

ET0009

Hazard Type: EXTRATERRESTRIAL

Hazard Cluster: Extraterrestrial

Specific Hazard: Near-Earth Object

Definition

A near-Earth object (NEO) is an asteroid or comet whose trajectory brings it to within 1.3 astronomical units of the Sun and hence within 0.3 astronomical units, or approximately 45 million kilometres, of the Earth's orbit (UN OOSA, no date).

References

UN OOSA, no date. UN-SPIDER knowledge Portal, Near-Earth Objects. United Nations Office for Outer Space Affairs (UN OOSA). www.un-spider.org/disaster-type/near-earth-objects Accessed 14 October 2020.

Annotations

Synonyms

Not identified.

Additional scientific description

The definition above includes objects that will come close to Earth at some point in their future orbital evolution. Near-Earth objects (NEOs) generally result from objects that have experienced gravitational perturbations from nearby planets, moving them into orbits that allow them to come near to Earth.

Metrics and numeric limits

A near-Earth asteroid is said to be a potentially hazardous asteroid when its orbit comes within 0.05 astronomical units of the Earth's orbit and it has a measured absolute magnitude $H < 22$ mag (an estimated diameter greater than 140 meters) (NASA, no date).

Key relevant UN convention / multilateral treaty

The Committee on the Peaceful Uses of Outer Space (COPUOS) was set up by the United Nations General Assembly in 1959 to govern the exploration and use of space for the benefit of all humanity: for peace, security and development (COPUOS, no date). The Committee was tasked with reviewing international cooperation in peaceful uses of outer space, studying space-related activities that could be undertaken by the United Nations, encouraging space research programmes, and studying legal problems arising from the exploration of outer space.

Examples of drivers, outcomes and risk management

The International Asteroid Warning Network (IAWN) was established in 2013 as a result of the UN-endorsed recommendations for an international response to a potential NEO impact threat, to create an international group of organisations involved in detecting, tracking, and characterising NEOs. IAWN is tasked with developing a strategy using well-defined communication plans and protocols to assist governments in the analysis of asteroid impact consequences and in the planning of mitigation responses. Currently, IAWN includes members from Europe, Asia, South and North America (IAWN, 2020).

IAWN has proposed the following definition of an NEO: An asteroid, meteoroid, or a comet as it passes near Earth, enters the Earth's atmosphere, and/or strikes the Earth, or provokes changes in inter-planetary conditions that affect the Earth's magnetosphere, ionosphere, and thermosphere. The criteria and thresholds related to this definition are as follows (UN OOSA, no date):

- The probability that an NEO will impact Earth (either 1% for warning and 10% for terrestrial preparedness planning).
- The probable size, or at least its luminosity in the night sky (greater than 10 meters or at least absolute magnitude 28).
- How far in the future the NEO will impact Earth (20 years).

The European Space Agency's (ESA) Space Situational Awareness (SSA) programme partners with many countries, organisations and individuals. In particular, it has strong links to COPUOS, which facilitates the Space Mission Planning Advisory Group (SMPAG) and IAWN. SMPAG and IAWN were both established in response to the need for an international response to the threat of NEO impacts. SMPAG coordinates the technological know-how of agencies, including ESA, recommending specific responses to asteroid threats, including basic research and development, impact mitigation measures and deflection missions. Depending on the capabilities and specific technologies available to each agency, options are made to ensure the best use of skills within each organisation. ESA's primary projects are the SSA programme – in particular, the dedicated NEO segment, mapping of threat scenarios to mission types, as well as AIM – ESA's Asteroid Impact Mission (ESA, 2018).

IAWN and SMPAG have agreed on the following criteria and thresholds for impact-response actions:

1. IAWN shall warn of predicted impacts exceeding a probability of 1% for all objects characterised to be greater than 10 meters in size, or roughly equivalent to absolute magnitude of 28 if only brightness data can be collected.

Rationale: Impact probabilities greater than 1% are rare. Most objects greater than 10 meters in size will have effects (air blast and pieces) that could reach the Earth's surface. IAWN is compelled to warn populations if bodies will have effects that reach the ground. Setting the threshold at 1% is a compromise between not being overly alarmist and not warning too late for necessary action to be initiated. It is a probability figure that individuals and governments can comprehend. An alert such as this demonstrates that the IAWN is functioning. Further, it ensures the flow of communication from IAWN to the public and the United Nations.

2. Terrestrial preparedness planning is recommended to begin when warned of a possible impact is predicted to be within 20 years; the probability of impact is assessed to be greater than 10%; and the object is characterised to be greater than 20 meters in size, or roughly equivalent to absolute magnitude of 27 if only brightness data can be collected.

Rationale: Terrestrial preparedness and the increased potential for impact will also involve determination of a 'risk corridor' from objects with 10% impact probabilities and impacts in less than 20 years. This provides populations and population centres on Earth with information to begin preparations for emergency preparedness if needed. The surprising effects of the Chelyabinsk event in 2013 from an object ~18 meters in size, in turn led to the establishment of a lower limit (20 meters) in these threshold criteria.

3. SMPAG should start mission option(s) planning when warned of a possible impact predicted to be within 50 years; where the probability is assessed to be greater than 1%; and if the object is characterised to be greater than 50 meters in size, or roughly equivalent to absolute magnitude of 26 if only brightness data can be collected.

Rationale: Several decades warning, if available, enables sufficient lead time to mount characterisation missions. If a 1% probability on a 100-meter object is assessed, SMPAG will be informed immediately following verification of the precise orbit. Part of such a characterisation mission would likely deploy a transponder with the object.

References

COPUOS, no date. Committee on Peaceful Uses of Outer Space. United Nations Office for Outer Space Affairs. www.unoosa.org/oosa/en/ourwork/copuos/index.html

ESA, 2018. Space Mission Planning Advisory Group (SMPAG). European Space Agency (ESA). <https://sdg.esa.int/activity/space-mission-planning-advisory-group-smpag-4311> Accessed 15 October 2020.

IAWN, 2020. 'IAWN's functions are:' International Asteroid Warning Network (IAWN). <http://iawn.net/about.shtml> Accessed 15 October 2020.

NASA, no date. NEO Basics. National Aeronautics and Space Administration (NASA). https://cneos.jpl.nasa.gov/about/neo_groups.html

UN OOSA, no date. UN-SPIDER knowledge Portal, Near-Earth Objects. United Nations Office for Outer Space Affairs (UN OOSA). www.un-spider.org/disaster-type/near-earth-objects Accessed 14 October 2020.

Coordinating agency or organisation

World Meteorological Organization (WMO) in collaboration with other space weather organisations.