National Aeronautics and
Space Administration

Hold for Release Until
Presented by Witness

March 19, 2013

Committee on Science, Space and Technology

U.S. House of Representatives

Statement by:
Charles Bolden
Administrator

113th Congress

HOLD FOR RELEASE
UNTIL PRESENTED
BY WITNESS
March 19, 2013

Statement of
Mr. Charles Bolden
Administrator
National Aeronautics and Space Administration

before the

Committee on Science, Space, and Technology
U.S. House of Representatives

Mr. Chairman and Members of the Committee, thank you for the opportunity to appear today to discuss the topic of Near Earth-Objects (NEOs). NEOs are defined as those non-manmade objects in space whose orbits bring them within 1.3 Astronomical Units of the Sun, or to a set distance to the Earth's orbit that is generally equivalent to approximately 50 million kilometers (31 million miles).

The events of February 15, 2013 were a stark reminder of why NASA has for years devoted a great deal of attention to Near Earth Objects and why this hearing is so timely and important. The predicted close approach of a small asteroid, called 2012 DA14, and the unpredicted entry and explosion of a very small asteroid about 15 miles above Russia, have focused a great deal of public attention on the necessity of tracking asteroids and other NEOs and protecting our planet from them -- something this Committee and NASA have been working on for over 15 years. The events of February 15th also highlight the wisdom of the Congress, the Administration and NASA in enabling the human exploration of an asteroid.

The new public attention is not hard to understand. The coincidence of having these two very rare events, happening on the same day, along with the unfortunate injuries to over 1,000 people on the ground in Russia, made this a very big news story. However, we should remember that the probability of any sizable NEO impacting the Earth anytime in the next 100 years is extremely remote. The small fraction of objects we have discovered which do have the potential to impact the Earth are tagged by the Minor Planet Center as Potentially Hazardous Objects (or PHOs) and are subjected to further study and observation to assess just how hazardous they may be. Smaller objects, such as the recent impact in Russia, will always be difficult to detect and provide adequate warning; however, progress will be made over the next decade in this area as well.

To put these two recent events in context, very small objects enter the Earth's atmosphere all the time. The larger NEOs (those with a maximum physical dimension of more than a meter) are generally referred to as either asteroids or comets, while smaller objects are referred to as meteoroids. Current estimates are that on average about 100 tons of material in the form of dust grains and small meteoroids enter the Earth's atmosphere each day. Objects the size of a basketball arrive about once per day, and objects as large as a car arrive about once per week. Our Earth's atmosphere protects us from these small objects, so nearly all are destroyed before hitting the ground and generally pose no threat to life on Earth.

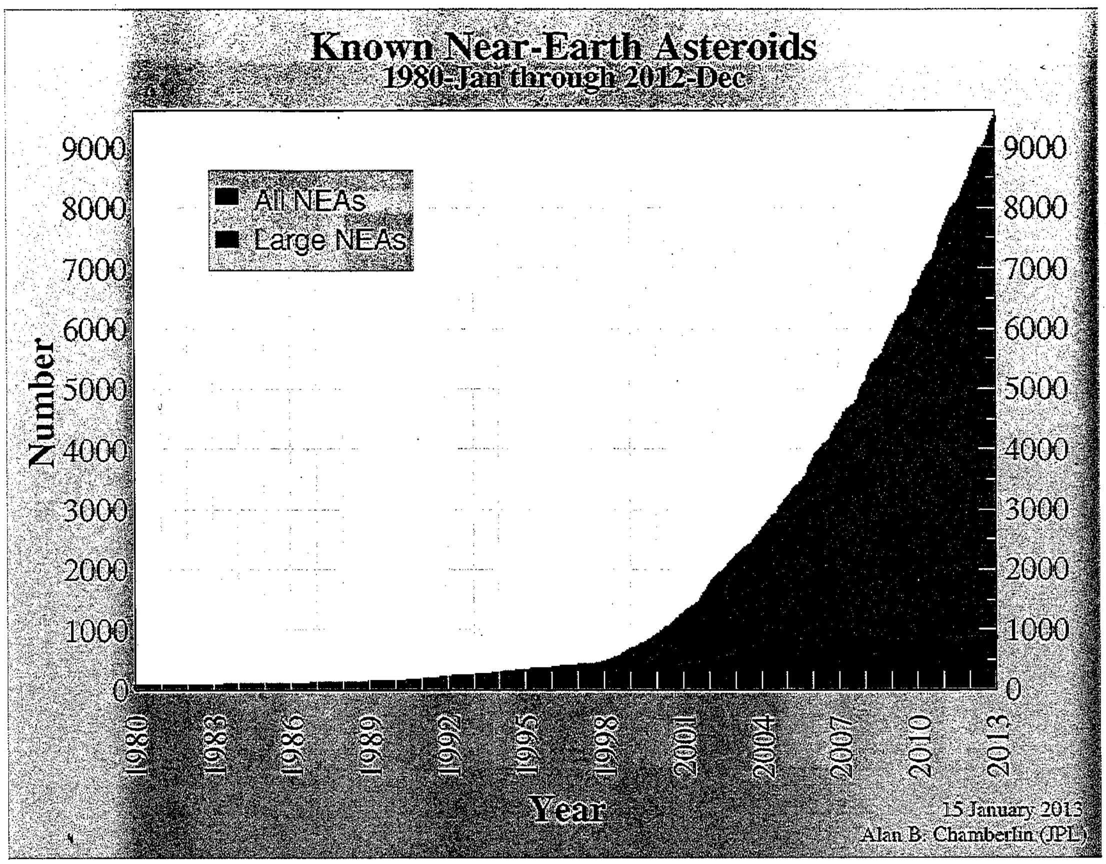
However, while objects the size of the one that exploded over Russia, which we have assessed as a rocky asteroid about 17 meters in diameter and weighing from 7,000 to 13,000 metric tons, enter the Earth's atmosphere very rarely on human timescales, they do have serious consequences. NASA has been at the forefront in leveraging our own resources, as well as interagency, international, academic and commercial partnerships, to study both these rare and more common NEO close approach events, and to expand our knowledge about NEOs and the potential threat they pose to the Earth. The 2010 National Space Policy specifically directs NASA to take a leadership role to "pursue capabilities, in cooperation with other departments, agencies, and commercial partners, to detect, track, catalog, and characterize near-Earth objects to reduce the risk of harm to humans from an unexpected impact on our planet and to identify potentially resource-rich planetary objects."

NASA leads the world in the detection and characterization of NEOs, and is responsible for the discovery of about 98 percent of all known NEOs. Over 15-plus years of collecting data on NEOs has helped to shape the scientific consensus about these objects and the potential threat they pose to the Earth. NASA is leading a wide array of activities related to NEOs, including a long-standing ground-based observing campaign, focused flight missions to study both asteroids and comets, as well as conceptual studies and technology development to improve our ability to find NEOs. NASA uses radar techniques to better characterize the orbits, shapes, and sizes of observable NEOs, and funds research activities to better understand their composition and nature. NASA also funds the key reporting and dissemination infrastructure that allows for world-wide follow-up observations of NEOs as well as research related activities, including computer modeling, sample analysis and workshops to disseminate information about NEOs to the larger scientific and engineering community. Consistent with NASA's role as outlined in President's National Space Policy, NASA continues to collaborate with the Executive Office of the President and the Department of Defense on planning and exercises for responding to future hazardous NEOs.

NASA is also developing new vehicles and capabilities, including the Orion Multi-Purpose Crew Vehicle and the Space Launch System, which will enable human exploration of the solar system beyond low Earth orbit. As the President stated in his April 15, 2010, speech at the Kennedy Space Center, NASA's intention is to "[send] astronauts to an asteroid for the first time in history." NASA is working to accomplish this mission by 2025. This mission, and the vital precursor activities that will be necessary to ensure its success, should result in additional insight into the nature and composition of NEOs and will increase our capability to approach and interact with asteroids.

Detection-related Activities
NASA was tasked by Congress in 1998 to catalog 90 percent of all the large NEOs (those of 1 kilometer or more in size) within 10 years; these would be large enough that should they strike Earth, it would result in a global catastrophe. NASA worked with a number of ground-based observatories and partners as part of our Spaceguard survey to reach that goal; NASA has now catalogued an estimated 95 percent of all NEOs over 1 km in size. None of these known large NEOs pose any threat of impact to the Earth anytime in the foreseeable future.

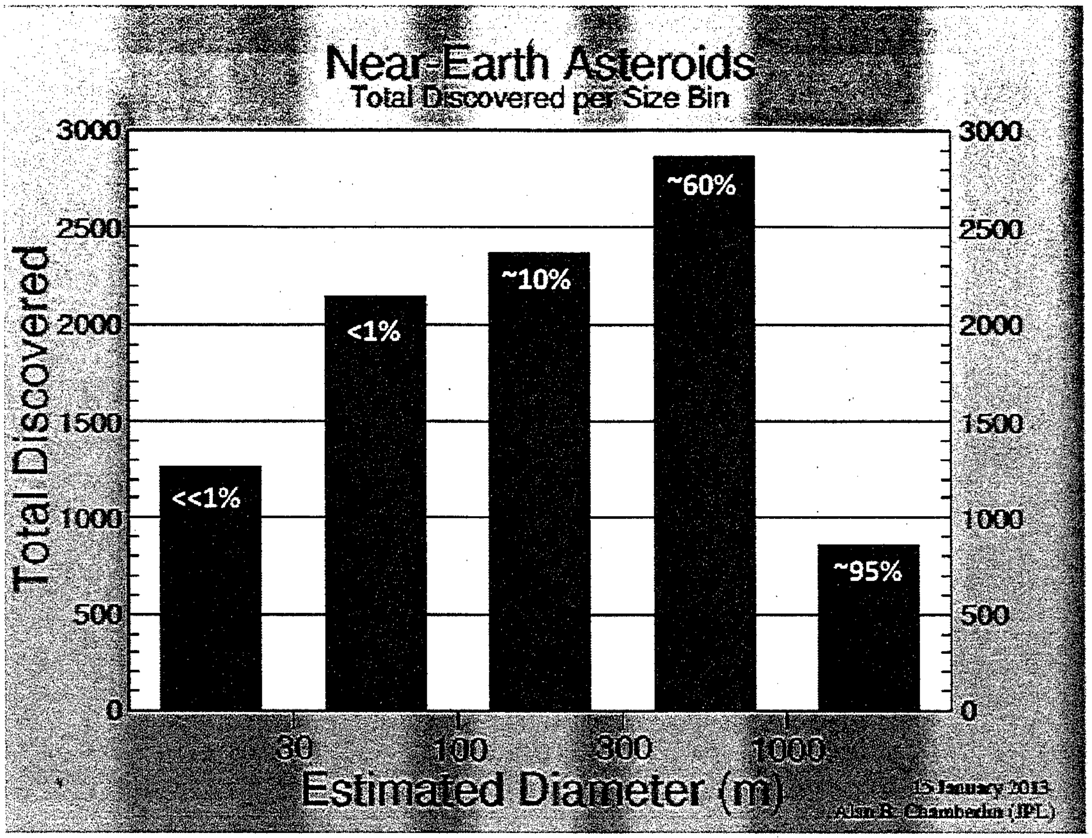
As shown in the next graphic, the cumulative discovery of Near-Earth Asteroids, the largest subset of NEOs, started picking up dramatically in 1998 with the start of NASA's Spaceguard search program and the number of known NEOs has grown from a few hundred to nearly 10,000 in just 15 years.



In 2005, as part of the NASA Authorization Act of 2005 (P.L. 109-155), Congress also directed NASA to initiate the George E. Brown, Jr. Near-Earth Object Survey, to "detect, track, catalogue, and characterize the physical characteristics of near-Earth objects equal to or greater than 140 meters in diameter" and set a goal for this program to achieve 90 percent completion by 2020. That effort is underway. NASA's NEO Observation Program currently funds three survey teams that operate five ground-based telescopes involved in the NEO search effort. Each team conducts independent operations for 14 to 20 nights per month, as weather permits, avoiding approximately a week on either side of the full moon when the sky is too bright to detect these extremely dim objects from the ground.

NASA also leveraged its investment in the Wide-field Infrared Survey Explorer (WISE) spacecraft to discover NEOs. WISE was designed originally as an astrophysics mission that would scan the entire sky in infrared light to study the coolest stars and the universe's most luminous galaxies. After completion of its astrophysics mission, WISE's operations were extended specifically as a NEO-finding mission. NASA made investments, referred to collectively as NEO-WISE, to adapt existing software, add data pipelines, and to put in place data collection, archive and retrieval software for the new NEO-WISE database. Overall, NASA's investments in NEO-WISE resulted in the discovery of 146 previously unknown objects, including 129 near-Earth asteroids, of which 21 are Potentially Hazardous Objects, and 17 comets.

As noted in the following graphic, NASA continues to make progress toward the goals of the George E. Brown, Jr. Near-Earth Object Survey. To date, over 9,600 Near-Earth Asteroids of all sizes have been found. In addition to the 95 percent of NEOs over 1 km in size, our current estimate is that we have also found about 60 percent of the NEOs that are between 300 meters and 1 km.



Risk Assessment and Characterization
Observations from all observatories around the world are sent to the international "clearinghouse" for small body observation data, the Minor Planet Center (MPC). The MPC maintains the database of observations and orbits on all known small bodies (asteroids, comets, dwarf planets, Kuiper Belt Objects, etc.) in the Solar System. It is funded by NASA and hosted by the Smithsonian Astrophysical Observatory's Center for Astrophysics. The MPC verifies and validates the observations by determining if they are of an already known object (by comparing them to the known orbits), or are indeed a new discovery. The MPC then determines and publishes an initial orbit for the new discovery so that observatories world-wide may look for the object and confirm its existence.

Once a new object's orbit is secured, its potential for impacting the Earth is assessed. As mentioned previously, well over 99 percent of all objects discovered have no potential for Earth impact even over many thousands of years, but the small fraction which do have some potential are tagged as PHOs by the Minor Planet Center. More detailed and refined analyses of a PHO's orbit, and an assessment of the risk posed by a particular object, are conducted by NASA's NEO Program Office at the Jet Propulsion Laboratory (JPL). Observations on PHOs are automatically forwarded to JPL and their orbits updated with high-precision analysis to determine a level of probability of the object impacting the Earth in the next 100 to 200 years. The results of this analysis are routinely updated and published on the NEO Program website at http://neo.jpl.nasa.gov.

When an NEO passes close enough to the Earth to be scanned by ground-based radar, NASA funds targeted radar observations. When an object passes close enough to the Earth to achieve a measurable radar return (about 20 million miles depending on the size), this allows NASA to obtain additional information about these objects. As was the case with 2012 DA14, the primary facility currently being used by NASA for routine planetary radar is NASA's own Goldstone facility, part of our Deep Space Network (DSN). NASA also uses the National Science Foundation's (NSF) Arecibo Radio Telescope facility for planetary radar observations. There are significant differences with the planetary radar capability at Arecibo compared to Goldstone. The Goldstone radar is a 70-meter steerable dish, allowing it to access objects significantly lower to the horizon than the more limited sky area accessible to the Arecibo radar. However, Arecibo is twice as powerful as Goldstone and has a much larger (304 meter) collection dish, which allows it to observe objects significantly farther away than Goldstone. Each plays an important role in the quick refinement of the orbit to a precision not obtainable by other means, and for understanding the object's size, shape and rotation rate. They can also aid in the detection of possible binary objects (~15 percent of NEOs), which in turn provides data that can be used to determine their mass.

NASA's NEO Observation (NEOO) Program has initiated development of several additional capabilities to the NEO detection network, with the recent additional funding it received starting in FY2012. Some of these involve collaboration on projects with the Defense Advanced Research Projects Agency (DARPA) and the U.S. Air Force, such as background detection of asteroids by the new Space Surveillance Telescope (SST), which is on track to start routinely providing observations this year. There is also the planned augmentation of the Panoramic Survey Telescope & Rapid Response System or Pan-STARRS facility with a second aperture. The wide field of view survey capabilities of these two assets are expected to provide a significant increase in NEO detection rate.

An important new development project that was started last year is the Asteroid Terrestrial-impact Last Alert System Project, or ATLAS Project. NASA's NEOO program has funded a five-year grant to the University of Hawaii to develop this innovative system. It will couple modest-sized, commercially-available telescopes with custom charge-coupled device cameras and rapid sky survey software to cover the entire available sky each night, detecting any asteroid bright enough to be seen by its detectors. ATLAS will find 100-meter sized asteroids millions of miles away, and smaller objects as they come closer to the Earth. It could provide days to weeks of warning of an object tens of meters in size that is on an impact trajectory with Earth. The prototype system is planned to begin sky testing by the end of calendar year 2014.

However, ATLAS, like SST and Pan-STARRS, will still be limited to the night sky and by weather. The only way to overcome these impediments is to use the vantage point of space. This is the idea behind a privately funded effort by the B612 Foundation to build a space observatory called Sentinel. NASA is providing B612 technical and operations assistance through a Space Act Agreement. Sentinel is being designed to find 100-meter sized objects and larger that could come near Earth's orbit.

To find the more numerous smaller asteroids near Earth, NASA also is investigating development of an instrument that could be hosted on geo-synchronous platforms such as communications, TV broadcast or weather satellites. This instrument would be a modest-sized, wide field telescope with detectors that operate in the infrared bands where these faint asteroids are more easily detected against the cold background of space. Though limited by the telescope size that can be hosted by a commercial geo-satellite, such a capability shows promise to increase the detection rate of near Earth asteroids. We plan to initiate this project with an instrument solicitation later this year. The NASA Science Mission Directorate is testing detectors initiated in its Discovery Program that may be used in such a hosted asteroid detection telescope.

And, to further leverage international capabilities, NASA has been a leading participant in the NEO activities of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS). Over the past several years, a working group on NEOs under the UNCOPUOS Scientific and Technical Subcommittee has been examining the topic of Earth-threatening NEOs. Results of that work led to recommendations this year, endorsed by the Subcommittee, to broaden and strengthen the international network to detect and characterize NEOs, and to call for relevant national space agencies to form a group focused on designing reference missions for a NEO deflection campaign. NASA has been at the forefront of these activities and will continue to take on that role.

Reconnaissance Activities

NASA's remote ground-based observations of comets and asteroids have been augmented by close-up reconnaissance data from the agency's science missions. Since the main asteroid belt located between the orbits of Mars and Jupiter is the source of NEOs, it is important to study it to fully understand these objects. NASA's Galileo spacecraft flew by and studied the main-belt asteroids Gaspra in 1991 and Ida in 1993 on its way to Jupiter. NASA's Near Earth Asteroid Rendezvous or NEAR mission (later renamed NEAR Shoemaker) flew by the main-belt asteroid 253 Mathilde in 1997, and beginning in 1988 flew by, then orbited, and in 2001 landed on the near-Earth asteroid 433 Eros. NASA is cooperating with the European Space Agency on its Rosetta mission, which encountered the main-belt asteroids 2867 Šteins in 2008 and 21 Lutetia in 2010, and is scheduled to rendezvous and land on the Near-Earth comet 67P/Churyumov–Gerasimenko next year. NASA's Deep Space-1 spacecraft flew by a small Mars crossing asteroid, 9969 Braille, in 1999. NASA's Stardust spacecraft flew by the main-belt asteroid 5535 Annefrank in 2002. NASA's Deep Impact mission was specifically designed to impact and observe the effects on a comet. After imaging the comet Temple 1 in July 2005, the larger "flyby" spacecraft pointed high-precision tracking telescopes at the comet and released the "impactor" spacecraft into the comet's path for a planned collision. NASA's Stardust spacecraft later flew by Tempel 1 in February 2011, to further study what happened after the impact. NASA collaborated on Japan's Hayabusa mission which in 2010 successfully returned a small amount of samples from its 2006 encounter with the near-Earth asteroid 25143 Itokawa; 10 percent of these microscopic samples will be available for research by U.S. scientists as a result of NASA's agreement with the Japan Aerospace Exploration Agency (JAXA).

Most recently, NASA's Dawn spacecraft spent a year orbiting and observing the large main-belt asteroid 4 Vesta. Dawn provided close-up views of Vesta and unprecedented detail about the giant asteroid. Dawn's observations confirmed that the asteroid had completely melted in the past, forming a layered body with an iron core. The spacecraft also revealed the collisions Vesta suffered in its southern hemisphere. The asteroid survived two colossal impacts in the last 2 billion years. Without Dawn, scientists would not have known about the dramatic troughs sculpted around Vesta, which are ripples from the two south polar impacts. Dawn departed Vesta last August, and is now on its way to its planned rendezvous in 2015 with Ceres, the only dwarf planet in the inner solar system and the largest asteroid, so large that it is estimated to contain a third of the mass of the entire main asteroid belt.

These reconnaissance missions have greatly redefined what we know about asteroids and comets. These missions have observed asteroids that are binary systems, like Ida and Dactyl, where two objects travel together through space orbiting each other, which provides us insight into how these objects are formed and provide challenges for getting close to them. They have visited asteroids with primitive compositions that teach us about the origin of our solar system, and others that have undergone many of the same processes as terrestrial planets, providing a mirror for understanding our own. For example, data from our NEAR/Shoemaker mission suggests that Eros is a cracked but solid rock, probably a fractured chip off a larger body, made of some of the most primitive materials in the solar system. Judging from the meteorites, we have many more interesting varieties to visit in the future, from asteroids made of solid iron nickel alloys, to cosmic rubble piles, having collected bits and pieces over time and are only loosely connected.

A significant part of NASA's exploration of asteroids is to characterize the variety of asteroid composition and other characteristics that have both fundamental science value and provide critical information to inform the potential risk of PHOs. To this end, NASA is moving toward confirmation later this year for the Agency's planned asteroid rendezvous and sample return mission, dubbed OSIRIS-REx (for Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer) that is planned to launch in 2016. After traveling three years, OSIRIS-REx will approach a near Earth asteroid, currently named 1999 RQ36, in 2019. 1999 RQ36 is believed to be the most exciting, accessible, volatile and organic-rich remnant currently known from the early Solar System; it also is thought to have abundant regolith (a blanket of loose materials covering rock), comprised of fine gravel that is ideal for collecting a sizable sample. With this sample, scientists will be able to analyze the asteroid's composition, mineralogy and geology to learn more about it and other organic-rich B-type asteroids. Once within three miles of the asteroid, the spacecraft will begin six months of comprehensive surface mapping. The science team then will pick a location from where the spacecraft's arm will take a sample of between 60 and 1000 grams (up to 2.2 lbs) for return to Earth in 2023. The careful study of 1999 RQ36 will permit scientists to fully understand the context in which the sample was selected, which should greatly increase the scientific value of the sample. NASA recently sponsored a contest for students worldwide to re-name 1999 RQ36 and draw attention to the important issues surrounding NEOs. The contest deadline was December 2, 2012, and we anticipate announcing a winner in the coming months.

NASA is also in discussions with our international partners to collaborate on several missions or mission concepts that could, in the future, grant access to U.S. researchers to valuable data on asteroids. NASA is working with JAXA on potential collaboration on the Japanese-led Hayabusa II mission. NASA is also discussing with the European Space Agency potential collaboration on two of their mission concepts: 1) the Marco-Polo-R mission concept which is focused on returning a sample from a primitive near-Earth asteroid in the late 2020s, and, 2) the Asteroid Impact and Deflection Assessment (AIDA) mission concept that could be used to study the binary asteroid system Didymos with two spacecraft and see if a small interceptor can affect any the change in the relative orbit of the two bodies.

Finally, NASA is working to accomplish an astronaut visit to an asteroid by 2025. This mission, and the vital precursor activities that will be necessary to ensure its success, should result in additional insight into the nature and composition of NEOs and will increase our capability to approach and interact with asteroids.

Conclusion

NASA has a long history of observing comets and asteroids but as their importance has become apparent as potentially hazardous objects, NASA has significantly increased its program of detection, reconnaissance, and characterization. NASA's current program utilizes extensive ground-based telescope observations in partnership with academia, U.S. Air Force, the National Science Foundation, and many international groups as well. We have a nearly complete understanding of our largest NEO population. NASA has determined that it is unlikely that the world will suffer a global catastrophic impact over the next several hundred years similar to the dinosaur extinction event. We are making marked progress in assessing the risk to our planet from smaller objects that could produce regional disasters. NASA is regularly reevaluating the risk to our planet and constantly updating our knowledge of the NEO population. Smaller objects, such as the recent impact in Russia, will always be difficult to detect and provide adequate warning; however, progress will be made over the next decade in this area as well.

Again, thank you for the opportunity to testify today, and I look forward to responding to any questions you may have.