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Near-Earth objects

Near-Earth objects

Interim report of the Action Team on Near-Earth Objects (2009-2010)

I. Introduction

1. The Action Team on Near-Earth Objects[1] was established in response to recommendation 14 of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) and was given the following terms of reference:

(a) Review the content, structure and organization of ongoing efforts in the field of near-Earth objects (NEOs);

(b) Identify any gaps in the ongoing work where additional coordination is required and/or where other countries or organizations could make contributions;

(c) Propose steps for the improvement of international coordination in collaboration with specialized bodies.

2. At its fifty-first session, in 2008, the Committee on the Peaceful Uses of Outer Space noted with satisfaction the work carried out by the Working Group on Near-Earth Objects of its Scientific and Technical Subcommittee and by the Action

* A/AC.105/C.1/L.300.

[1] A near-Earth object (NEO) is an asteroid or comet whose orbit brings it close to the Earth, usually defined as within approximately 45 million kilometres of the Earth's orbit. This includes objects that will come close to the Earth at some point in their future orbital evolution. NEOs generally result from objects that have experienced gravitational perturbations from nearby planets, moving them into orbits that allow them to come near to the Earth.

Team on Near-Earth Objects and endorsed the following amended multi-year workplan for 2009-2011:[2]

2009 Consider the reports submitted in response to the annual request for information on near-Earth object activities and continue intersessional work. Continue to review policies and procedures related to the handling of the NEO threat at the international level and consider drafting international procedures for handling the NEO threat. Work within the framework of the International Year of Astronomy, 2009 to raise awareness of the NEO threat. Review and prepare an updated interim report of the Action Team on Near-Earth Objects.

2010 Consider the reports submitted in response to the annual request for information on near-Earth object activities and continue intersessional work. Continue drafting, and seek agreement on, international procedures for handling the NEO threat. Review progress on international cooperation and collaboration on NEO observations. Facilitate, for the purpose of NEO threat detection, a more robust international capability for the exchange, processing, archiving and dissemination of data. Review and prepare an updated interim report of the Action Team on Near-Earth Objects.

2011 Consider the reports submitted in response to the annual request for information on near-Earth object activities and continue intersessional work. Finalize agreement on international procedures for handling the NEO threat and engage international stakeholders. Review progress on international cooperation and collaboration on NEO observations and on the international capability for the exchange, processing, archiving and dissemination of data for the purpose of NEO threat detection. Consider the final report of the Action Team on Near-Earth Objects.

3. The present interim report is a summary of the input received from members of the Action Team on Near-Earth Objects for 2009-2010 and serves as an update to its previous interim report, which covered the period 2008-2009 (A/AC.105/C.1/L.298). The present report covers activities and issues relating to the NEO hazard, the current understanding of the risk posed by NEOs and the measures required to mitigate that threat. In accordance with the terms of reference of the Action Team, it is expected that an updated interim report will be issued each year to reflect the existing state of knowledge, related activities and the consensus on prioritization of the issues to be addressed and their possible solutions. More detailed descriptions of activities are provided in the annual national reports provided to the Committee by Member States and in the presentations made by the Committee members and observers at the annual session of the Subcommittee.

[2] *Official Records of the General Assembly, Sixty-third Session, Supplement No. 20* (A/63/20), para. 153.

II. Interim report of the Action Team on Near-Earth Objects

A. Near-Earth object detection and remote characterization

4. The first step in addressing the risk posed by an NEO is to detect its presence and measure its trajectory as well as infer its size from its observed brightness and albedo. The United States of America makes the most significant contribution to the field of NEO detection and remote characterization. The Near-Earth Object Program of the National Aeronautics and Space Administration (NASA) of the United States funds five NEO search teams to operate nine separate 1-metre class survey telescopes across the south-western United States, Hawaii and one in Australia, which can detect objects, on average, down to magnitude 20. The Near-Earth Object Program is supplemented by orbit follow-up observation activities carried out by a variety of professional and amateur astronomers around the world.

5. The Action Team was pleased to learn that the European Space Agency (ESA) started its space situational awareness programme, which contains a segment dealing with the NEO threat. As documented in the user requirements document, part of that programme will be observation activities focusing mainly on follow-up observations. Among other telescopes, the Optical Ground Station, a 1-metre telescope of ESA on Tenerife, is expected to be made available for NEO observations four nights every month starting in 2010. The involvement in survey activities is still being discussed.

6. The Action Team recognized that significant efforts were being made internationally to detect and, to a lesser degree, follow-up observations of potentially hazardous NEOs larger than 1 kilometre in diameter. As at 1 October 2009, 876 objects more than 1 kilometre in diameter had been found, out of a population of such objects estimated at less than 1,000. However, the Action Team noted that objects with diameters ranging from 100 metres to 1 kilometre, for which the current surveys were not optimized, still posed a significant impact threat.

7. The Action Team encouraged NASA, along with its international partners, to continue to seek ways in which the threshold for the detection of NEOs could be reduced to 140 metres, as the Action Team recognized that such objects were likely to pose a more immediate threat to the Earth than the smaller number of kilometre-sized objects. The Action Team in particular encouraged ESA to implement their plans for follow-up and characterization, and also support survey programmes. Emphasis should be placed on establishing observing capabilities in the Southern hemisphere. Further, the Action Team noted that discovery and precision orbit determination were the critical first steps in characterizing an NEO threat and initiating a mitigation action, and that facilities and capabilities for collecting and rapidly processing the discovery data were essential. The Action Team also noted that some NEOs were binary in nature (that is, they had accompanying moons), which were themselves large enough to pose a hazard, and that those moons might complicate considerations for deflection plans. The Action Team therefore expressed concern that the planetary radar at Arecibo, operated by Cornell University for the United States National Science Foundation, which had the world's best capabilities for determining the orbit of NEOs such as Apophis, as well as estimating their size and spin state and detecting accompanying bodies, was scheduled to be shut down during the 2012-2013 apparition of Apophis. The Action Team recognized that the

use of Arecibo during that period could be important for determining whether Apophis posed a serious threat of impact with the Earth in 2036, and that it was likely to have a similar critical value as new objects that could pose a threat were discovered.

8. The Action Team agreed that a coordinated campaign for the observation of Apophis should be implemented during the winter of 2012-2013, when Apophis would have an apparent magnitude of approximately 17 (mv~17), in order to refine its ephemeris and in particular characterize the magnitude of the non-gravitational forces (Yarkovsky effect), which need to be known for orbit extrapolation. Given that Apophis will be in the southern hemisphere, it is expected that such a campaign would mainly involve observatories in Africa, Australia and South America.

9. The Action Team was encouraged to note that the Panoramic Survey Telescope and Rapid Response System (Pan-STARRS), funded by the United States Air Force, was expected to start regular survey operations on its first prototype instrument in the near future. The capability to detect moving objects in the collected image data and extract observations for newly discovered objects, as well as known objects, had been completed with NASA funding, and NASA would also fund a portion of the Pan-STARRS-1 operations for NEO search purposes, starting in 2010. The Planetary Science Division of NASA has also funded efforts to incorporate NEO detection capability within the data-processing segment on the recently launched Wide-field Infrared Survey Explorer (WISE) mission, sponsored by the Astrophysics Division of NASA. The primary mission of the spacecraft was to produce a detailed map of the extra-galactic sky in four infrared bands, but during the collection of those data over the planned six-month prime mission, the infrared signature of many NEOs and other asteroids and comets could be extracted and processed to produce observations to be sent to the Minor Planet Center. The transient image data would also be archived for use in making more accurate size estimates of known objects and to provide another resource for finding precovery detections (extraction of observation data from existing image archives once an object is discovered and previous positions can be calculated and correlated with the archived image sets). That enhancement of the mission required only additions to the ground processing of the WISE data, which could be incorporated even if the spacecraft were less than a year from planned launch. Approximately 200 new NEOs were expected to be detected during the six-month mission, and the capability existed to extend the mission an additional few months if it performed well, increasing the amount of data that could be obtained. The Action Team was encouraged to learn that the Canadian Space Agency was supporting the Near-Earth Object Surveillance Satellite project (NEOSSat), which is fully funded and has a projected launch date of 2011. The objective of that microsatellite is to understand the orbital distribution, physical characteristics, composition, origin and history of NEOs. It is being developed to survey 50 per cent of all Aten-class asteroids with a diameter of at least 1 kilometre in one year of nominal operation. The Action Team encouraged agencies to consider other opportunities to address such complementary primary and secondary objectives for future prospective missions.

10. The Action Team welcomed the news of progress with the Warm Spitzer NEO Survey regarding the observation of about 700 known NEOs in the two warm Spitzer channels (namely, 3.5 and 4.5 microns) and the expectation that for most targets it was anticipated to be able to derive sizes and albedos at least. That

represents an order-of-magnitude increase in the number of known NEOs for which such crucial information is available.

11. The Action Team recognized the importance of observational effort to physically characterize the NEO population using ground-based telescopes, including in particular infrared telescopes (for sizes, albedos, composition, surface characteristics, thermal properties) and radar (surface characteristics, composition, sizes) and encouraged agencies to consider making resources available to strengthen this activity in the relevant programmes.

B. Orbit determination and cataloguing

12. The Action Team considered that it was important that objects detected from the ground were uniquely identified and that their orbits were refined to assess the impact threat to the Earth. The Minor Planet Center was fundamental in that process. The Center was operated by the Smithsonian Astrophysical Observatory, in coordination with the International Astronomical Union, on the basis of a memorandum of agreement giving the Center an international charter. Pursuant to the memorandum of agreement, the Center had, since 1978, served as the international clearing house for all asteroid, comet and satellite astrometric (positional) measurements obtained worldwide. The Center processed and organized data, identified new objects, calculated orbits, assigned tentative designations and disseminated information on a daily basis. For objects of special interest, the Center solicited follow-up observations and requested archival data searches. The Center was responsible for the dissemination of astrometric observations and orbits via so-called Minor Planet Electronic Circulars (issued as necessary, generally at least once a day) and related catalogues. In addition to distributing complete orbit and astrometric catalogues for all small bodies in the solar system, the Center facilitated follow-up observations of new potential NEOs by placing candidate sky-plane ephemerides and uncertainty maps on the Internet via the NEO confirmation page. The Center focused specifically on identification, short-arc orbit determination and dissemination of information pertaining to NEOs. In most cases, observations of NEOs were distributed to the public free of charge within 24 hours of receipt. The Center also provided a variety of tools to support the NEO initiative, including sky coverage maps, lists of known NEOs, lists of NEO discoverers and a page of known NEOs requiring astrometric follow-up. The Center also maintained a suite of computer programs to calculate the probability that an object was a new NEO, on the basis of two sky-plane positions and magnitude. Links to those Internet resources can be found on the website of the Center (www.cfa.harvard.edu/iau/mpc.html).

13. The Action Team recognized that the role of the Minor Planet Center was critical to the dissemination and coordination of observations and welcomed the confirmation by NASA of its increased sponsorship of the Center to upgrade its capability to process all observations received from worldwide observatories and disseminate the resulting orbit information without charge via the Internet, and to allow the Center to accommodate the anticipated significant increase in NEO observation data with the “next generation” search efforts. The Action Team continues to recognize the benefit of establishing a “mirror” capability complementing the Center, possibly hosted in Europe or Asia. The two nodes could

share analysis protocols and processes, and could have a common data management and access policy, but would perform a complementary operational role, perhaps performing the same operations on a different subset of the observation data, but independently maintaining a complete database. The two sites could also then act to validate and verify their more critical respective outputs. The Action Team recognized that ESA has started discussions on how to support the Minor Planet Center, possibly by setting up a backup capability in Europe, as part of its NEO programme. The Action Team encouraged the continuation of these discussions and the reaching of a support agreement — preferably by setting up a backup site — within the next year.

14. On a daily basis, the Minor Planet Center made NEO astrometric data available to the Near-Earth Object Program and to a parallel, but independent, orbit computation centre in Pisa, Italy, with a mirror site in Valladolid, Spain. Through the Sentry system of the NASA Jet Propulsion Laboratory (http://neo.jpl.nasa.gov/risk), risk analyses were automatically performed on objects that had a potential for Earth impact, usually when the object had been recently discovered and lacked the lengthy data interval that would make its orbit secure. Those objects were prioritized for the Sentry System according to their potential for close approaches to the Earth's orbit and according to the existing quality of their orbits. The Sentry System automatically updated the orbits of approximately 40 NEOs per day and close-approach tables were generated and posted on the Internet (http://neo.jpl.nasa.gov/cgi-bin/neo_ca). Approximately five risk analysis cases were performed each day, with each analysis providing 10,000 multiple solutions up to 2105. That process was also performed in parallel in Pisa, Italy, and significantly non-zero Earth-impact cases were manually checked at the Laboratory and at the orbit computation centre in Pisa before the risk analysis data were posted on the Internet. For recently discovered objects of unusual interest, the Minor Planet Center, the Laboratory and the centre in Pisa would often alert observers that additional future or recovery observation data were needed.

15. The Action Team noted that the Sentry System and the Near-Earth Objects Dynamic Site (NEODyS) system were completely independent systems that employed different theoretical approaches to providing impact risk assessments. Hence, if the long-term orbit propagations from each converged to a single solution, the wider community could have some confidence in the predicted outcome. While the Sentry System was funded as part of the Near-Earth Object Program of NASA, and thus its operational future could be considered relatively secure, until recently, the long-term funding for NEODyS was not so clear. However, the Action Team was encouraged to learn that discussions were ongoing between the NEODyS team and the ESA Space Situational Awareness programme to establish a well-funded service, based on the existing software. As with the operation of the Minor Planet Center, the Action Team considered that an independent but complementary capability to the Sentry System was critical for the purposes of independent verification and validation of predicted close approaches.

16. The Action Team was particularly encouraged to note how effectively the process outlined above had been implemented in the recent discovery and subsequent impact of NEO 2008 TC3. That very small (about 3 metres in diameter) object had been discovered by the United States Catalina Sky Survey team just 20 hours before it entered the Earth's atmosphere on 7 October 2008. Within

eight hours of collection of the discovery observations, the Minor Planet Center had identified the object as a potential impactor and alerted both NASA and the Jet Propulsion Laboratory. While the Center requested follow-up from all available observers and the Jet Propulsion Laboratory produced more precise predictions and compared results with the NEODyS system, NASA headquarters started the actions required to alert the global community to the impending impact. During the subsequent 12 hours, the worldwide NEO network had provided the Center with some 570 observations from 27 different observers. On the basis of the precise predictions provided by the Jet Propulsion Laboratory and the Near-Earth Objects Dynamic Site system, NASA had provided information for public release and dissemination via diplomatic channels to the effect that the entry would take place over northern Sudan at 0245 Coordinated Universal Time on 7 October 2008. Released six hours in advance, the information had been accurate to within seconds of the entry observed by meteorological satellites and detected by infrasound sensors.

17. The Action Team was interested to learn that within the ESA technology programme, a number of activities were ongoing that were relevant to the NEO topic. One of them is the planetary database, covering planets, moons and small bodies of the solar system. An evaluation is under way to determine whether the database can be used as the backbone of a database system, which would be part of the ESA space situational awareness programme. Another activity is GRAVMOD, under which gravity models of asteroids are developed and stored in the database.

18. Having recognized the critical role that the Minor Planet Center played, the Action Team was pleased to learn that the Planetary Science Division of NASA was continuing to fund the Center’s operations and upgrades and almost wholly supported the Center, providing over 90 per cent of its financing. Recognizing the importance of the NEODyS system, the Action Team noted with satisfaction the efforts currently being made by the ESA Space Situational Awareness programme to establish firm funding for the NEODyS service and in setting up a backup data storage activity.

C. Consequence determination

19. The Action Team recognized that, in considering a science-based policy to address the risk posed by NEOs, it was important for Governments to evaluate the societal risk posed by such impacts and to compare those risks with the thresholds established for dealing with other natural hazards (for example, meteorological and geological hazards) so that a commensurate and consistent response could be developed. The Action Team felt that more work needed to be done in that area, especially on impactors of less than 1 kilometre in diameter. The issue was discussed in detail at the Tunguska Conference, held in Moscow in June 2008, hosted by the Russian Academy of Sciences and attended by a number of Action Team members. The 1908 Tunguska airburst from a small asteroid had generally been estimated to have had an energy of 10 to 15 megatons. The corresponding size for a rocky impactor was roughly 60 metres in diameter. The Action Team noted that Mark Boslough of Sandia National Laboratories, United States, had generated new supercomputer simulations that had suggested a smaller Tunguska explosion. Boslough’s models required less energy in the explosion because of the inclusion of

a substantial downward momentum of the rocky impactor, rather than modelling it as a stationary explosion. If that revision (down to an estimated energy of 3 to 5 megatons and a corresponding diameter of perhaps as little as 40 metres) was correct, the expected frequency of such impacts would change from once every couple of millenniums to once every few hundred years, with consequent implications for hazardous impact event statistics.

D. In situ characterization

20. The Action Team noted the importance of the Hayabusa (MUSES-C) mission, which had rendezvoused with the near-Earth asteroid 25143 Itokawa in late 2005, not only because of the scientific knowledge that had been gained on the characteristics of the asteroid, such as topography and composition, but also because of the important operational lessons that had been learned from rendezvous and proximity operations in a very low gravity environment and because of the implications for future in situ investigations and possible mitigation activities. Hayabusa followed a long line of successful missions, such as Near Earth Asteroid Rendezvous, Deep Space 1, Stardust and Deep Impact, which had provided unique insights into the characteristics of the surprisingly diverse population of NEOs. Detailed NEO characterization could not be derived from remote observations and the Action Team looked ahead with anticipation to the upcoming missions to NEOs.

21. The Action Team was encouraged by the news that the Space Council of the Russian Academy of Sciences and the Russian Federal Space Agency had decided to fund a feasibility study for a low-cost space mission to Apophis in 2013. The major goal of the mission was to put a transponder in a circum-asteroid orbit, thereby improving the accuracy of the Apophis orbit determination. The Action Team welcomed the news that the Planetary Science Division of NASA had also funded a concept study for a low-cost, small-satellite, in situ characterization mission to Apophis during its next apparition, which was expected to occur in 2012 or 2013. The spacecraft would be launched as a secondary payload from a geosynchronous primary mission and rendezvous with Apophis about one year later, during the asteroid’s next approach near the Earth. A suite of miniaturized cameras and other instruments would fully characterize the potentially hazardous asteroid and provide sufficient high-precision ranging data to fully determine the orbit of the asteroid on subsequent close approaches over the following century. NASA had also funded a United States science team to participate in the study and development of the proposed Marco Polo mission of the European Space Agency, a planned sample return mission from an NEO, which was being considered under the Cosmic Vision programme of the European Space Agency.

E. Mitigation

22. Mitigation in this context is the process of either negating or minimizing the impact hazard posed to Earth by the subclass of NEOs called “potentially hazardous objects”, through some form of intervention or interaction with the risk body, or by minimizing its impact on the population through evacuation or a similar response.

23. The Action Team noted that, in addition to the probability of impact and the time to impact, other parameters that would influence the response strategy would be the anticipated locus of intersection on the surface of the Earth and the vulnerability of that area to the impact. The various options for deflection and the implications (technical readiness, political acceptability, cost of development and operation, and translation of locus of intersection) of a particular deflection strategy would also have to be weighed against the alternatives. The Action Team acknowledged that it was possible that a specific impact might threaten only non-spacefaring nations. It might be considered more attractive for one capable actor to take the lead in mounting a particular deflection mission, rather than a group of agencies with different roles, owing to the complexity of the mission and the political expediency of protecting sensitive technical information. The Action Team therefore envisaged a range of options, with agreed responses to a range of impact scenarios and with identified players performing specific roles. In this respect, the Action Team identified the need for an international technical forum wherein a range of probable impactor scenarios could be determined and a corresponding matrix of mitigation options developed to a level of maturation to permit reliable mission timelines to be mapped onto a decision timeline for the international community in response to a specific threat. Further, the Action Team considered that our current state of knowledge was an inadequate basis on which to decide the relative effectiveness of different mitigation strategies, recognizing that while the Deep Impact mission demonstrated some elements of kinetic deflection, the deflection was not measurable owing to the effects of cometary outgassing. Accordingly, the Action Team considered that a true demonstration of kinetic deflection remained to be done, and that the development and execution of mitigation test-missions was a prudent and top-priority goal for the near future, and that they should be carried out with international participation.

24. The Action Team welcomed the work of the Space Generation Advisory Council and its recognition of the importance of the International Year of Astronomy in acting as a framework to raise awareness about NEO issues among the public and, in particular, youth. Among its initiatives, the Move an Asteroid 2009 technical paper competition, held annually since 2008, asks students and young professionals to send in novel proposals on how to deflect an asteroid. The entries are reviewed by experts and the winner of the competition is awarded a trip to present the paper at the Council’s annual Space Generation Congress. The Council intends to continue raising awareness and involving youth in the NEO field, as well as to inform youth about current issues such as the work of the Action Team.

F. Policy

25. The Action Team recognized that the threat of impact posed by NEOs was real and that any such impact, although its probability was low, was potentially catastrophic. It was also recognized that the effects of such an impact would be indiscriminate (that is, it was unlikely that they would be confined to the country of impact) and that the scale of those effects was potentially so great that the NEO hazard should be recognized as a global issue that could be addressed effectively only through international cooperation and coordination. No country was known to

have a national NEO strategy. Thus, the United Nations had an important role to play in informing the process of developing the required policy.

26. A further challenge for the global community is that it will likely be confronted in the next 15 years with a perceived impact threat (though it will most likely turn out to be a near miss), making it necessary to push forward to critical decisions about whether and what action should be taken to protect life on Earth from a potential NEO impact before the reality of the threat is completely understood. This is due to the accelerating discovery of the population of NEOs and the evolution of human capability to intervene in an anticipated impact by proactively deflecting the NEO. The probability of the spacefaring nations having to decide between action and non-action is further heightened by the likely necessity of having to decide prior to the availability of certain knowledge that an impact will or will not occur. The need for decision-making may therefore be significantly more frequent than the incidence of impacts. Given early warning that a possible impact is predicted, and knowing that a deflection capability exists to prevent this impact from occurring, it is recognized that humankind cannot avoid responsibility for the outcome of either action or inaction. Since the entire planet is subject to NEO impact and since the process of deflection intrinsically results in a potential but temporary increase of risk to populations not otherwise at risk in the process of eliminating the risk to all, the United Nations could be called on to facilitate the global effort to evaluate trade-offs and arrive at decisions on what actions to implement collectively.

27. Having recognized the need to advance the NEO decision-making process, the Committee on Near-Earth Objects of the Association of Space Explorers concluded, in September 2008, a series of international workshops and transmitted its widely anticipated report to Action Team 14 (see A/AC.105/C.1/L.298, Annex) The Action Team welcomed this important contribution to a possible NEO policy framework, and recognized its value in informing the workplan of the Working Group on Near-Earth Objects in its review of potential policies related to the handling of the NEO hazard, and its consideration of drafting international procedures for handling such a threat.

28. The Action Team met during the forty-sixth session of the Scientific and Technical Subcommittee of the Committee in February 2009 to review the report of the Association and, as a result, developed a conference room paper (A/AC.105/C.1/2009/CRP.13) in an attempt to build on the recommendations of the report of the Association and prepare a formal document, which would be further reviewed by Member States and the Working Group with a view to developing the international procedures for NEO threat handling, identified in the Working Group’s workplan. During a number of further meetings of the Action Team during the Subcommittee session in February, an informal review of the paper began. The Action Team completed a first review of the document in the margins of the Committee session in June 2009, and the resulting text was presented in annex I to that report. The draft recommendations in the annex will be submitted to the Working Group and Member States for their consideration and review during the forty-seventh session of the Scientific and Technical Subcommittee, to be held in Vienna from 8 to 19 February 2010.

Annex

Draft recommendations for international response to the Near-Earth Object Impact Threat

A. Introduction

1. At its fifty-first session, in 2008, the Committee on the Peaceful Uses of Outer Space noted with satisfaction the work carried out by the Working Group on Near-Earth Objects of its Scientific and Technical Subcommittee and by the Action Team on Near-Earth Objects and endorsed the amended workplan for 2009-2011, under which it was expected, inter alia, to continue to review policies and procedures related to the handling of the Near-Earth Object (NEO) threat at the international level and consider drafting international procedures for handling the NEO threat.[a]

2. The Action Team on Near-Earth Objects[b] convened two open meetings on 16 and 17 February 2009, in the margins of the forty-sixth session of the Scientific and Technical Subcommittee, and convened further open meetings on 3, 4 and 5 June 2009 in the margins of the fifty-second session of the Committee on the Peaceful Uses of Outer Space in order to discuss and review the report of the international Panel on Asteroid Threat Mitigation (PATM) of the Association of Space Explorers (ASE) entitled “Asteroid threats: a call for a global response”.[c] On the basis of the discussions in those meetings, the Action Team has prepared the following draft recommendations for NEO threat mitigation for further discussions in the Working Group on Near-Earth Objects.

Draft recommendations for near-Earth object threat mitigation

1. Background

3. The Committee on the Peaceful Uses of Outer Space established the Action Team on Near-Earth Objects (Action Team 14) in 2001 in response to a recommendation from UNISPACE III with 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 brings it periodically close to the Earth, defined as within 7.5 million kilometres of the Earth’s orbit.

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[a] *Official Records of the General Assembly, Sixty-third Session, Supplement No. 20* (A/63/20), para. 153.

[b] The Action Team on Near-Earth Objects was established in response to recommendation 14 of UNISPACE III and was given the terms of reference that include, inter alia, identifying any gaps in the ongoing work where additional coordination is required and/or where other countries or organizations could make contributions, as well as propose steps for the improvement of international coordination in collaboration with specialized bodies.

[c] http://www.space-explorers.org/committees/NEO/docs/ATACGR.pdf.

4. Since the establishment of Action Team 14, it has become a common understanding among the international community that the Earth's geological and biological history has been punctuated by evidence of repeated and devastating impacts from space, and that NEOs continue to pose an impact risk to humankind. The global nature of the NEO impact hazard and the need for coordinated international response has 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 those 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 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.

5. In 2007, the Working Group on Near-Earth Objects was established by the Scientific and Technical Subcommittee of the Committee in the expectation that international procedures to address the NEO threat would be proposed by the Working Group for consideration by the Committee on the Peaceful Uses of Outer Space. In 2007 and 2008, the Association of Space Explorers convened the 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, ASE submitted its recommendations in a report entitled "Asteroid threats: a call for a global response" to the Action Team on Near-Earth Objects and for consideration by the Working Group on Near-Earth Objects of the Scientific and Technical Subcommittee.

6. Response to the NEO impact hazard requires measures that can be divided in two categories: those that detect, track and characterize the orbital and physical properties of potentially hazardous NEOs; and measures that seek to modify the trajectory of potentially hazardous NEOs to prevent an impact, and/or those that seek to limit the consequences on the ground, e.g. evacuation and other forms of disaster and emergency response.

2. Rationale

7. According to current statistical knowledge, the population of NEOs increases as the size of objects decreases. Within the next decade, advanced telescopes will greatly increase our ability to find the more numerous smaller NEOs and thus will help us to discover a significantly larger number of potentially threatening NEOs. Because NEO collisions can have disastrous effects on our interconnected society and our planet, the international community will need to decide on a necessary response to the threat.

8. Since substantial time is needed to execute a NEO deflection campaign and, in some cases, there may be limited time before the expected impact, a decision will need to be made quickly on what action to take. There may in fact be occasions when the international community will have 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 relevant options become, and the higher the risk that any option finally chosen may have undesirable consequences. In the absence of an agreed decision-making process, it is recognized that 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 impending impact. The prompt adoption of an international programme of coordinated activities and 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 involve established deflection criteria and campaign plans that can be implemented rapidly, without the need for extended debate.

9. Once in place, these measures should enable the global community to identify a specific impact threat and decide on effective prevention or disaster responses. A series of outline recommendations relating to a decision-making programme for a global response to asteroid threats have been developed by PATM. The Committee on the Peaceful Uses of Outer Space 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 developed by PATM and drawing on the basic definitions in its report, and in accordance with the United Nations treaties and principles on outer space.

3. Application

10. 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.

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

12. It is recognized that the implementation of individual recommendations or elements thereof is governed by the provisions of United Nations treaties and principles.

4. Near-Earth object threat mitigation functions

A. Information, analysis and warning

13. Capacities should be established and sustained by, or on behalf of, the international community, with the capability to:

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

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

(c) Provide the internationally recognized clearing-house function for receipt, acknowledgment and processing of all NEO observations;

(d) Assess impact analysis results and communicate them to entities identified by Member States as being responsible for the receipt of notification of an impact threat, which exceeds an established criterion threshold;

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

(f) Assist in the analysis of impact consequences and in the planning of mitigation responses.

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

(a) To receive notification of an impact threat that exceeds an established threshold; and

(b) To take appropriate action in response to this impact threat notification.

B. Monitoring and oversight

15. The Committee on the Peaceful Uses of Outer Space should recommend that appropriate organs of the United Nations establish and mandate an entity to be responsible for monitoring the NEO impact risk and overseeing the corresponding NEO threat response. Specifically, such an entity 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 deflection campaign);

(b) Consideration of decision and event timelines for NEOs identified for preliminary deflection campaign analysis;

(c) Consideration of the recommended process for deflection campaign operational responsibility;

(d) Identification, in cooperation with Member States, of methods to engage designated national/international disaster response entities and exploit existing functions and infrastructures;

(e) Development and maintenance of detailed procedures for the consideration of impact threat scenarios and agreement 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 by the international community to mount a deflection mission;

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

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

C. Deflection campaign planning and operations

16. An inter-agency body should be established by appropriate institutions of the international community, composed of spacefaring nations, whose responsibilities should include:

(a) Recommendation of generic decision and event timelines for NEOs that have the potential to impact the Earth;

(b) Determination of specific decision and event timelines for NEOs that exceed an established threshold;

(c) Recommendation of operational responsibility for both generic and specific deflection campaigns;

(d) Recommendation of policies regarding criteria and thresholds to initiate a deflection campaign;

(e) Assessment of alternative deflection concepts based on feasibility and technical maturity;

(f) Development of specific information required to support deflection campaign planning efforts.