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Near-Earth objects

Near-Earth objects, 2011-2012

Draft recommendations of the Action Team on Near-Earth Objects for an international response to the near-Earth object impact threat

I. Background

1. In accordance with the multi-year workplan on near-Earth Objects for 2009-2011, as contained in the report of the Scientific and Technical Subcommittee on its forty-fifth session (A/AC.105/911, annex III), the present report contains the draft recommendations of the Action Team on Near-Earth Objects on international procedures for handling the threat of a potential near-Earth object (NEO) impact on Earth, taking into account the work carried out by the Action Team during 2011.
2. At its fifty-fourth session, in 2011, the Committee on the Peaceful Uses of Outer Space endorsed the recommendation of the Subcommittee and its Working Group on Near Earth Objects that the multi-year workplan on near-Earth objects be continued for the period 2012-2013.¹ According to the workplan (A/AC.105/987, annex III, paragraph 9), the Subcommittee will consider the final report of the Action Team at its 50th session, in 2013.
3. The interim report of the Action Team, reflecting the existing state of knowledge on the NEO hazard, the current understanding of the risk posed by NEOs, the measures required to mitigate that threat and the consensus on

* A/AC.105/C.1/L.310.

¹ *Official Records of the General Assembly, Sixty-sixth Session, Supplement No. 20 (A/66/20)*, para. 134.



prioritization of the issues to be addressed and their possible solutions, is contained in A/AC.105/C.1/L.316.

II. Introduction

4. In 2007, the Working Group on Near-Earth Objects was established by the Scientific and Technical Subcommittee in the expectation that international procedures to address the NEO threat would be proposed by the Working Group for consideration by the Committee. In 2007 and 2008, the Association of Space Explorers convened a Panel on Asteroid Threat Mitigation, consisting of renowned non-governmental, multidisciplinary experts in science, diplomacy, law and disaster management from around the world. In 2008, the Association submitted a report by the Panel entitled “Asteroid threats: a call for global response” (available from www.space-explorers.org/committees/NEO/docs/ATACGR.pdf) to the Action Team and for consideration by the Working Group. In addition, the international community of entities engaged in NEO-related activities has conducted many workshops and conferences in recent years, which have made a number of recommendations concerning an international response to the NEO impact threat.

5. In 2009 and 2010, the Action Team and Working Group carried out their work in accordance with the amended workplan. During its meetings, the Action Team discussed and reviewed the report by the Panel on Asteroid Threat Mitigation and considered information provided by its members, reports on NEO-related activities and documents submitted to it.

6. In 2011, the intersessional work of the Action Team was carried out during two workshops. The Workshop on International Recommendations for NEO Threat Mitigation, held in California, United States of America, on 25 and 26 August 2011, addressed key issues related to the required response and cooperation needed by a mission planning and operations group in preparing for a possible NEO impact threat to Earth. The workshop prepared a first draft of the terms of reference for the mission planning and operations group, an essential part of the overall NEO threat mitigation system. The NEO Media/Risk Communications Workshop was held in Colorado, United States, on 14 and 15 November 2011. During the Workshop, discussions were held on how best to inform the public of the threat of an NEO impact in a way that would avoid misinformation and on how to provide guidance on the development of an outreach and education plan that fostered accurate and timely information about the possible effects of a potentially hazardous NEO.

7. On the basis of the discussions held both during its meetings and through correspondence afterwards, the Action Team prepared the following updated version of the draft recommendations for an international response to the near-Earth object impact threat for further consideration by the Working Group during the forty-ninth session of the Scientific and Technical Subcommittee.

A. Background

8. The Action Team on Near-Earth Objects (Action Team 14) was given a mandate to: review the content, structure and organization of ongoing efforts in the field of NEOs; identify any gaps in the ongoing work where additional coordination

is required and/or where other countries or organizations could make contributions; and propose steps for the improvement of international coordination in collaboration with specialized bodies. For the purposes of this document and the work of the Committee, a potentially hazardous NEO is an asteroid or comet whose orbit periodically brings it close to the Earth. These potentially hazardous objects, a subset of the NEO population, have orbits that bring them to within approximately 7.5 million kilometres of the Earth's orbit.

9. Since the establishment of the Action Team, it has become commonly accepted by the international community that there is evidence that the Earth's geological and biological history has been punctuated by repeated and devastating impacts from space and that NEOs continue to pose an impact risk to humankind and the Earth as a whole. The global nature of the NEO impact hazard and the need for a coordinated international response have also been recognized. The consequences of NEO impact events, although less frequent than more familiar geological and meteorological hazards, can be much more severe than hazards resulting from phenomena such as earthquakes or extreme weather events. Perhaps uniquely among natural hazards, there is the potential to prevent NEO impact events through timely actions, and it is the combination of the potentially catastrophic scale, the predictability of events and the opportunity to intervene that obligates the international community to establish a coordinated response to the NEO threat.

10. Response to the NEO impact hazard requires measures to detect, track and characterize the orbital and physical properties of potentially hazardous NEOs, including measures to modify the trajectory of such NEOs in order to prevent an impact and measures to limit the consequences on the ground, such as evacuation and other forms of disaster mitigation and emergency response.

B. Rationale

11. According to current scientific knowledge, the population of NEOs increases as the size of the objects decreases. Within the next decade, it is expected that advanced telescopes will greatly facilitate detection of the numerous smaller NEOs and thus make it possible to discover a significantly larger number of potentially threatening NEOs. Because NEO collisions can have disastrous effects on Earth, the international community will need to decide on a necessary response to a detected impact threat.

12. As NEO search, tracking and prediction capabilities improve, astronomers will not only predict more impacts from small objects that do not penetrate the atmosphere to strike the surface, but will also discover many larger near-Earth asteroids that present a worrisome probability of impact. The key to finding these objects in time to take action to prevent a possible damaging impact is to detect them early through a vigorous international search and tracking programme.

13. Since substantial time is needed to execute an NEO deflection campaign and, in some cases, there may be limited time before the expected impact, a decision may need to be made quickly on what action to take. There may be occasions when the international community will need to act before it is certain that an impact will occur. The longer the international community delays in deciding to undertake responsive actions, the more limited the options become and the greater the risk that

any option that is finally chosen may have undesirable consequences. In the absence of an agreed decision-making process, the international community may miss the opportunity to act against an NEO in time, leaving evacuation and disaster management as the only responses to an otherwise preventable impending impact. The prompt adoption of an international programme of coordinated activities and a set of preparatory measures for action is therefore considered a prudent and necessary step in anticipation of such a potential impact event. To be effective, such a programme must establish action criteria and campaign plans that can be implemented rapidly, without the need for extended debate.

14. Once in place, these measures should enable the global community to identify a specific impact threat and quickly implement effective prevention or disaster responses. A series of outline recommendations relating to a decision-making programme for a global response to asteroid threats has been developed by the community of entities engaged in NEO-related activities, including the Panel on Asteroid Threat Mitigation and planetary defence conferences. The Committee acknowledges the benefit of such a series of high-level recommendations having wide acceptance among the global space and disaster response community. The Working Group on Near-Earth Objects has therefore derived such a set of international measures for handling the NEO threat, based on those outline recommendations and in accordance with the United Nations treaties and principles on outer space.

C. Application

15. Member States and international organizations should take measures, through national or other applicable mechanisms, to support the implementation of these recommendations to the greatest extent feasible. Building on existing relationships, institutions and activities, this support should include the availability of a commensurate level of resources to address the specific potential threat posed by NEOs.

16. These recommendations are applicable to Governments, intergovernmental, regional and non-governmental organizations, institutions and relevant United Nations entities with responsibility for the coordination of space activities and the safety of citizens and with disaster-reduction functions.

17. It is recognized that the implementation of individual recommendations or elements thereof is governed by the provisions of United Nations treaties and principles on outer space and should not impose any financial obligations on the United Nations budget.

III. Near-Earth object threat mitigation functions

18. There are three primary components of threat mitigation: discovery of threatening asteroids and comets and identifying those objects that pose a threat requiring action (action may include the initiation of civil defence measures); planning a mitigation campaign that includes both deflection or disruption and civil defence activities; and, if the threat warrants, authorizing the initiation of a mitigation campaign.

19. The nature and consequences of the threat posed by asteroids and comets are international, and it is likely that any mitigation effort will require action by and coordination of efforts among many nations. The following steps are recommended to ensure that all nations are aware of potential threats and to assure the design and coordination of mitigation activities, including civil defence activities, among those nations that are threatened by a possible impact and that might play a direct role in any eventual asteroid or comet deflection or disruption campaign.

A. Information, analysis and warning

20. An Information, Analysis and Warning Network (IAWN) should be established by linking together the institutions that are already performing many of the proposed IAWN functions, including the following, and adding capabilities as needed:

(a) To discover and monitor the potentially hazardous NEO population using optical and radar facilities and other assets based in both the northern and southern hemispheres and in space;

(b) To provide an internationally recognized clearing-house function for the receipt, acknowledgment and processing of all NEO observations;

(c) To act as a global portal, serving as the international focal point for accurate and validated information on the NEO population;

(d) To coordinate campaigns for the observation of potentially hazardous objects;

(e) To recommend policies regarding criteria and thresholds for notification of an emerging impact threat;

(f) To assess hazard analysis results and communicate them to entities identified by Member States as being responsible for the receipt of notification of an impact threat in accordance with established policies;

(g) To assist Governments in the analysis of impact consequences and in the planning of mitigation responses.

21. Several institutions are currently engaged in NEO detection, tracking, cataloguing, impact prediction and notification of threats exceeding established risk thresholds. These include the Near-Earth Object Observations Program of the National Aeronautics and Space Administration (NASA), the NASA-supported Minor Planet Center of the International Astronomical Union and Sentry computational centre at the NASA Jet Propulsion Laboratory. Ongoing NEO programmes also include the computational centre at the Near-Earth Objects Dynamic Site (NEODyS) at the University of Pisa, Italy, as well as the NEO survey and follow-up elements of the space situational awareness programme of the European Space Agency. Additional expert centres contributing to the objectives of IAWN should be encouraged.

22. IAWN should develop a communications strategy using well-defined communication plans and protocols, grounded in the science of risk communications and psychology. News and information should be distributed using words that are

easily understood by the public and policymakers and should be accurate, timely and aimed at responding promptly and directly to misinformation and media errors. IAWN should investigate the communication channels and contacts used by other disaster warning networks to communicate with the disaster management community. IAWN could benefit from the large body of knowledge about the human response to other natural disasters and should therefore include among its members risk analysis experts familiar with the behavioural and psychological elements of disaster management. It should also draw on the lessons learned from other disaster response and risk management organizations.

23. In order to inform the public about the risk of NEOs, IAWN should develop an education plan that identifies the major NEO risk factors. IAWN should coordinate an NEO outreach plan using entities such as the International Astronomical Union, the American Geophysical Union, space agencies and amateur astronomical observer organizations.

24. Continued research will be essential to the efficient functioning of IAWN. IAWN should therefore identify and call for necessary NEO-related research in order to address gaps in knowledge of impact prediction, impact effects or other areas necessary for the IAWN mission.

25. IAWN should emphasize the value of finding hazardous NEOs as soon as possible in order to obtain precision tracking data, thus averting the considerable costs of unnecessary NEO threat mitigation missions. This strategy requires upgraded NEO search and tracking capabilities:

(a) Rapid enhancements to current detection and tracking systems are a wise investment. Assessment of the impact hazard requires a thorough survey of the NEO population in order to detect the hundreds of thousands of small near-Earth asteroids (and comets) that can cause ground damage. Early execution of this survey, at a relatively modest cost, will enable repeat observations and precise orbit determination that will eliminate many spurious NEO impact scenarios and the associated deflection planning and operational costs;

(b) Priority NEO research should include an analysis of the value of space-based detection and tracking in order to accelerate identification of potentially hazardous NEOs and enable precise orbit determination.

26. A steering group, composed of IAWN members, should be created to propose and assist the long-term development of IAWN. Such a group would then be in an ideal position to integrate IAWN with the functions to be carried out by a mission planning and operations group and a mission authorization and oversight group. The steering group should consider the many issues related to the establishment of IAWN, such as resources, structure, institutional model, and legal and liaison issues.

27. Member States should ensure that IAWN-related facilities are supported at an appropriate level to enable them to perform their critical functions. Further, as appropriate, Member States should establish the capacities and procedures needed to facilitate the following actions for impact warning response at the national and regional levels:

(a) Receiving notification of an impact threat that meets established notification policies;

- (b) Taking appropriate action in response to an impact threat notification.

B. Mission campaign planning and operations

28. Uncertainties are associated with the discovery and tracking of any asteroid or comet, and these uncertainties will make it difficult to predict an Earth impact with certainty until additional tracking data are available. As a result, it is possible, and even likely, that efforts to mitigate a threat must begin before it is certain that a particular object will actually impact. The international nature of an asteroid or comet threat necessitates coordination among entities involved in mitigation and civil defence as the threat evolves; at the same time, it must be recognized that, in many cases, the threat may vanish once additional data are available.

29. Two activities are essential in order to prepare the foundation for an effective response to a threat of asteroid or comet impact. The first is to lay out the framework, timeline and options for initiating and executing response activities; the second is to inform the civil defence community of the nature of impact disasters and incorporate that community into the overall mitigation planning process.

30. An inter-agency body whose functions would be similar to those identified for the mission planning and operations group, as proposed in the report prepared by the Panel on Asteroid Threat Mitigation, should be established by space agencies. The Action Team could assist in that process. The group should be composed of representatives of spacefaring nations and other relevant entities and, once established, it should be sanctioned by the United Nations on behalf of the international community. Its responsibilities should include:

(a) Recommendation and promotion of key research required for planetary defence. Such research can take the form of NEO observations, computer simulations, laboratory research and deep space missions;

(b) Identification of research opportunities for international collaboration on technologies and techniques for NEO deflection. This will help avoid costly duplication of effort and speed the development of an effective deflection capability;

(c) Development and adoption of a set of reference missions addressing a variety of potential NEO impact scenarios and deflection and disruption possibilities. These reference missions will facilitate accurate technical planning and provide a basis for mitigation campaign cost estimates;

(d) Development of decision and event timelines for a variety of potential Earth impactors and trajectories identified for mitigation campaign analysis;

(e) Evaluation of technical maturity and consequences of deflection techniques;

(f) Recommendations to the appropriate authorities, in collaboration with IAWN, on criteria and thresholds for action (e.g. notification of a significant impact risk, initiation of an observation and/or mitigation campaign);

(g) Recommendation of a minimum acceptable Earth-miss distance and other criteria for deflection targeting;

- (h) Recommendation of operational responsibilities for a mitigation campaign;
- (i) Preparation to coordinate with the relevant actors involved in the implementation of the threat response;
- (j) Identification for a detailed review of any legal issues (e.g. liabilities) that may arise in undertaking NEO mitigation actions or selecting any likely mitigation option;
- (k) Communication of its activities to the international community;
- (l) Provision of a yearly briefing to the Committee on the Peaceful Uses of Outer Space on the status of these activities.

31. The mission planning and operations group could be organized and function in a manner similar to the Inter-Agency Space Debris Coordination Committee, with the position of Chair rotating among representatives of spacefaring nations and activities supporting the terms of reference of the group being undertaken by institutions of each member State.

32. The mission planning and operations group should identify, for the benefit of space agencies, the technical issues involved in planetary defence in order to take advantage of synergies among human exploration, science and NEO hazard research activities.

33. The preparation of the terms of reference of the mission planning and operations group could be facilitated by the Action Team.

C. Mission, oversight and authorization

34. The Committee should identify and recommend that appropriate organs of the United Nations sanction the establishment of an international entity to be responsible for monitoring the NEO impact risk and overseeing the corresponding NEO threat response. Specifically, such an entity, whose functions would be similar to those of the mission authorization and oversight group proposed in the report of the Panel on Asteroid Threat Mitigation, should ensure the accomplishment of the following functions:

- (a) Consideration of recommended criteria and thresholds for action (e.g. notification of a significant impact risk, initiation of observation and/or mitigation campaign);
- (b) Consideration of decision and event timelines for NEOs identified for mitigation campaign analysis;
- (c) Consideration of the recommended process for mitigation campaign operational responsibilities;
- (d) Identification, in cooperation with Member States, of methods to engage designated national and international disaster response entities and utilize existing functions and infrastructures;
- (e) Development and updating of detailed agreements on the criteria and thresholds that will guide the choice and implementation of an appropriate response

by the international community to a specific impact threat, from the initial identification of a potential for impact to the criteria requiring action;

(f) Communication of the agreements to the international community through the relevant United Nations organizations;

(g) Coordination of the relevant actors involved in the implementation of the agreements.

35. It is important that discussions as to how to develop an international decision making framework within the present structure of the United Nations, notably as regards the possible roles of the Security Council and General Assembly, begin within the framework of the Committee as soon as possible.
