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PLANETARY DEFENSE INTERAGENCY TABLETOP EXERCISE 4

Read-ahead information for Planetary Defense Interagency Tabletop Exercise 4

This tabletop exercise (TTX) will inform and assess our nation's ability to respond effectively to a (simulated) asteroid impact threat. It will include a diverse set of federal, state, and local agencies and exercise many aspects of a potential asteroid impact (initial detection, uncertainty, notification, potential mitigation, ground preparation, and ground recovery). This will be the first effort at an end-to-end exercise for this type of disaster.

This document briefly summarizes planetary defense and the exercise scenario. The organizers encourage participants to read this short document, consider their agency's potential role and responsibilities, and think about how they may contribute to the discussions and decisions that are integral to the exercise.

What is planetary defense?

Planetary defense encompasses all the capabilities needed to detect and warn of potential asteroid or comet impacts with Earth, and attempt to either prevent them or mitigate their possible effects. Planetary defense involves:

- Finding and tracking near-Earth objects (NEOs) that pose a hazard of impacting Earth. NEOs are asteroids and comets that orbit the Sun like the planets, but their orbits can bring them into Earth's neighborhood.
- Characterizing each NEO to determine its trajectory, size, shape, mass, composition, rotational dynamics, and other parameters to assess the likelihood and severity of a potential Earth impact, warn of its timing and potential effects, and determine possible means to mitigate the impact.
- Planning and implementation of measures to deflect or disrupt (break up) an object on an impact course with Earth, or to mitigate the effects of an impact if it cannot be prevented. Mitigation measures that can be taken on Earth to protect lives and property include evacuation of the impact area and movement of critical infrastructure.

NASA established the Planetary Defense Coordination Office (PDCO) to manage the elements of its ongoing mission of planetary defense.

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This is a simulated event.

What is the hypothetical asteroid threat scenario for this TTX?

Astronomers discover an asteroid, designated 2022 TTX, that might impact the Earth in 6 months. As the exercise unfolds, it becomes clear that the asteroid will indeed impact Earth and is large enough to cause substantial regional damage. The asteroid size, and therefore its impact energy and the detailed damage it would cause, remains highly uncertain until just days before impact. The timeline below illustrates the events that occur before the first day of the TTX.

11 February 2022
Astronomers discover a previously unknown near-Earth asteroid.

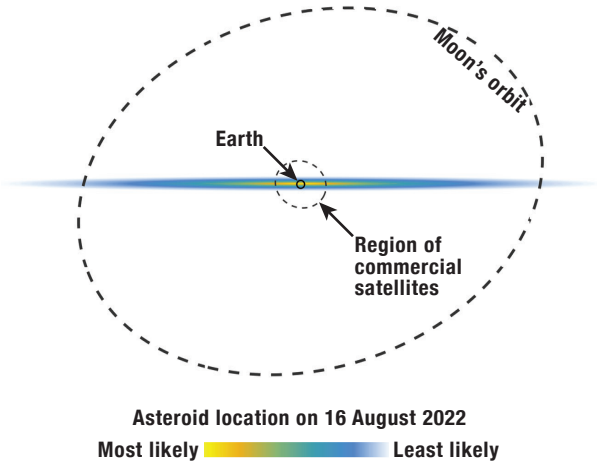

Figure 1. Asteroid's future position uncertainty as of 16 February 2022. The colored region illustrates the area in space in which the asteroid could be on 16 August 2022. The probability of Earth impact is 5%.

16 February 2022
After 6 days of tracking the asteroid, the impact probability has risen to 5%. The predicted position of the asteroid on the potential impact date is still very uncertain (Figure 1), but 5% of possible trajectories intersect the Earth, some of them within the CONUS.

The asteroid is just a point of light in the sky, and its size is highly uncertain. It could range anywhere from 40 to 400 meters (~100–1000 feet). Depending on its true size, if the asteroid struck a populated area, the effects could range from broken windows to widespread injuries/casualties and structural damage over a region extending tens to 100+ kilometers (~6 to 60+ miles) with localized, unsurvivable blast waves.

The impact probability and asteroid size now exceed the threshold to begin planning space mission options as defined in the *Report on Near-Earth Object Impact Threat Emergency Protocols*.

The exercise will consist of four modules. Each module covers a different period of time and focuses on different aspects of the exercise scenario. Figure 2 shows the locations of the asteroid and the Earth during each module. Module 1 is set on the first day of the TTX. For the sake of the exercise, modules 2–4 jump to the dates shown in the timeline below.

In reality, the information listed for modules 2–4 would not be known in advance. Participants should remember that decisions must be made in the face of very limited information and large uncertainties.

Module 1:
Mitigation Options
23 February 2022 (6 months to go)
New observations show that the asteroid has a 70% chance of impact, potentially in the CONUS.

Want to learn more about planetary defense and the asteroid threat? Visit www.nasa.gov/planetarydefense or click here to watch a short set of videos provided by NASA.

Want additional details on the TTX asteroid scenario? Visit cneos.jpl.nasa.gov/pd/cs/ttx22

Module 2:
Early Preparedness
15 June 2022 (2 months to go)
New data reveal that the asteroid will impact North Carolina. The size of the asteroid is still uncertain.

Module 3:
Final Preparedness & Readiness
10 August 2022 (6 days to go)
Radar data show that the impact will occur near Winston-Salem, NC. The radar data finally reveal the true size of the asteroid.

Module 4:
Response & Transition to Recovery
16 August 2022 (impact)
The asteroid has impacted near Winston-Salem, NC.

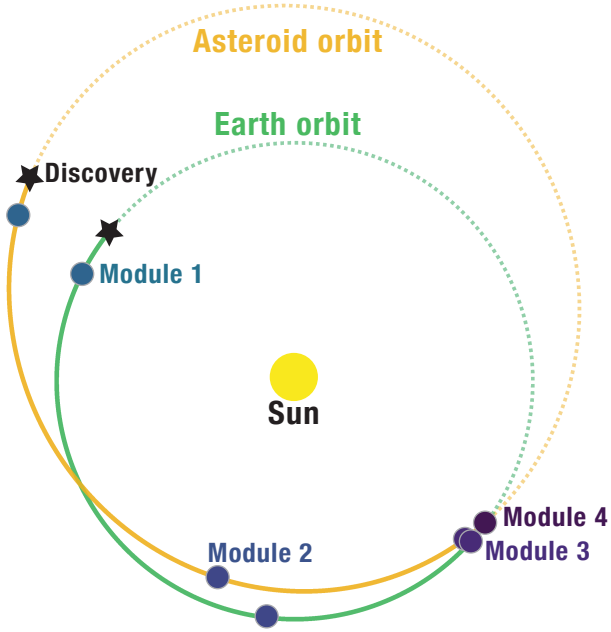

Figure 2. Orbits of Earth and asteroid around the Sun. The solid arcs are the orbital paths traversed during the time between asteroid discovery and impact. Colored dots mark the locations of the Earth and asteroid for each module. Black stars mark the Earth's and asteroid's locations at the time the asteroid was discovered.

What is the nation's planetary defense strategy?

The *National Near-Earth Object Preparedness Strategy and Action Plan* (2018) outlines the nation's strategy. The *Report on Near-Earth Object Impact Threat Emergency Protocols* (2021) provides decision criteria for notifications and actions based on asteroid size, probability of impact, warning time, and feasibility. The organizers encourage participants to review these documents. They can be accessed here:

www.nasa.gov/sites/default/files/atoms/files/ostp-neo-strategy-action-plan-jun18.pdf
www.nasa.gov/sites/default/files/atoms/files/neo-impact-threat-emergency-protocols-jan2021.pdf

Have asteroid impacts caused damage?

Yes. On 15 February 2013, a previously undetected, tiny asteroid exploded over Chelyabinsk, Russia, causing an airburst and shockwave that struck six cities around the region (Figure 3). The blast injured >1600 people and caused an estimated $30 million in damage. The Chelyabinsk object was about 60 feet (18 meters) in size. The hypothetical asteroid in the exercise is known to be much larger. Larger asteroid impacts lead to graver consequences.

Figure 3. Asteroid airburst over Chelyabinsk, Russia.

How often do asteroids impact the Earth?

The chart below shows about how often asteroids of different sizes impact the Earth, the associated consequences, and the percent discovered. Astronomers estimate that there are ~25,000 NEOs roughly 500 feet (140 meters) or larger in size—big enough to cause regional devastation if they were to impact Earth. Only about 40% of those asteroids have been found to date. No currently known asteroid has a significant chance to impact Earth for the next 100 years. But, given the large numbers of NEOs yet to be discovered, an unpredicted impact could occur at any time.

	10 meters	50 meters	140 meters	1000 meters	10,000 meters
How Big?					
How Often?	~1 per **decade**	~1 per **1000 years**	~1 per **20,000 years**	~1 per **700,000 years**	~1 per **100 million years**
How Bad?	Very bright fireball, strong sonic boom could break windows if close to habitation	Local devastation, regional effects, may or may not leave an impact crater	Crater of 1-2 kilometer diameter, deadly over metro areas/states, mass casualties	10-kilometer crater, global devastation, possible collapse of civilization	100-kilometer crater, global devastation, mass extinctions of terrestrial life
Approx. impact energy (megatons)	0.1	10	300	100,000	100,000,000
How Many?	**~45 million**	**~120,000**	**~25,000**	**~900**	**4**
% Discovered	**0.03%**	**7%**	**40%**	**95%**	**100%**

What kinds of damage could the hypothetical asteroid cause?

While most asteroids explosively disintegrate in the atmosphere, some may make it all the way to the ground and form an impact crater. The outcome depends on an asteroid's size and other properties. Either way, the event would create a blast wave and, potentially, thermal effects. The damage caused by this asteroid will be revealed as the TTX unfolds. The table below provides a sense of the degrees of damage that may occur. Figure 4 shows an example map of damage levels. Damage is assessed at four severity levels, with each level affecting different fractions of the population within a region.

Damage Level	Affected Population	Potential Effects
Serious	10%	Shattered windows, minor structural damage, and/or potential 2nd degree burns
Severe	30%	Widespread structural damage and/or potential 3rd degree burns
Critical	60%	Most residential structures collapse and/or clothing ignition
Unsurvivable	100%	Complete blast devastation and/or structure ignition

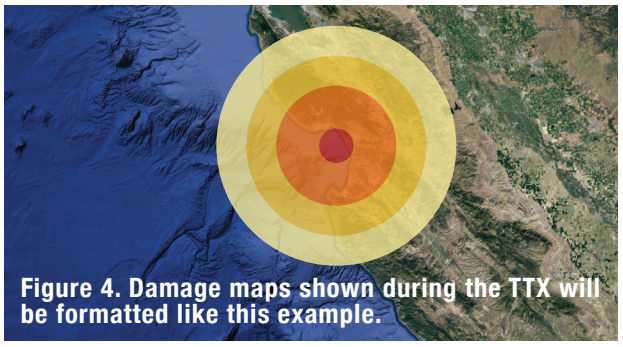

Figure 4. Damage maps shown during the TTX will be formatted like this example.