



PROTECTING EARTH FROM ASTEROIDS AND COMETS

An AIAA Position Paper

Approved by
AIAA Space Systems Technical Committee
AIAA Space Operations and Support Technical Committee
AIAA Systems Engineering Technical Committee
AIAA Atmospheric and Space Environments Technical Committee
and
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SUMMARY

The purpose of this Position Paper is to briefly review what is now known about the threat to Earth posed by close approaching asteroids and comets (called Near Earth Objects or NEOs). Based on our current understanding (recently reviewed at the 2004 Planetary Defense Conference sponsored by AIAA and The Aerospace Corporation), AIAA recommends that the following steps be taken to protect the Earth from NEO impacts:

- **Create an organization within the U.S. government responsible for planetary defense.**
- **Extend the Spaceguard Survey, currently focused on finding and cataloging 1-km-class objects and larger, to include finding and cataloging 100-m-class NEOs and larger.**
- **Develop and fund ground-based techniques as well as missions to several asteroids to gather information that contributes to designing deflection missions.**
- **Conduct mission design studies to characterize requirements for short-, medium-, and long-term missions.**
- **Conduct flight tests to demonstrate our ability to change a NEO's orbit.**
- **Sponsor research to assess the political, social, legal, and disaster relief consequences of a serious NEO threat, mitigation effort, or possible impact.**

DISCUSSION

Significant progress has been made in a number of areas to better understand the nature and physical characteristics of NEOs. These include a well-defined program to detect and determine the orbits of potentially hazardous NEOs (Spaceguard Survey) and missions to comets (Stardust, Deep Impact) and an asteroid (NEAR). These areas have been addressed in a series of national and international conferences culminating in the 2004 Planetary Defense Conference sponsored jointly by the AIAA and The Aerospace Corporation (www.aero.org/conferences/planetdef).

A primary result of these conferences and related studies is the agreement that the threat of NEO impact is real and must not be ignored. They have noted that although the present NEO search efforts are looking for large NEOs (>1 Km diameter), impacts of smaller objects, while not likely to cause worldwide disasters, can result in significant loss of life and major property damage and need to be considered. There is also a growing concern that a small impact in the wrong area at the wrong time could be mistaken as an attack, possibly leading to the use of nuclear weapons.

It is clear that the world community is only in the very early stages of developing deflection technologies. Much work must be done before a deflection mission can be fielded with any confidence that it would actually be successful in reducing the likelihood of impact. The success of a deflection mission will depend on public funding and support and, as a result, increasing

public awareness of the NEO threat is important. Providing credible information on past impacts, on observed and predicted close approaches, and on mitigation activities will increase public awareness that impacts do happen and that the possibility of future impacts is not being ignored.

A major shortcoming is the lack of an organization within the U.S. government responsible for the planetary defense issue. Such an organization would coordinate measurement activities and threat warnings, sponsor mission design studies, encourage innovative deflection techniques, and be a focal point for worldwide planetary defense-related research.

The cost and disaster relief implications of a NEO impact suggest that disaster relief agencies should utilize hypothetical impact scenarios to examine issues and develop responses to possible emergencies of this type (note: some NEO impact scenarios may already be covered by existing plans for earthquake, tsunami, or other disasters).

RECOMMENDATIONS

Following are the principal AIAA recommendations:

1. **Create an organization within the U.S. government responsible for planetary defense.** AIAA^{1,2} recommends establishment of an “interagency office charged with dealing with all aspects of Planetary Defense” and further recommended that a “senior level inter-agency working group be formed to define the appropriate makeup and reporting structure of the planetary defense organization, develop a roadmap leading to its implementation, and procure funding for its support.” This interagency office should establish a formal protocol for disseminating information regarding NEOs when the probability of impacting Earth exceeds specified thresholds. The office should begin a dialog among nations and international institutions to characterize the challenges implicit in worldwide planning and execution of future deflection missions.
2. **Extend the Spaceguard Survey, currently focused on finding and cataloging 1-km-class objects and larger, to include finding and cataloging 100-m-class NEOs and larger.** These smaller objects pose a significant portion of the impact hazard. This task can be accomplished by relatively inexpensive telescopic and/or spacecraft systems; however, a substantial increase in the funding base beyond the current level of NASA funding (~\$4.0 million per year) is required. This funding must be maintained into the future to watch for long-period comets and rogue asteroids.
3. **Develop and fund ground-based techniques as well as missions to several asteroids to gather information that contributes to designing deflection missions.**

¹ Tagliaferri, Edward, “Dealing with the Threat of an Impact of an Asteroid or Comet on Earth: The Next Step,” AIAA Position Paper, April 1990.

² Tagliaferri, Edward, Warren Greczyn, Lawrence Cooper, “Addressing the Comet and Asteroid Impact Threat: A Next Step,” AIAA Information Paper, July 2002.

Critical information includes object sizes and dynamics, object types (e.g., binary), characteristics of surface and sub-surface materials, responses to explosive and impact forces, and characteristics relating to attaching a spacecraft or other large structures to NEOs. Without these studies there is a potential to make matters worse by an inappropriate response.

4. **Conduct mission design studies to characterize requirements for short-, medium-, and long-term missions.** Mission design studies would compare current capabilities with mission requirements and help to identify and prioritize technology research and development goals. These studies would also suggest experiments to be included in upcoming asteroid and comet missions. Mission design studies should examine political and policy-level decisions and decision timelines for various deflection scenarios (short-term, long-term, nuclear, non-nuclear), potential public and government concerns and responses to a potential threat and subsequent deflection effort, and management of a deflection effort in the face of public expectations and uncertainty.
5. **Conduct flight tests to demonstrate the ability to change a NEO's orbit.** Flight tests involving non-threatening NEOs would verify the effectiveness of mission designs and deflection techniques and increase public confidence in our ability to mitigate these threats.
6. **Sponsor research to assess the political, social, legal and disaster relief consequences of a serious NEO threat, mitigation effort, or possible impact.** The response of the public, elected and government officials, the media and disaster relief agencies to a NEO impact or to a serious threat and mitigation effort should be investigated. Such information may be critical to minimizing the effects of an actual impact or maximizing the likelihood that a deflection mission would be successful.

CONCLUSION

While noteworthy efforts are being made to detect threatening objects, Earth is effectively blind to NEO objects of a size range that could lead to immediate and long term deaths of thousands to millions of people and is unprepared should a short term threat be detected.

The Executive Summary of the “Report of the Task Force on Potentially Hazardous Near Earth Objects”³ states:

The threat of Near Earth Objects raises major issues, among them the inadequacy of current knowledge, confirmation of hazard after initial observation, disaster management (if worst came to worst), methods of mitigation including deflection, and reliable communication with the public. ...Steps should be taken at government

³ “Report of the Task Force on Potentially Hazardous Near Earth Objects,” British National Space Center, August 2000.

level to set in place appropriate bodies...where these issues can be discussed and decisions taken.

Consistent with the recommendation of the Task Force and previous AIAA Position Papers, this Position Paper also iterates that world governments must take the threat of NEO impacts seriously and must support actions that lead to the development of credible defensive capabilities.

While the probability of an impact of an object of sufficient size to cause major loss of life and property damage is low, it is not zero. For the first time, life on our planet has the ability to defend itself against the inevitable. The AIAA is of the position that the world must begin to prepare for that eventuality now.