mission concept consists of a launch vehicle and a corresponding orbital transfer vehicle (OTV) design. Launch vehicles will be responsible for orbital insertion while the OTV supplements the relative velocity needed to attain the desired impact speed. Trade studies explore launch vehicle options and determine the optimal OTV mass to minimize costs and maximize relative arrival speed. However, constraints on the trade studies include the use of readily available launch vehicles (Delta, Atlas, Ariane), different types of propellants for the OTV, and specific mission design sequences. The mission ΔV consists of the Earth-departure maneuver and trajectory correction maneuvers. Once the V is calculated, fuel estimates are found which are reflected in the mission cost. The mission cost is influenced on how much ΔV is required for the mission. Then, launch vehicle and OTV combinations are placed into corresponding budget classes. Within each budget class, another selection process is used to determine the most feasible configuration. Previous studies assumed that a 1500-kg NED yields approximately 2 Mt of energy, a 1000-kg NED yields about 1 Mt, and a 300-kg NED yields about 300 kt.

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